AN EXPLORATION ON THE STRATEGIC ELEMENTS ENSURING E-RETAILERS' HOME DELIVERY PERFORMANCE – A PERCEPCEPTION FROM CONSUMER'S PERSPECTIVE IN AN EMERGING MARKETPLACE

Chengbo Wang[1], Jun Wang[2] and Baomin Qi[3]
[1]Oxford Brookes University, Oxford, UK
[2]Guangdong University of Foreign Studies, Guangzhou, China
[3]University of Bolton, Bolton, UK

Introduction and background of the research

In recent years, E-commerce has been widely implemented in industries (Power et al., 2010; Yang, et al., 2006), especially in the retail sector in both developed and developing countries; many E-retailers are harnessing their profit by conducting their businesses on-line (Chang et al., 2013; Lockwood, 2013).

An emerging market – China, has a large on-line shopping consumer population (Chang et al., 2013; Lockwood, 2013), and is a profitable and highly attractive marketplace for E-retailers domestically and internationally. However, there are still E-retailers failing to survive well in this marketplace (CYONE, 2013; Liu and Xu, 2010), even though these E-retailers work hard to maintain the effectiveness of their operations. Therefore, there is a need to investigate on what strategic factors can drive E-retailers' success in the marketplace. Among the strategies applied by E-retailers, home delivery strategy has tight relationship with customer satisfaction and retention, and is one of the critical success factors (Benady, 2013; Sebastianelli and Tamimi, 2013). Based on the contention from Asdemir et al. (2009) and Punakivi and Saranen (2001), home delivery in this paper is defined as: through their own logistics service and/or third party logistics providers, E-retailers deliver goods ordered on-line to customers' home address or a destination per their preference.

E-retailers have already paid much attention to the efficiency and effectiveness of home delivery, demonstrated by the various offers and promises of delivery time, mode and delivery quality confirmation. However, there are always customer complaints on retailers' home delivery service, especially in peak seasons (CERC, 2012, 2014; Benady, 2013). This situation reflects a current fact that to ensure the home delivery service performance to satisfy the customers has continuously been a challenge to the E-retailers.

Thus, within this research, the authors investigate, in the context of the Chinese E-retail marketplace, the following:

1) The existing home delivery strategic elements;
2) The prioritised order of the home delivery strategic elements of their importance to secure customer satisfaction from the customers' perspective.

The findings will guide both the Chinese and international E-retailers to develop appropriate home delivery strategies for operating in and/or entering the Chinese market, as well as other emerging markets, since the E-retailing in these markets share a similar business pattern and growth rate as China's (Chang et al.,2013). This research will also contribute to the theory development besides provide practical guidance to enhance E-retailing logistics performance to ensure a high level of consumer satisfaction.

Based on literature review and screening by a focus group with five experienced E-retail business professionals and further reflection by the authors, the main strategic dimensions defining/measuring the E-retailers' home delivery operations are identified as: Delivery time arrangement (DTA), Flexibility of the delivery arrangement (FDA), Delivery information provision (DIP), Modes of delivery (MD), Quality guarantee of delivery (QD), Quality of the delivery staff's work (QSW). All the above dimensions and their associated elements as well as the sources are listed in Table 1.

Dimensions and elements (attributes)	Code	Sources
Delivery time arrangement (DTA)	**DTA**	MICROS, 2012; Starkey, 2010; Forbes, et al., 2005; Greasley and Assi, 2012; Benady, 2013; Li and Dinlersoz,
Same day delivery	DTA_1	
Two-day delivery	DTA_2	
Weekend delivery	DTA_3	
Delivery by customer appointed date	DTA_4	
Delivery by customer appointed date and time	DTA_5	
Flexibility of the delivery arrangement (FDA)	**FDA**	
Can only deliver in the time slot decided by retailer	FDA_1	Starkey, 2010; MICROS, 2012; Forbes, et al., 2005; Greasley and Assi, 2012; Benady, 2013; Grewal and Levy,
Can deliver according to the customer's special requirements	FDA_2	
Can deliver to the different location decided by customers	FDA_3	
Can deliver to overseas according to the customer requests	FDA_4	
Deliver to international customers	FDA_5	
Retailer endeavours in expanding businesses to overseas	FDA_6	
Delivery information provision (DIP)	**DIP**	MICROS, 2012; Starkey, 2010; Forbes, et al., 2005; Benady, 2013; Grewal and Levy, 2009; Rose, et al., 2012; Li and Dinlersoz, 2012
Clearly links to the delivery information website on the retailers' homepage	DIP_1	
Customer can easily find delivery information on the website through input key words	DIP_2	
Information of payments clearly stated	DIP_3	
Customer can track the delivery status information on the ordered goods	DIP_4	
Retailer informs customers of the delivery status information instantly through message/email	DIP_5	
Instantly reply email/message, etc. from customers' enquiry on the delivery status of goods	DIP_6	
Instantly reply customers' telephone enquiry of the delivery status of goods	DIP_7	
Customer signature after receiving the goods	DIP_8	
On website, clearly stating the request of signature for customer after receipt of goods	DIP_9	
After customers purchasing the goods, retailers email enquiring feedback from customers	DIP_10	
Modes of delivery (MD)	**MD**	Bruer, 2008; Greasley and Assi,
Retailer-self delivery	MD_1	
Third party logistics provider delivery	MD_2	
Combination of retailer delivery and third party logistics provider delivery	MD_3	Expert focus group
Quality guarantee of delivery (QD)	**QD**	Xing, 2006; Forbes, et al., 2005; Kuhn and Sternbeck, 2013; Grewal and Levy, 2009; Li and
Avoiding the damage of goods through using materials with sufficient strength	QD_1	
Training delivery staff avoiding the knock and scratch	QD_2	
Quick action to customers' complaint, increase the satisfaction level of customers	QD_3	
Quality of the delivery staff's work (QSW)	**QSW**	
Recruiting high quality staff	QSW_1	Expert focus group
Regular training before and after the staff assuming posts	QSW_2	Expert focus group

Table 1: Strategic dimensions and their elements for E-retailing home delivery

However, the dimensions and their respective component elements in Table 1 are just identified as key strategic factors by the literature and a few focus group experts, whether the general consumers also see them as important need to be explored.

China is one of the fast developing countries and has a huge marketplace (CERC, 2012; Zhang and Zhang, 2012) with a significant large on-line consumer population; this market deserves further exploration by domestic and international E-retailers. Therefore, studying home delivery strategies from consumers' perspective in Chinese context will make significant contribution to the development of theoretical knowledge and the practical guidance for managers' decision making in E-retailers' home delivery operations.

Research methodology and data analysis

Research Design

The research was conducted by combining literature review, focus group and survey, in five steps:
Step 1, an extensive review was conducted on literature focusing on the dimensions of home delivery strategies implemented by E-retailers and associated elements of each dimension.

Step 2, to enhance and triangulate the literature review findings, a focus group consisting of e-retail professionals was conducted to enrich and validate these strategic dimensions and their elements (Table 1).

Step 3, a survey was conducted with on-line consumers, in order to get their evaluations of the importance level and corresponding performance level of the aforementioned strategic elements, and to obtain new dimensions/elements missed in the literature.

Step 4, a statistical analysis and consequently the prioritisation/classification of the strategic elements was conducted and summarised.

Step 5, based on the summary of research findings from previous step, the conclusions and future research are presented.

Selection of the Sample Respondents

From three demographically different areas (eastern/costal, middle and northern parts of China) in the representative high level e-commerce presence regions (EEO, 2010), the respondents were selected through directly and randomly enquiring individuals at different public premises.

The response rates from on-line consumers in the three areas are 15%, 16% and 18%, respectively from being invited for participation of customer numbers of 220, 244 and 300. Although the sample sizes are small, these individual respondents all have abundant experience about the E-retailers' home delivery performance and have provided solid insights for the research.

Validity and reliability of the research

Validity

Content validation and construct validation have been examined within this research to attest its validity.

For content validity, the investigation questions' (containing the same content elements as those in Table 1) appropriateness has been assessed by a focus group. The group experts' evaluation result following a five-point scale is very positive for all the questions with average ratings of 4 or above, except that vast majority of the feedback either rated the importance of QSW_2 very low or suggested its non-relevance to customers, thus this element has been removed from the analysis.
To check the construct validity, its two components – convergent validity and discriminant validity have been calculated.

For convergent validity, the communality values and loadings of the elements to factors (the strategic dimensions) are above 0.6 for all the elements; this prove the appropriateness of the investigation questions (van Beuningen, 2012) and primarily attest to the convergent validity

following Cole's contention (1987). Meanwhile, the average variance extracted (AVE) and construct reliability (CR) were also calculated; all AVE values are above threshold value of 0.5 and all CR values are above threshold value of 0.7, this has further attested to the convergent validity of the research.

For examining discriminant validity, the comparison between AVE and the corresponding squared interconstruct correlation (SIC) has been made. The AVE being larger than the SIC can evidence a discriminant validity (Paswan, 2009). In this research, the AVE corresponding to the constructs summarised are all larger than the SIC; this ensures a confident argument of the research's discriminant validity.

Reliability

The CR values indicate that the construct reliability of the research is within the acceptable range (Paswan, 2009), revealing that the research has its internal consistency. The Cronbach's α and the Spearman-Brown reliability coefficient values further confirm the survey investigation's reliability (Cronbach and Meehl, 1955; Engs, 1996).

Findings and analysis

Based on ANOVA analysis, only DIP_1 (p = 0.01) and QSW_1 (p =0.001) shows a difference of the importance level recognised by on-line consumers from different areas. Thus these two will be analysed separately area-wise.

Importance-performance (IPA) analysis

In order to prioritise the strategic elements for practical guidance of e-retailing home delivery strategy development, IPA has been applied on the collected data.

IPA (Martilla and James, 1977) is used to identify strengths and weaknesses of business activities by comparing the importance of the attributes and the performance level in terms of these attributes (Wang, et al, 2011-12), herein referring to the consumer perceived importance and performance levels of the e-retailing home delivery operations strategic elements.

The recognised importance level of the home delivery strategic elements and their performance level by the on-line consumers are presented in Table 2.

Strategic elements	Importance level	Performance level	Strategic elements	Importance level	Performance level
DTA_1	3.75	3.23	DIP_4	4.1	3.51
DTA_2	3.54	3.29	DIP_5	3.8	3.21
DTA_3	2.73	2.89	DIP_6	3.6	3.11
DTA_4	3.2	3.16	DIP_7	3.4	3.17
DTA_5	3.1	2.75	DIP_8	3.8	4.12
FDA_1	3.5	3.43	DIP_9	3.6	2.90
FDA_2	3.5	3.38	DIP10	3.2	2.97
FDA_3	3.3	3.29	MD_1	3.1	3.11
FDA_4	3.2	3.57	MD_2	3.6	3.21
FDA_5	3.4	3.38	MD_3	2.9	3.66
FDA_6	2.7	3.13	QD_1	4.4	3.06
DIP_2	4.2	3.75	QD_2	4.5	3.41
DIP_3	4.1	3.73	QD_3	4.4	3.33

Table 2: Strategic elements' importance and performance levels (less the two elements to be analysed separately)

Based on Table 2, using average importance/performance level score (3.56/3.3) as demarcation criterion, the difference between the individual scores for each elements and the average are demonstrated in Figure 1 and 2.

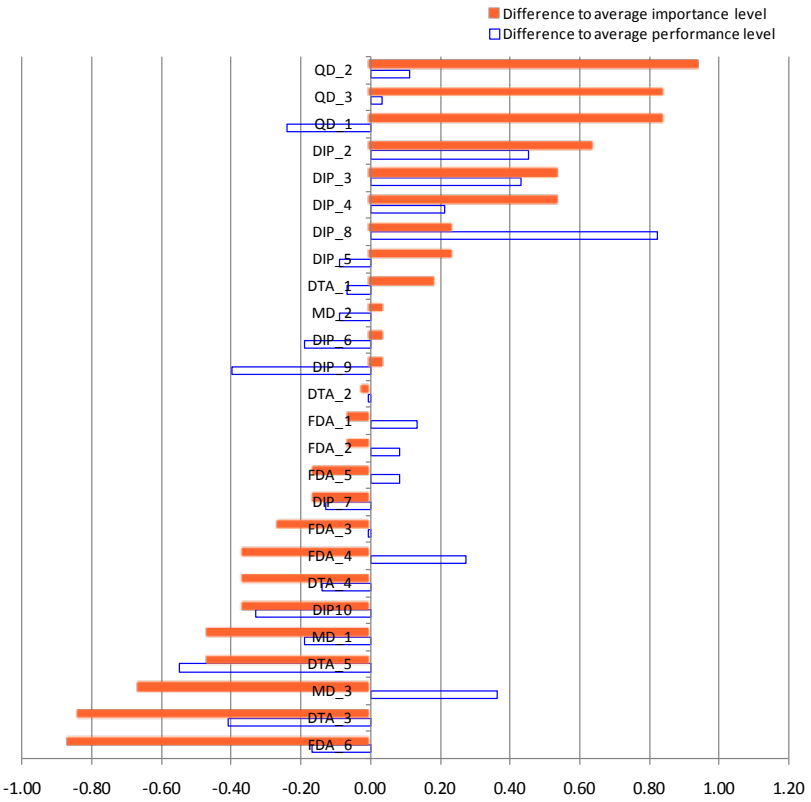


Figure 1: The difference between individual elements' importance/performance and the average

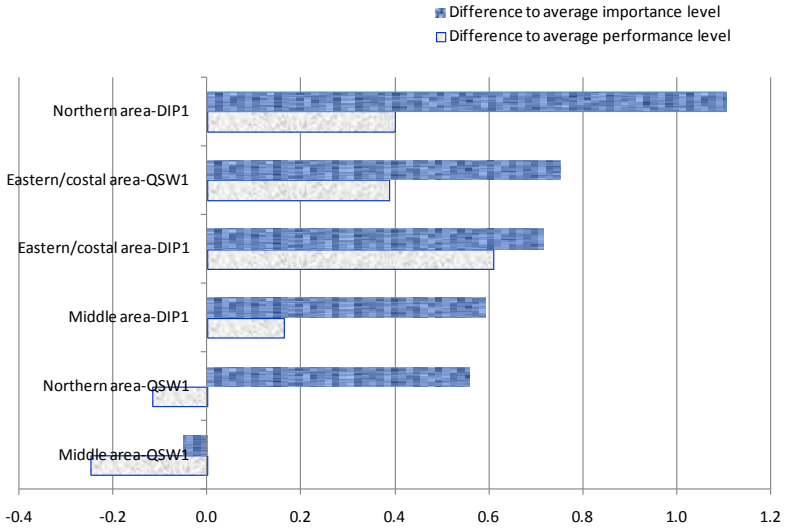


Figure 2: The difference between individual elements' importance/performance and average (the two elements analysed separately)

Strategic Element Groups for Home Delivery

Based on the importance/performance levels in Table 2 as well as the difference illustrated by Figure 1 and 2, the strategic elements are classified and prioritised into three groups (termed as Group for Consumers Valued Home Delivery Strategic Elements – GCVHDSE) listed in Table 3, for facilitating the

E-retailers to effectively allocate their resources to improve the home delivery performance in order to satisfy the customers.

CVHDSEs	Critical strategic elements	Remarks
1st GCVHDSE	DTA_1, DIP_5, DIP_6, DIP_9, MD_2, QD_1, QSW_1(Northern area)	Elements with higher than average importance but lower than average performance
2nd GCVHDSE	DTA_2, DTA_3, DTA_4, DTA_5, FDA_3, FDA_6, DIP_2, DIP_3, DIP_4, DIP_8, DIP_7, DIP_10, MD_1, QD_2, QD_3, DIP_1 (Northern area), QSW_1(Eastern/costal area), DIP_1(Eastern/costal area), DIP_1(Middle area), QSW_1(Middle area)	1. Elements with higher than average importance also higher than average performance; 2. Elements with lower than average importance also lower than average performance
3rd GCVHDSE	FDA_1, FDA_2, FDA_4, FDA_5, MD_3	Elements with lower than average importance but higher than average performance

Table 3: GCVHDSEs and their corresponding strategic elements

Conclusions

In contemporary era, the home delivery performance has become a crucial factor affecting the customers' satisfaction and retention to E-retailers' businesses; and it heavily impacts E-retailers' healthy survival in the marketplaces with intensified competition alongside demanding consumers.
This research has identified/confirmed a set of important E-retailing home delivery strategic elements and explored their importance/performance levels from the perspective of on-line consumers.

Based on the research findings, the authors classified and prioritised the strategic elements into three GCVHDSEs (Table 3) with the strategic elements' detail contents listed in Table 1, to guide the E-retailers' home delivery strategy development and implementation. The level of resources and effort needed to be allocated to the business aspects focused by the corresponding GCVHDSEs' elements can be decided according to their ranked levels; e.g., for the 1st GCVHDSE elements, the resources and effort devoted to them should be the largest. Through applying the GCVHDSEs as a guidance to plan, acquire and allocate resources for improving the performance of home delivery, E-retailers can ensure a high level of customer service and meet or even exceed customers' demand in China and also other emerging markets, this will consequentially enhance their competitiveness.

Future research

To further enhance the insights obtained from this research, future research can focus on:

- To enlarge the sample size, especially to include those in the regions with lower level of e-commerce application, to obtain more in-depth and inclusive understanding;
- A comparative investigation on the difference and similarity between the viewpoints from Chinese on-line consumers and other countries', with regard to the level of the importance of the individual strategic elements.

References

- *Asdemir, K., Jacob, V. S. and Krishnan, R. (2009), "Dynamic pricing of multiple home delivery options" European Journal of Operational Research, Vol. 196, pp. 246-257.*
- *Benady, D. (2013), "Dynamic delivery: changing the rules of retail, Marketing, on-line at [Accessed December]: http://www.marketingmagazine.co.uk/article/1208897/dynamic-delivery-changing-rules-retail.*
- *Bruer, S. (2008), "Internet Retailing Opportunities and Challenges for the UK's Distribution Property Markets", on-line at [Accessed January 2013]: http://www.prologis.co.uk/pdfs/e-tail.pdf.*
- *China E-commerce Research Centre (CERC) (2012), "The monitoring report on the experience and complaints of the Chinese e-commerce users in 2011", on-line at [Accessed January 2013]: http://www.100ec.cn.*
- *China E-commerce Research Centre (CERC) (2014), "Monitoring report on the e-commerce market data of China in 2013", on-line at [Accessed April]: http://www.100ec.cn.*
- *Chang, E., Chen, Y. and Dobbs, R. (2013), "China's e-tail revolution, McKinsey Quarterly, No. 3", China Market Intelligence Centre, on-line at [Accessed August]: http://www.ccidreport.com/ market/article/content/3698/201207/277364.html.*
- *Cole, D. A. (1987), "Utility of confirmatory factor analysis in test validation research", Journal of Consulting and Clinical Psychology, Vol. 55, No. 4, pp. 584–594.*
- *Cronbach, L. J. and Meehl, P. E. (1955), "CONSTRUCT VALIDITY IN PSYCHOLOGICAL TESTS", Psychological Bulletin, Vol. 52, pp. 281-302.*
- *CYONE (2013), "Listing the famous foreign multinational companies recently withdrawing from China", on line at [Accessed April 2014]: www.cyone.com.cn/Article/Aritcle_23 333.html.*
- *Economic Observer (EEO) (2010), "Gradual imbalance of the distribution of e-commerce, three major factors impeding its development", The Economic Observer, on-line at: [Accessed August 2012] http://www.eeo.com.cn/2010/1009/182242.shtml.*
- *Engs, R. C. (1996), "Construct validity and re-assessment of the reliability of the HEALTH CONCERN QUESTIONNAIRE", Advances in Health Education/Current Research (4), Edited by Robert H.L. Feldman and James H. Humphrey, AMS, Press, Inc., New York: pp. 303–313.*
- *Forbes, L. P. Kelley, S. W. and Hoffman, K. D. (2005), "Typologies of e-commerce retail failures and recovery strategies", Journal of Services Marketing, Vol. 19, No. 5, pp. 280–292.*
- *Greasley, A. and Assi, A. (2012), "Improving "last mile" delivery performance to retailers in hub and spoke distribution systems", Journal of Manufacturing Technology Management, Vol. 23, No. 6, pp. 794-805.*
- *Grewal, D. and Levy, M. (2009), "Emerging Issues in Retailing Research", Journal of Retailing, Vol. 85, No. 4, pp. 522-526.*
- *Kuhn, H. and Sternbeck, M. G. (2013), "Integrative retail logistics: An exploratory study", Operations Management Research, Vol. 6, pp. 2-18.*
- *Li, H. and Dinlersoz, E. (2012), "Quality-based Price Discrimination: Evidence from Internet Retailers' Shipping Options", Journal of Retailing, Vol. 88, No. 2, pp. 276–290.*
- *Liu, J. and Xu, W. (2010), "Nearly 1000 internet retailers went out of marketplace, soft environment needs to be improved", on-line at [Accessed April 2014]: http://tech.qq.com/a/ 20101231/000250.htm.*
- *Lockwood, L. (2013), "China Tops E-Commerce Opportunity Study", Women's Wear Daily, Vol. 206, No. 104.*
- *Martilla, J. and James J. (1977), Importance - Performance Analysis, Journal of Marketing, Vol. 14, pp. 77-79.*
- *MICROS (2012), "on-line retail delivery Report 2012", on-line at [Accessed January 2013]: http://www.metapack.com/sites/default/files/downloads/whitepaper/2012-On-line-Retail-Delivery-Report-IMRG-Annex-sponsored-by-MetaPack.pdf.*

- *Paswan, A. (2009), "Confirmatory Factor Analysis and Structural Equations Modeling: An Introduction", on-line at [Accessed February, 2013]: www.cob.unt.edu/slides/paswan/ BUSI6280/CFA-SEM%20-%20Intro-May%2018%202009.pp*
- *Power, D., Hanna, V., Singh, P. J. and Samson, D. (2010), "Electronic markets, data access and collaboration: relative value to performance in firm operations", Supply Chain Management: An International Journal, Vol. 15, No. 3, pp. 238–251.*
- *Punakivi, M. and Saranen, J. (2001), "Identifying the success factors in e-grocery home delivery", International Journal of Retail & Distribution Management, Vol. 29, No. 4, pp. 156-163.*
- *Sebastianelli, R. and Tamimi, N. (2013), "An Examination of Attributes Affecting Consumers' Perceptions of E-tailer Quality", Journal of Internet Commerce, Vol. 12, No. 3, pp. 268-283.*
- *Starkey (2010), "e-Retail - Using home delivery as a service differentiator and strategic marketing tool", Journal of Direct, Data and Digital Marketing Practice, Vol. 12, No. 2. pp. 165-173.*
- *van Beuningen, J. (2012), "The Satisfaction With Life Scale Examining Construct Validity", Statistics Netherlands, The Hague/Heerlen.*
- *Wang, C., Yang, T., Mao, Z., Zhang, L., Vaughan, J. and Mercer, J. (2011-12), "An Empirical Exploration of Hospital Service Quality Assessment Criteria in China", Journal of General Management, Vol. 37, No. 2, pp. 51-68.*
- *Yang, Y., Humphreys, P. and McIvor, R. (2006),"Business service quality in an e-commerce environment", Supply Chain Management: An International Journal, Vol. 11, No. 3, pp. 195-201.*
- *Zhang, L. and Zhang, Y. (2012), "A Comparative Study of Environmental Impact of Two Delivery Systems in the Business-to-Customer Book Retail Sector", Journal of Industrial Ecology, Vol. 17, No. 3, pp. 407-417.*

SUPPLY CHAIN FINANCE: NEW HORIZONS

Simon Templar[1], Xuanmiao Wang[1], William Extra[2] and Charles Findlay[3]
[1]Cranfield University, UK
[2]PwC, Netherlands
[3]Supply Chain Finance Community, UK

Introduction

Supply Chain Finance (SCF) is not a new phenomenon, however it has been given more importance by the business community since the financial crisis of 2008/09 because many organisations faced the lack of available funds due to the economic downturn. In 2012 Prime Minister David Cameron stressed the importance of cash flow as an enabler of growth when announcing a new SCF initiative:

> *"This Government is determined to back all those businesses who aspire to get ahead and take on more people. In the current climate, viable businesses can struggle to get the finance they need to grow - this scheme will not only help them secure finance and support cash flow, but will help secure supply chains for some of our biggest companies and protect thousands of jobs. It can be a win-win, with large companies and small suppliers both benefiting from this innovative scheme."*

However, a research study conducted by R3 in 2016 identified that late payments are still an issue:

> *"A survey of the insolvency profession reveals that late payment for goods or services was a primary or major cause of 23% of insolvencies in the last twelve months, while the failure of a supplier or customer was the primary or major factor in 20% of cases."*

SCF solutions enable organisations to shorten their cash-to-cash cycles, improve their liquidity, enhance financial performance and build financially sustainable demand chain networks. Hence, SCF provides an opportunity to create a win-win solution for buyers and suppliers, a win-win-win for buyers, suppliers and financial providers or even a multiple-win (Templar *et al*., 2016). A recent study by Greensill (2018:5) estimates the accounts payable market:

> *"We believe it is in excess of $3.5 trillion and the volume of outstanding SCF assets at about $100 billion."*

Therefore, there is a big question: how will SCF develop in the near future?

Literature review

Cosse (2011:33), defines the most common approach to SCF as a:

> "*buyer-driven payables solution, mainly referring to any types of reverse factoring solutions, supported by the appropriate IT technology"*.

Therefore, a typical SCF ecosystem consists of a four-party model which includes the supplier, the buyer, the supplier's bank and the buyer's bank. Figure 1 illustrates the four-party ecosystem model together with the three flows (financial, physical and information) that are present within the SCF ecosystem (Templar *et al*., 2016:151).

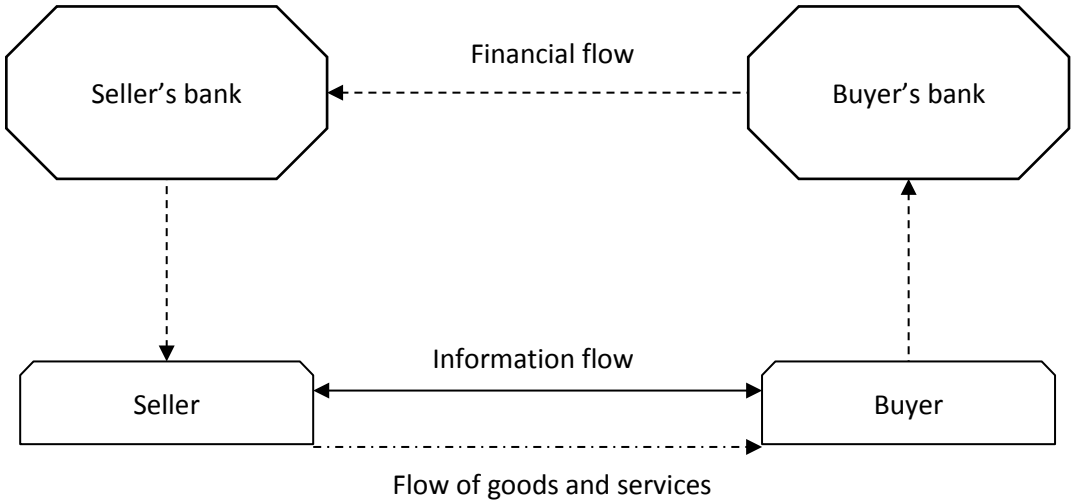


Figure 1: Four-party model and associated flows

Fairchild (2015) extends the SCF ecosystem further with the addition of the technology/platform provider and the Global Supply Chain Finance Forum (2016:8) includes the technology platform provider in their SCF definition:

> *"Supply Chain Finance is defined as the use of financing and risk mitigation practices and techniques to optimise the management of the working capital and liquidity invested in supply chain processes and transactions. SCF is typically applied to open account trade and is triggered by supply chain events. Visibility of underlying trade flows by the finance provider(s) is a necessary component of such financing arrangements which can be enabled by a technology platform."*

However, Camerinelli (2010) argued that there are more SCF stakeholders including consultants, logistics providers, credit card providers, associations and governments.

There is a considerable range of SCF instruments and Cosse (2011:42) classified these instruments by the components of working capital cycle (Days In Inventory [DII], Days Sales Outstanding [DSO] and Days Payable Outstanding [DPO]), reduce operational risk and costs as depicted in Table 1.

Reducing DSO	**Increasing DPO**	**Reducing DII**	**Reducing Operational Risks/costs**
• Forfaiting/Discounting • Factoring • Distributor finance • Trade receivable backed financing • Pre-shipment financing • Post-shipment financing • Early payment discount programme • Collateral management	• Reverse factoring /confirming • Extended payment terms • Purchasing card	• Warehouse finance • Goods in transit finance • Vendor managed inventory • Financing of supplier's inventory • Trade acceptance discounting	• Cash management and e-banking • Processing service/platforms • Pre-shipment buyer credit risk protection • Letter of credit • Open Account • Foreign Exchange and interest rate hedging • Credit Insurance • Investment financing

Source: Cosse (2011:42)

Table 1: Supply Chain Financial Instruments

The influencing factors which have an impact on the future development of SCF identified from the literature include technology (Auboin *et al.*, 2016), regulation (Deng and Lu, 2017 and More *et al*., 2012), people (Hofmann and Belin, 2011 and Martin and Hofmann, 2016) and industry environment (Canitato *et al.*, 2017, More *et al.*, 2012 and SCF Briefing, 2017) and are illustrated in Figure 2.

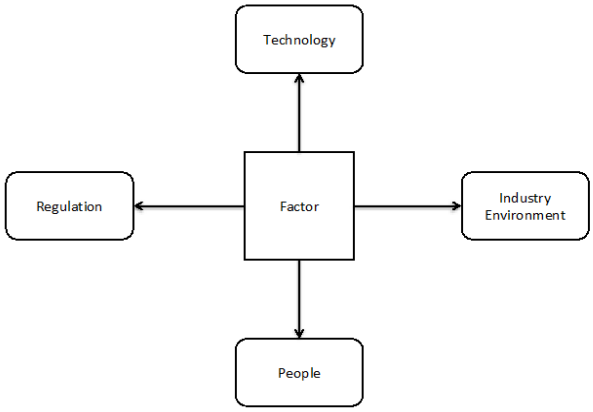


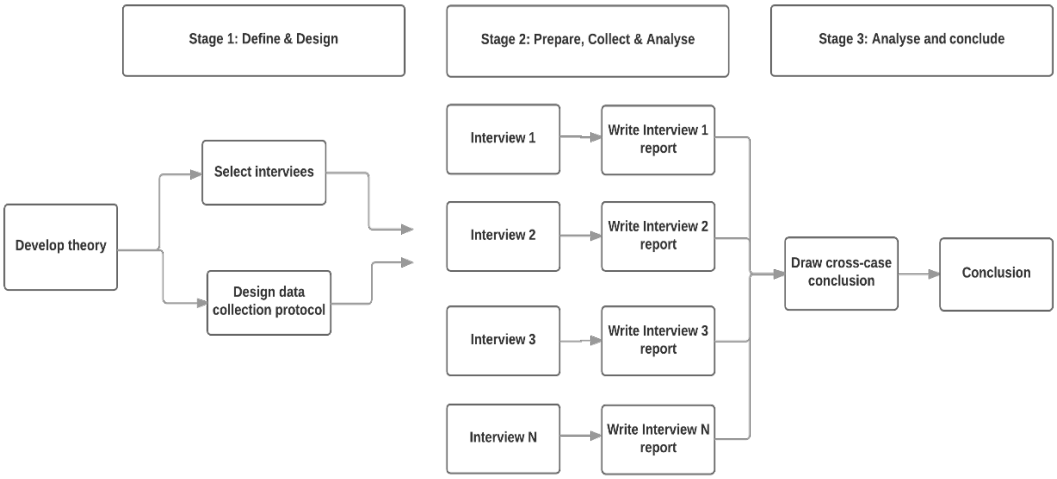
Figure 2: Factors influencing SCF Future

Research method

The justification for adopting a case study research approach to the study was based on Yin's (2003:1) selection criteria:

> *"In general case studies are the preferred strategy when how or why questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context."*

The research study met Yin's criteria as its aim was to investigate how SCF will develop in the near future. The focus of research study is the SCF ecosystem, which is a contemporary phenomenon set in a real-life context and the researcher has no control over SCF events. The study's research method is depicted in Figure 3.



Source: Adapted from COSMO Corporation, cited in Yin (1994:49)

Figure 3: Research Logic

Primary data was collected using semi-structured interviews. Nine SCF stakeholder types were identified by the literature:

- Buyer
- Supplier
- Technology providers
- Government
- Consultants
- Credit card providers
- Financial providers
- Logistics providers
- Associations

However, it was not possible to gain access and insights from two stakeholder groups (government and credit card providers). The final interview set comprised of 7 stakeholder groups and 14 interviews were conducted (buyer [B], supplier [S], 3 technology providers [TP1, TP2 and TP3], logistic provider [LP], 3 consultants [C1, C2 and C3] and 3 associations [A1, A2 and A3]). The data was collected by face-to-face interviews (2) and by telephone interviews (12), using a structured set of questions derived from the literature review. Data capture was by interviewer notes (14) and supporting audio recordings (13). The data was analysed within stakeholder type by factor (technology providers by regulation), aggregated by factor (regulation by stakeholder groups) and finally by comparing the data collected with the literature findings by factor.

Findings

The analysis of the 14 interviews confirmed the 4 factors impacting on the future development of SCF (technology, regulation, people and industry environment) identified by the literature review. However, three additional factors emerged from the interviews, they were SCF implementation cost (A1), economic fluctuations (C2) and credit rating (C1 and C2).

The initial the model derived from the literature illustrated in Figure 2 was then updated to include these additional factors and the revised version is illustrated in Figure 4.

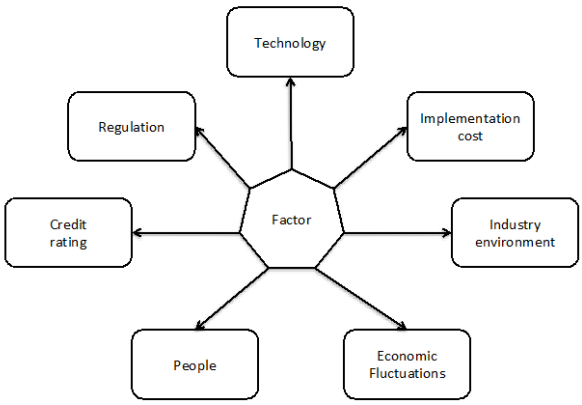


Figure 4: New version of factors influencing on SCF development

The interview findings relating to these SCF development factors are now explored individually.

Technology

Advanced technologies such as the Block Chain (BC) and Artificial Intelligence (AI) will have a significant impact on the future development of SCF (A1, A2, A3, C1, C2, C3, FP1, FP2, LP, S, TP1, TP2 and TP3). New technologies will increase the efficiency of the transaction process (C3), improve and extend the scope of the supply chain (C1 and LP), provide the opportunity to develop new financial solutions (A1), generate a risk profile for individual transaction, personalise SCF solutions by transaction, and optimise

the cost for vendors (TP3) and improve cash flow management and enhance business development (LP). According to stakeholder A3:

> *"Artificial Intelligence and Block Chain are impacting on SCF and every other area in finance and business transactions"*.

BC will facilitate transaction information exchange between different parties (A2), by enabling all the key information in the financial or physical supply chain to be available anytime (A1), improve the tracking of documentation (C1), increase the reliability of data (FP2, S and TP1) increase data accuracy (S and TP1) make easier to share data (S and TP1), and secure and manage the flow of data (A1).

AI will significantly impact the decision-making process, decisions will be automated and only exceptions will be reviewed by humans, in relation to optimal payment terms, discount rates and when to take early payment (S). With AI, algorithms have the potential to carry out a more accurate invoice payment decision and help enterprises to reduce transaction costs and improve their working capital (TP2). AI can help establish a reliable, good operational system, which is robust and responsive to client's needs (C1). An AI system is built based on the data collected over time by technology companies, with AI the payment behaviors and payment decisions of individual suppliers will be based on several scientific and intelligent rules, which means it could be more likely to match supplier and buyer's needs, and SCF programs will be more likely to be successful (TP1).

Regulation

Governments are placing a higher focus on paying faster (TP1), fair payment terms (FP1, S and TP1), promoting and protecting SMEs (C2). However, payment regulations will differ according to geographical location (A1, C1 and FP1). Regulation relating to advanced technology (FP2, LP, TP1, TP2) is an important theme, including block chain (increase visibility of transactions [A2 and TP2]) and electronic invoicing (S and TP1). Regulation relating to SCF relationships between the parties involved in the transaction (A1, A3 and C3) and need to be handled properly and ethically (A3) and with security and control of the SCF process (C3). In addition, regulation relating to payment terms will impact on the future development of SCF (FP1). Other regulation issues highlighted by the stakeholders interviewed were:

- accounting principles relating to SCF and debt (C1);
- the lack of a single SCF regulatory body for the entire ecosystem (C1);
- the impact of international trade regulations (TP3);
- and regulation to improve visibility of transactions (A2, C1, C2, TP1 and TP2).

People

The level of stakeholder knowledge (A1, A2, A3, C2, C3, FP1, FP2, LP, TP1, TP2 and TP3), skills (C1) and working/business experience (C2, FP1, FP3, S, TP2) is essential in achieving a successful adoption (A1, A2, A3, C2, C3, FP2, LP, S and TP2) and implementation (FP1 and TP1). The benefits of SCF experience, according to the supplier interviewed, can have a positive impact on financial performance:

> *"People's better working experience related to SCF equals better results, such as faster execution, higher adoption, and better working capital results."*

The need to gain an understanding of the different organisational functions and perspectives (C1 and A1) such as finance, purchasing, operations and supply chain management is essential for SCF adoption. SCF stakeholders need an understanding of advanced technologies such as AI and where to apply them (S and C3).

Industry Environment
Two themes emerged from the analysis of the responses, first the need for internal functions within an organisation to work closer together when adopting SCF, and second, externally, the need for the development of closer relationships between banks and technology suppliers.

An effective SCF adoption/implementation requires all the departments to work together/cooperation (A1, A2, B, C1, C2, C3, FP1, FP3, S, TP1 and TP3). Departments identified by stakeholders which need to work together include treasury (S and TP1), procurement (A1, C1, C2, FP1, FP2, S, TP1 and TP3), finance (A1, C1, C2, FP1, S, TP1 and TP3), legal (FP1), credit approval and management (FP2), operations (A1) and information technology (C1, C2, FP1, FP2 and S).

Development of future SCF models will lead to partnerships/collaboration (*"a win-win situation for banks and technology providers"* [A3]) cooperation between banks and technology providers/ fintech's (A1, A2, A3, B, C1, C3, FP3, S, TP1 and TP2). Stakeholder FP3 states that:

> "*Banks have to make the partnerships with technology providers. Everything happening in the banking system today is driving block chain thinking, and collaboration with technology providers enables banks to gain advantages in the SCF market".*

Implementation Cost
According to stakeholders A1 and A2 implementation cost is a factor relating to SCF adoption. A1 argues:

> *"The cost of implementing SCF can be high, and SCF should be viewed not just an alternative way of financing, improving margins, but as well as securing the physical 'end-to-end' supply chain."*

Economic Fluctuations
SCF adoption might be affected by economic fluctuations (C2). Some suppliers may have difficulties in paying debts to banks or other financial providers during global economic recession periods. Because of the market risk, SCF funders may hold neutral or even a negative attitude to the SCF adoption during economic downturn.

Credit Rating
Credit rating may affect future SCF adoption as well C1 and C2. The size of the SCF market is difficult to increase if the credit position of companies is negatively influenced when they implement SCF solutions. For example, many companies in Italy are not willing to purchase receivables because this will affect their credit position (C1).

Discussion

The research study indicated that there are number of enabling factors which will facilitate the further development of SCF, including advanced technologies, financial regulation, people and industry environment, which was consistent with the literature. However, implementation cost, economic fluctuations and credit rating were additional factors highlighted by some of the stakeholders. There was also a broad range of specific, or individually, challenges and opportunities for businesses from the different stakeholder's perspective, as illustrated in Table 2.

B	"The future challenge is about adoption. How to get business to understand what SCF means and what benefit they can receive from SCF."
S	"In future, the main challenge SCF is how to manage system data because the future is more about data. Also, SCF is likely to be a way to strengthen a business supply chain."
TP1	"There are so many businesses in the world, and there are so many companies in the USA that still do the payment by cheque, the opportunities are how to impact these companies and optimise the way of companies being paid."
TP2	"The technology changes the way of business payment fundamentally. With advanced technology, companies can improve their finance, and it is easier for their customer to do business with them."
TP3	"The challenge is about price and the cost of SCF, how it can be attractive for people and how to find a new way to add value in the value chain with SCF."
FP1	"The main challenge is to keep up with the technical innovation, especially for the financial providers such as banks."
FP2	"The development of technology may change the payment method between companies, and the challenge is how to keep pace with the emergence of advanced technology."
C1	"One of the challenges is that there are so many different SCF platforms for suppliers to deal with."
C2	Opportunities are "technology development, advanced solutions such as cash flow forecasting, data management, or procure to pay solutions." Challenges include "economic fluctuations, cost of funds and credit rating system."
C3	"How to make the SCF value more visible? How enterprises can recognise the value?
A1	"One of the challenges is that the cost of implementing SCF can be high, and SCF should be viewed not just an alternative way of financing, improving margins, but as well as securing the physical "end-to-end" supply chain. Hence, SCF should not be isolated from the other flows within the supply chain: physical flow and information flow."
A2	Opportunity: technology providers have a huge amount of transaction data to show to financial providers. The risk of lending in the SCF market can be managed to be virtually at non-risk. Challenge: implementing SCF is very costly, companies are required to spend too much at the beginning, but the saving in the long term is quite small.
A3	There will be more changes about business with advanced technology. The opportunity for SCF is that people from the whole world can be connected together and some financial programmes can be funded by a large number of individuals.
LP	The biggest challenge is the level of awareness and understanding of SCF, people's misperception of SCF will cause damage to SCF adoption.

Table 2: Future challenges and opportunities

The future challenges and opportunities for the adoption of SCF for both practitioners and academics, related to individuals' and organisations' perceptions of SCF net value. This may be impacted by the application of advanced disruptive technologies (BC and AI) will transform the accounts payables landscape in terms of efficiency (speed), effectiveness (data management and connectivity) and economics (new SCF products and cost reductions through economies of scale). Finally, SCF can be seen as an enabler of supply chain resilience and risk mitigation as it can improve the financial stability of members of the chain.

Conclusion

The study concludes that advanced technologies, future regulations, people and industry structure will all have significant impacts on the future adoption of SCF, which is consistent with the finding of literature review. The research study identified three additional factors influencing SCF, including the potentially high implementation costs; economic fluctuations including market risk; and, thirdly, the

role of credit rating agencies and how these organisations determine the credit position of companies using SCF solutions to improve their financial performance. The study also confirms that SCF is still emerging and evolving, that the potential market is underdeveloped and that additional financing solutions will materialise in future with the development of technology. However, the main future challenges facing future of SCF, is, firstly, ensuring that SCF solutions can add value and, secondly, that SCF solutions keep pace with the development of new technologies.

The study recommends that practitioners focus on technology and regulation as the two most important factors in the development of SCF, while tracking the broader range of factors listed above.

References

- Auboin, M., Smythe, H. and Teh, R,. (2016) 'Supply Chain Finance and SMEs: Evidence from International Factoring Data', CESifo Working Paper Series No. 6039.
- Camerinelli, E. (2010), Supply Chain Finance: A taxomony, Aite Group, Boston.
- Caniato, F., Gelsomino, L., Perego, A. and Ronchi, S. (2017). 'Does finance solve the supply chain financing problem?', *Supply Chain Management: An International Journal*, Vol. 21 Issue: 5, pp.534-549.
- Cosse, M. (2011) An Investigation into the Current Supply Chain Finance Practices in Business: A Case Study Approach. MSc Thesis unpublished. Cranfield University.
- Deng, A. M., and Lu, X. (2017). 'A Literature Review on the Study of Chattel Pledge Supervision in Logistics and Supply Chain Finance of China', *Journal of Financial Risk Management*, 6, pp.93-100.
- Fairchild, A. (2005). 'Intelligent matching: integrating efficiencies in the financial supply chain', *Supply Chain Management: An International Journal*, Vol. 10 Issue: 4, pp.244-248.
- Global Supply Chain Finance Forum (2016) Standard Definitions for Techniques of Supply Chain Finance, http://supplychainfinanceforum.org/ICC-Standard-Definitions-for-Techniques-of-Supply-Chain-Finance-Global-SCF-Forum-2016.pdf [Accessed 26/06/18]
- Greensill. (2018).'Technology and Supply Chain Finance',
- http:// www.Greensill.com/whitepapers/supply-chain-finance-and- technology [Accessed 26/06/18].
- Hofmann, E. and Belin, O. (2011), *Supply Chain Finance Solutions*, Springer Briefs in Business, Springer, Berlin.
- Martin, J. and Hofmann, E. (2016). 'Involving financial service providers in supply chain finance practices: Company needs and service requirements', *Journal of Applied Accounting Research*, Vol. 18 Issue: 1, pp.42-62.
- More, D. and Basu, P. (2012). 'Challenges of supply chain finance: A detailed study and a hierarchical model based on the experiences of an Indian firm', *Business Process Management* Journal, Vol. 19 Issue: 4, pp.624-647
- Prime Minister announces Supply Chain Finance scheme (2012) https://www.gov.uk/government/news/prime-minister-announces-supply-chain-finance-scheme [accessed 21/06/18]
- R3 (2016) Late Payments and Other Business Failures Cause Over 1-in-5 Corporate Insolvencies https://www.r3.org.uk/index.cfm?page=1114&element=27579 [Accessed 26/06/18]
- Supply Chain Finance Briefing. (2017). Event report: The Supply Chain Finance Community Forum Asia. [online] Available at: http://www.scfbriefing.com/event-report-the-supply-chain-finance-community-forum-asia/ [Accessed 18/08/17]
- Templar, S., Findlay, C. and Hofmann, E. (2016). *Financing the End to End Supply Chain: A Reference Guide to Supply Chain Finance*. 1st ed. Kogan page Ltd, London.
- Yin, R.K., (1994). *Case Study Research Design and Methods*. (2nd Ed) Sage, Newbury Park.
- Yin, R.K., (2003). *Case Study Research Design and Methods*. (3rd Ed) Sage, Newbury Park.

PHARMACEUTICAL SUPPLY CHAIN DISRUPTION BEHAVIOURS AND SHORTAGE MANAGEMENT PERFORMANCE

Paul Morris and Edward Sweeney
Aston University, UK, ESM

Copyright & moral rights for this paper are retained by the individual author(s) and/or other copyright holders

1. Introduction

The focus of this research is on post supply chain disruption management (SCDM) i.e. response actions taken after the disruption has occurred, extending the theoretical framework developed by Bode et al (2011). It employs a theory testing design that formulates and tests novel propositions to augment the existing academic body of work on disruption and risk management, thereby generating new insights into this field of study. In particular, this research's goal is to understand the interplay of post disruption actions after an event has occurred and to understand how and why those actions are selected, and what actually are the subsequent outcomes, rather than relying on the existing normative theory framework. This research employs a set of propositions, which incorporate fresh aspects of the dynamic and contextual nature of those actions and the resultant conclusions, providing a platform for further study. The research is uniquely set in the challenging and complex public healthcare service arena, specifically in the secondary care acute hospital sector, where critical patient care is provided.

2. Theory development

Bode et al. (2011) presented the first systematic empirical investigation of organisational responses to supply chain disruptions.They introduced the concept of supply chain disruption orientation, launching the construct into the supply chain literature, building on earlier organisational orientation works by Daft and Weick (1984) investigating active and passive firms. They examined why, how, and under what conditions firms respond to supply chain disruptions. Bode et al. (2011) introduced a model of organisational responses to supply chain disruptions, using dual theoretical lenses. These were resource dependency theory (Carroll, 1993) and information processing theory (Galbraithe, 1977, Tushman and Nadler, 1978). Pfeffer and Salancik (1978) stated in regard to resource dependency theory that, although organisations depend on their environment to survive, they seek to assert control over the resources they require to minimise their dependence. Galbraith (1973) p.150, proposed that uncertainty refers to the “difference between the amount of information required to perform a task and the amount of information already possessed by the organisation”. The more environmental uncertainty a firm faces, the more information it needs to gather and process to achieve a given level of performance.

2.1 Research Question

The research question (RQ) is:

How do the actions of buffering and bridging in response to supply chain disruption events affect the performance of shortage management?

Three key constructs were developed to answer this research question.

The first two constructs are drawn from the existing model of organisational responses to supply chain disruptions (Bode et al. (2011), and the third construct of performance extends the original model as per Figure 1. Each of the constructs were developed into a series of relevant propositions and expanded so each element of the construct can be measured, examined, and defined.

2.2 Supply Chain Disruption Orientation Construct

The first construct was concerned with the development of the concept of supply chain disruption orientation (SCDO) defined by Bode et al. (2011) p837 as "a firm's general awareness, consciousness of, concerns about, seriousness towards, and recognition of the opportunity to learn from supply chain disruptions".

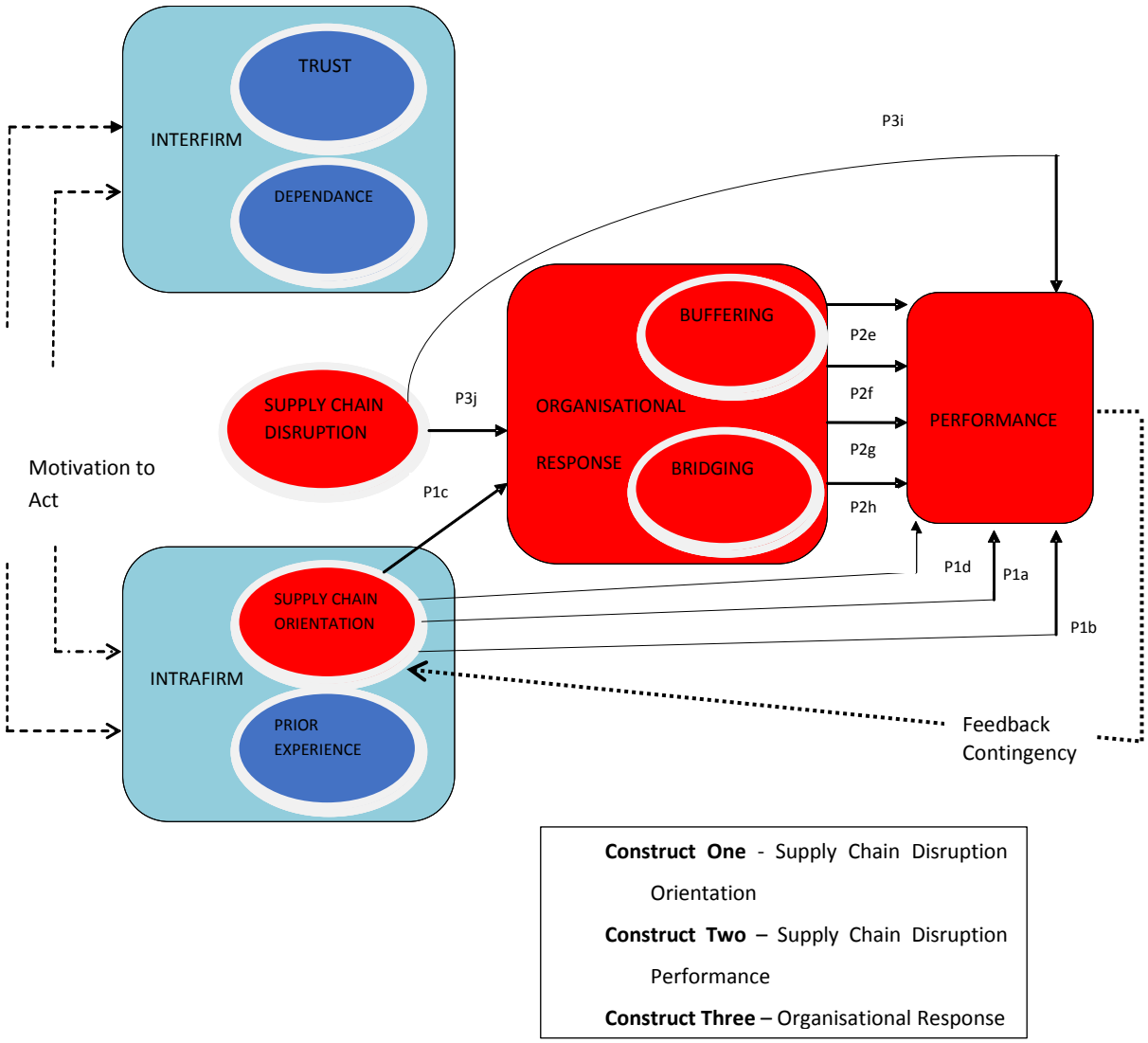


Figure 1: New proposed model of organisational responses to supply chain disruptions, integrating response action and output performance

2.3 Supply Chain Disruption Performance Construct

The second construct develops supply chain disruption understanding by considering the performance aspect. Performance implications were not considered in previous research on disruption orientation.The overall supply chain performance is multi-dimensional and affected by factors such as service quality and overall operating costs, and trade-off and compromise choices are necessary to achieve the best performance (Chopra and Sodhi, 2004). As highlighted by Daft and Weick (1984), overlapping with extant organisational information processing models, gathering, processing, and acting on data from the environment is a firm's main task**.** Taking an information processing perspective is critical to supply chain success (Bowersox et al., 1999).

2.4 Organisational Response Construct

The final construct extends the examination of post supply chain disruption strategic management, giving new insights by considering dynamic response and its effect on performance. Strategic management and responses do not operate in a vacuum or at a single point in time. Instead, they change and adapt to the environment they operate in (Ivanov and Sokolov, 2013). Organisations can learn from post-disruption decisions, and their performance can vary with the response spectrum.

3. Research Design

The deductive collection instrument of the online line survey in phase 1 Figure 2, followed by the qualitative interviews in phase 2 allows in depth answers to be made sense of and challenge the quantitative phase 1, and the inductive phase 3 focus groups, allows the researcher process understanding as a social phenomenon which is not undertaken by individuals in isolation from each other.

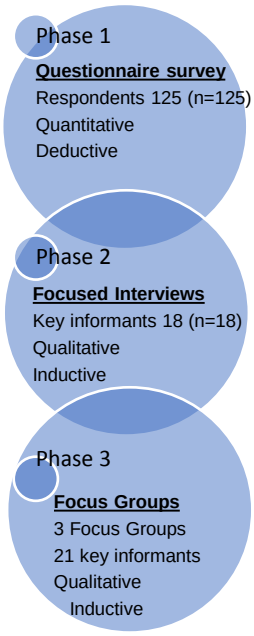
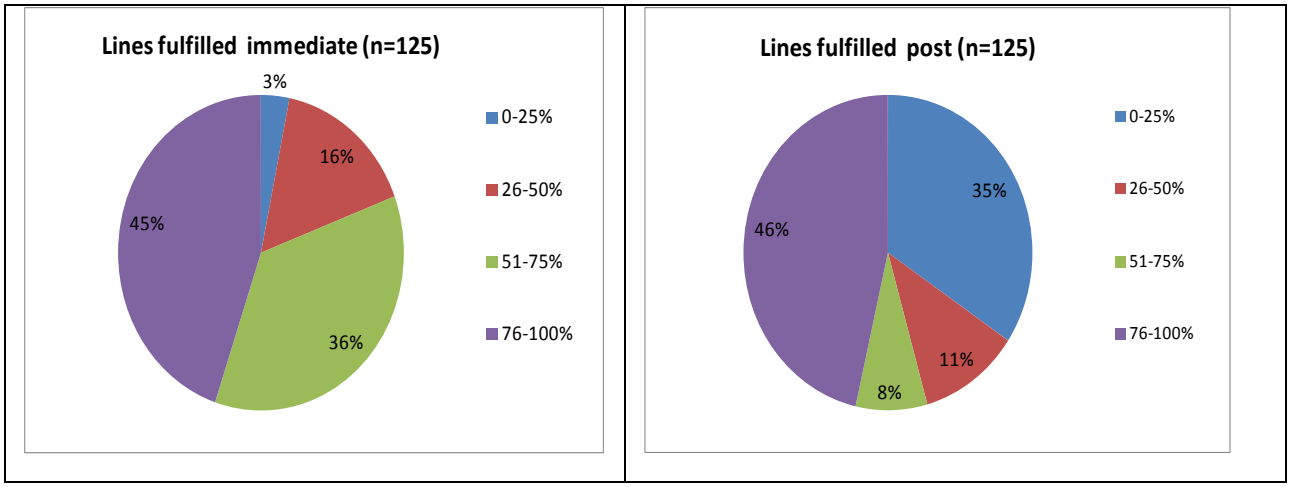


Figure 2: Three phase mixed method design

4. Findings



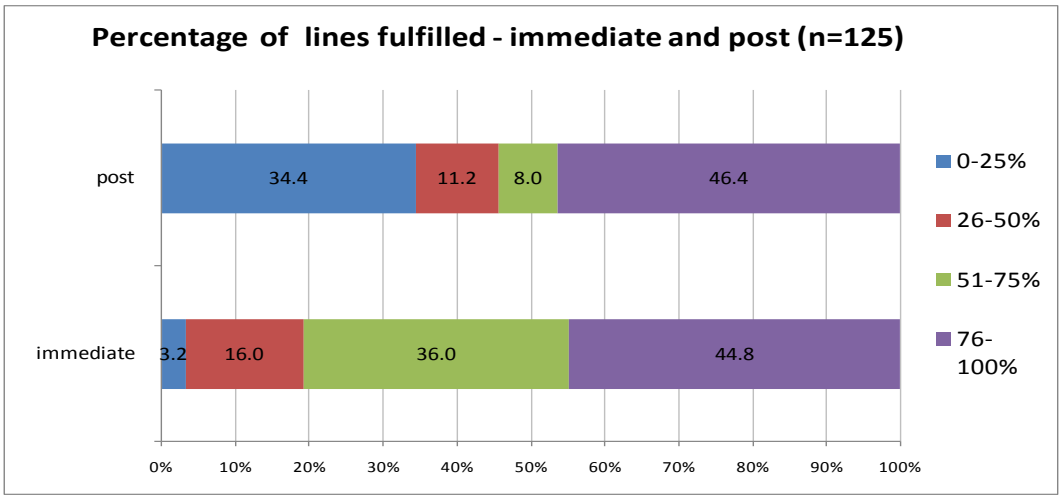


Figure 3: - Lines fulfilled

Figure 3 clearly summarises the differences between the immediate and post line fill rates, and further justifies the selection of both immediate and post measures rather than just one of the measures, as differences do exist. From the qualitative analysis of the semi-structured interviews a case by case variable matrix was used and then the outputs placed into a pivot table, ordering each case by value, before being compared and considered in relation to the research's propositions.

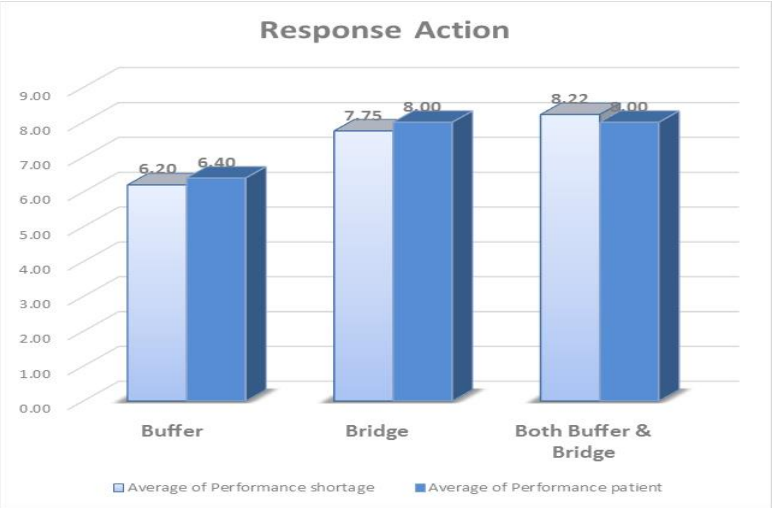


Figure 4: Buffering and bridging response action against shortage performance

Figure 4, shows the average of the performance score in shortage management in general and also by performance against patient impact. As can be seen in Figure 4, where actions of buffering and bridging were both taken in response to a shortage, the response action was most effective

5. Discussion

As shown in Figure 5 below, the buffering and bridging actions taken in the first 8 weeks were different to each other, and they again changed after the 8-week period for both bridging and buffering in a dynamic affect over time. As seen by the shortage performance line, the shortage performance percentage fill rate result at the 76-100% level changed and increased from the immediate period to the 8 week to 16 week period from first impact of the disruption.Post-performance changes over time, as do actions taken in an on-going 'fluid' interaction, shortage performance strategy cannot stop at the time of disruption impact, or be over reliant on pre impact risk matrix supply chain planning. In the data outputs of the analysis in Figure 5, bridging actions and buffering actions show a divergence from the initial impact date, with a resultant levelling off on the overall shortage performance.

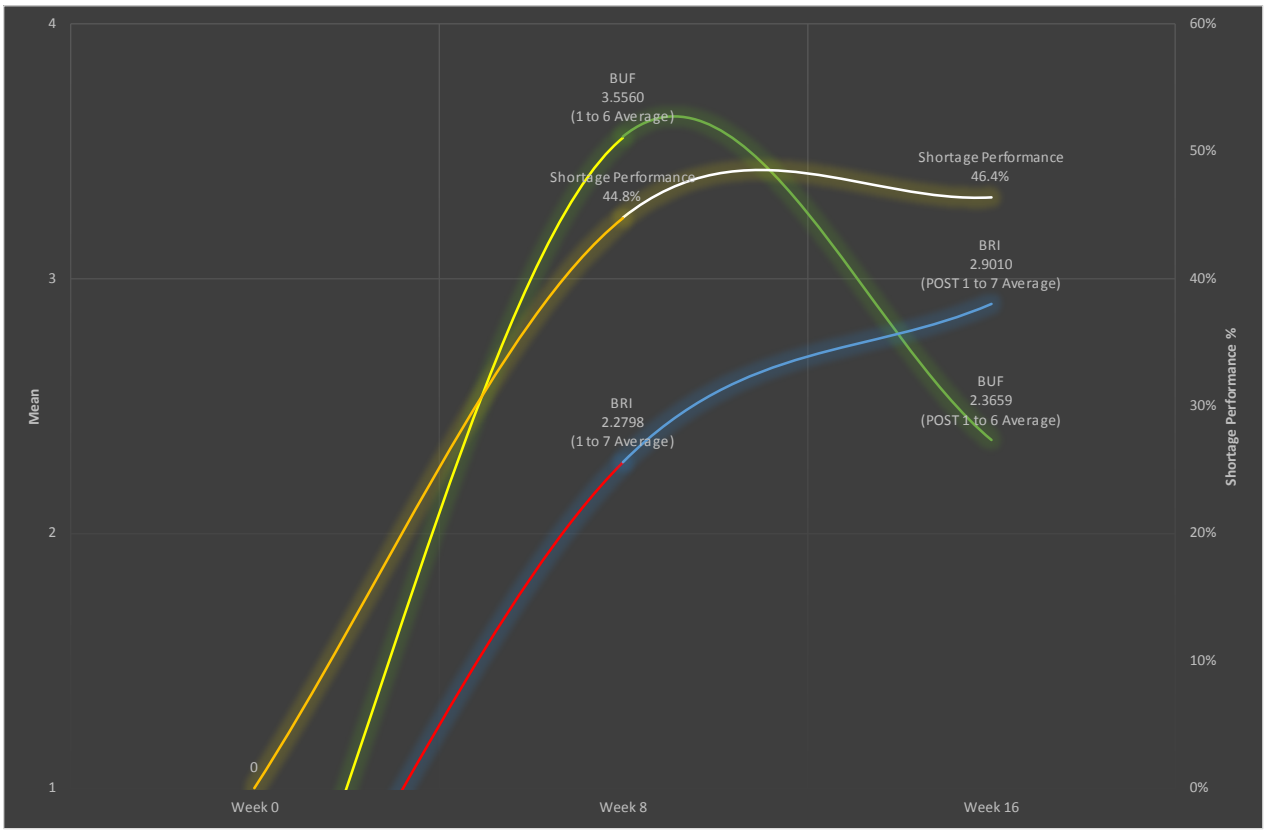


Figure 5: Buffering and bridging dynamic, including shortage performance

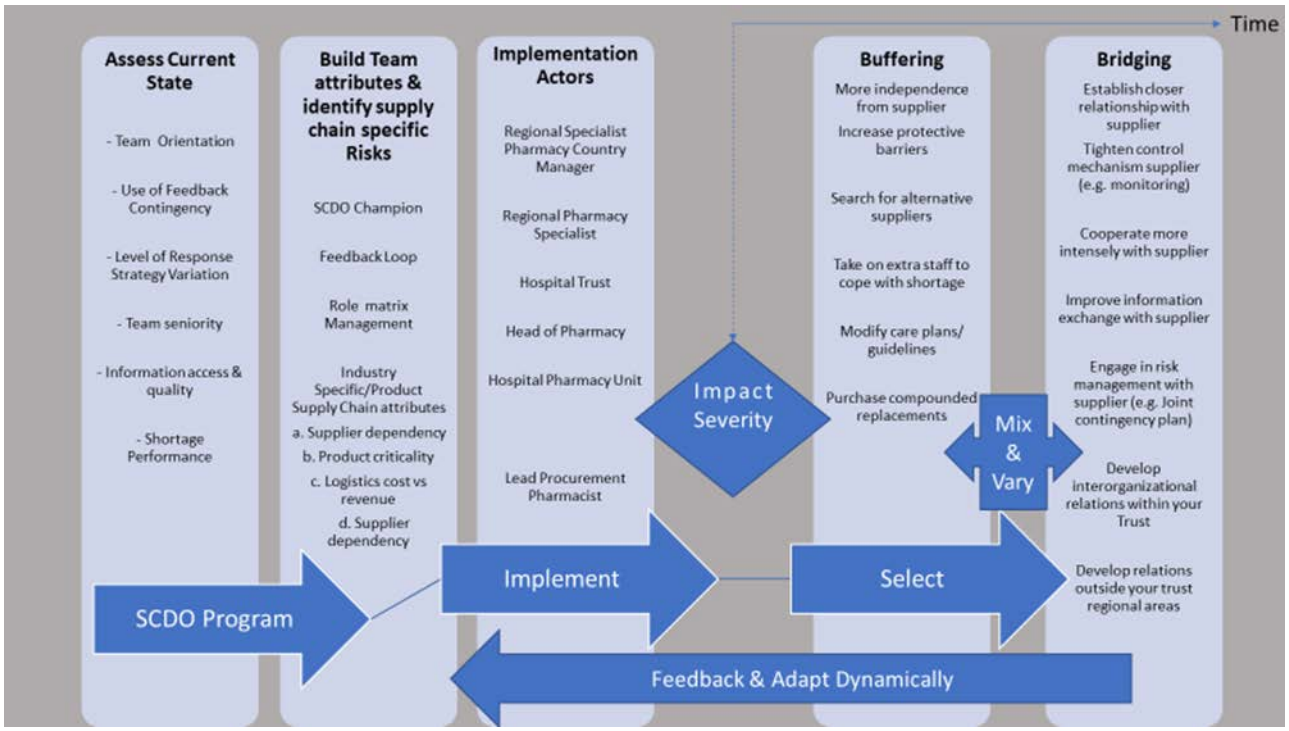
This is an important finding because response strategies in post disruption events demonstrated their dynamic versus static nature when developing theoretical frameworks to understand both supply chain resilience and the antecedents of response actions, whether the motivation to act for stability or interpretative postures, and must adopt appropriate underpinning academic theories in line with this dynamic nature.

5.1 Contribution: Implications for theory

The research question asked how the response actions affected shortage performance, and firms with higher SCDO select and execute the buffering and bridging actions affectively and hence have superior shortage performance. This supports Bode et al. (2011) and confirms previous work in risk management (Autry and Bobbitt (2008). From information processing theory, organisations may be more active in using information to perform more efficiently in uncertain environments (Galbraithe, 1973). Firms with a high supply chain disruption orientation are more likely to have an active approach (Daft and Weick (1984), and are more likely to respond quickly; the speed of response to disruptions has previously been identified as important (Chadist, 2012). Chadist (2012) proposed four constructs in the relationship between response time and factors underlying response; preparation, organisational development, partnerships, and appropriate reserves. However, the theory that greater response speed can reduce the impact of disruption is a broad statement; this research went deeper into the response alternatives into immediate and post response actions and their relative immediate and post performances on shortage management in the dynamic post-disruption environment, finding different actions were taken throughout the post-disruption time gap, and different performances were the output.

5.2 Managerial Implications

The below supply chain road map Figure 6, lays out a process plan to illustrate to practice stakeholders and managers how to improve shortage management performance at the operational level.



6. Conclusion

This research examined post supply chain disruptions, extending the theoretical framework of Bode et al. (2011), augmenting the need to balance the larger body of work on prior supply chain disruption decisions and risk management. By identifying new factors that moderate or mediate key relationships within the existing theoretical framework, the concept of supply chain disruption orientation is extended, and new causal relationships are identified through the expansion of thesis constructs: supply chain disruption orientation; supply chain disruption performance and organizational response, contributing to extant theory. Further, original insights were examined in disruption severity and feedback contingency, as well as the varying of response action empirically tested performance consequences.

References

- AUTRY, C. W. & BOBBITT, L. M. 2008. Supply chain security orientation: Conceptual development and a proposed framework. *International Journal of Logistics Management* 19**,** 42-64.
- BODE, C., WAGNER, S. M., PETERSEN, K. J. & ELLRAM, L. M. 2011. Understanding responses to supply chain disruptions: insights from information processing and resource dependence perspectives. *Academy of Management Journal,* 54**,** 833-856.
- BOWERSOX, D. J., CLOSS, D. J. & STANK, T. P. 1999. *21st century logistics: Making supply chain integration a reality. ,* Oak Brook, Illinois, Council of Logisitcs Management.
- CARROLL, G. R. 1993. A sociological view on why firms differ. *Strategic Management Journal,* 14**,** 237-249.
- CHADIST, P. 2012. *Factors Underlying Companies Response to Supply Chain Disruption: A Grounded Theory Approach.* City.
- CHOPRA, S. & SODHI, S. 2004. Managing risk to avoid supply-chain breakdown. *MIT Sloan Management Review,* 46**,** 53-61.
- DAFT, R. L. & WEICK, K. E. 1984. Toward a model of organizations as interpretation systems. *Academy of management review,* 9**,** 284-295.
- GALBRAITHE, J. R. 1973. *Designing complex organizations,* Reading, MA, Addison-Wesley.
- GALBRAITHE, J. R. 1977. *Organization design,* Reading, MA, Addison-Wesley.
- IVANOV, D. & SOKOLOV, B. 2013. Control and system-theoretic identification of the supply chain dynamics domain for planning, analysis and adaptation of performance under uncertainty. *European Journal of Operational Research,* 224**,** 313-323.
- TUSHMAN, M. L. & NADLER, D. A. 1978. Information processing as an integrating concept in organizational design. *Academy of Management Review,* 3**,** 613-624.

PROMOTING WATERBORNE TRANSPORTATION FOR BETTER SUSTAINABLE FREIGHT MOVEMENTS IN THE SOUTH WEST UK

Sapna Chacko, John Dinwoodie and Shunmugham Pandian
University of Plymouth, UK

Introduction

The importance of water freight as a sustainable mode of transport is growing continuously. As world trade depends on maritime transport, water transportation has a special place in the logistics industry. Water transportation is a sustainable mode of transport in a supply chain. The integration of water freight in to intermodal transportation and logistics will increase the efficiency and competitiveness of the freight transport industry while maintaining an environmental balance (Tailor, 1993). Water freight offers many environmental and financial advantages to society (Yassin et al, 2010). At present within the UK road transport is mostly used for domestic transportation of goods (Sea and Water, 2008). This study analyses the potential for water freight in the South West UK especially in Devon and Cornwall.

Research background

UK has 11,072 miles of coastline and 300 ports. At present 1000km of water ways are in regular use in the UK for larger scale freight traffic (DFT, 2010). The recent statistics from the Department for Transport UK revealed that waterborne transport has become a substantially underutilized mode (DFT, 2016). Today, rising environmental concerns and a government grant system to encourage business to seek alternatives from road transport renewed the interest in waterborne transport. The government of the UK is aiming to transfer 3.5 per cent of road freight movements to water. If used properly water transportation could perform an important role in eliminating freight from the road and rail networks (North West Freight Advisory Group, 2003). In this situation this research analyses the nature of water freight in the South West UK. There are 41 ports in Devon and Cornwall, all small but commercially active (Kuznetsov, 2014). A number of European Union countries such as France, Ireland, Portugal and Spain are geographically well placed to trade with this region. By developing coastal shipping links between regional ports, seaborne trade links can be developed with these European countries, which will in turn, result in substantial economic activity for the region and maximise local and regional economic development (Chang, 2011).

The literature review on the potential for water freight in the South West UK revealed few prior academic studies. The published list of the quantity of goods transported from each port provides little information about the potential of these ports in conducting different kinds of water transportation. Hence this study attempts to fill the gap in the literature by analysing general attitudes towards water freight transport in Devon and Cornwall, current practices in water freight, the importance of water as a sustainable mode of transport in the supply chain, the potential of water freight from a business point of view, and barriers to achieve this potential. At the same time an attempt has been made to identify whether the use of water freight as a sustainable mode of transportation is worthwhile to the logistics industry in Devon and Cornwall and its socio-economic impact in society.

Conceptual model

A conceptual model links the objectives of the research, literature review and issues which should arise from the literature review and brings out interrelationships among them, which inevitably leads to the formation of the most suitable methodology for making solutions for the issues (Miles et al, 2014). The formation of a conceptual model revealed the key factors and the assumed interrelationships that are important for the research problem. These factors have different levels of influence on the potential for

water freight in CAD. The key factors are arranged at the top of the display with normal arrows and factors with moderate influence listed at the bottom of the display, and dashed arrows towards the major boxes. The formation of a conceptual model revealed that the key factors and the assumed interrelationships are important for finding solutions for the research problem. Since the use of water freight is more limited in the SW compared to other regions, seeking experts' opinions and suggestions on the existing and future use of water freight in CAD was instructive. The best way to canvas experts' opinions on the topic of study as per the conceptual model was the Delphi method. It is a method of inquiry, a useful communication tool to achieve consensus in a given area of uncertainty and provides more accurate assessment obtained either by individuals or by interacting groups (Delbecq et al, 1975). The experts' opinions on the key factors and their interrelationships helped to analyse the situation without any predetermined views.

Research Methods

This study is exploratory. Consequently, it used a qualitative technique known as the Delphi method and secondary research for data collection. Secondary research is mainly the review of literature. Since water freight in Devon and Cornwall has been less studied than many other parts of the UK, the opinions and suggestions from the experts in the shipping and logistics field is very important to achieve the objectives of the study. Thus, the Delphi method was used for primary data collection. The consensus level is fixed at 75% and three rounds of the Delphi survey were conducted. The experts' panel was comprised of professionals from the shipping and logistics industry, government officials dealing with transportation, academics especially from shipping and logistics, journalists (Lloyds' list, Plymouth Evening Herald etc.), officials from ports, and politicians. A total of 24 experts' panel members participated in the first round Delphi survey. The second and third Delphi surveys were attended by a total of 23 and 22 expert panel members respectively and in each round one respondent dropped the survey due to lack of knowledge on the local ports and personal reasons.

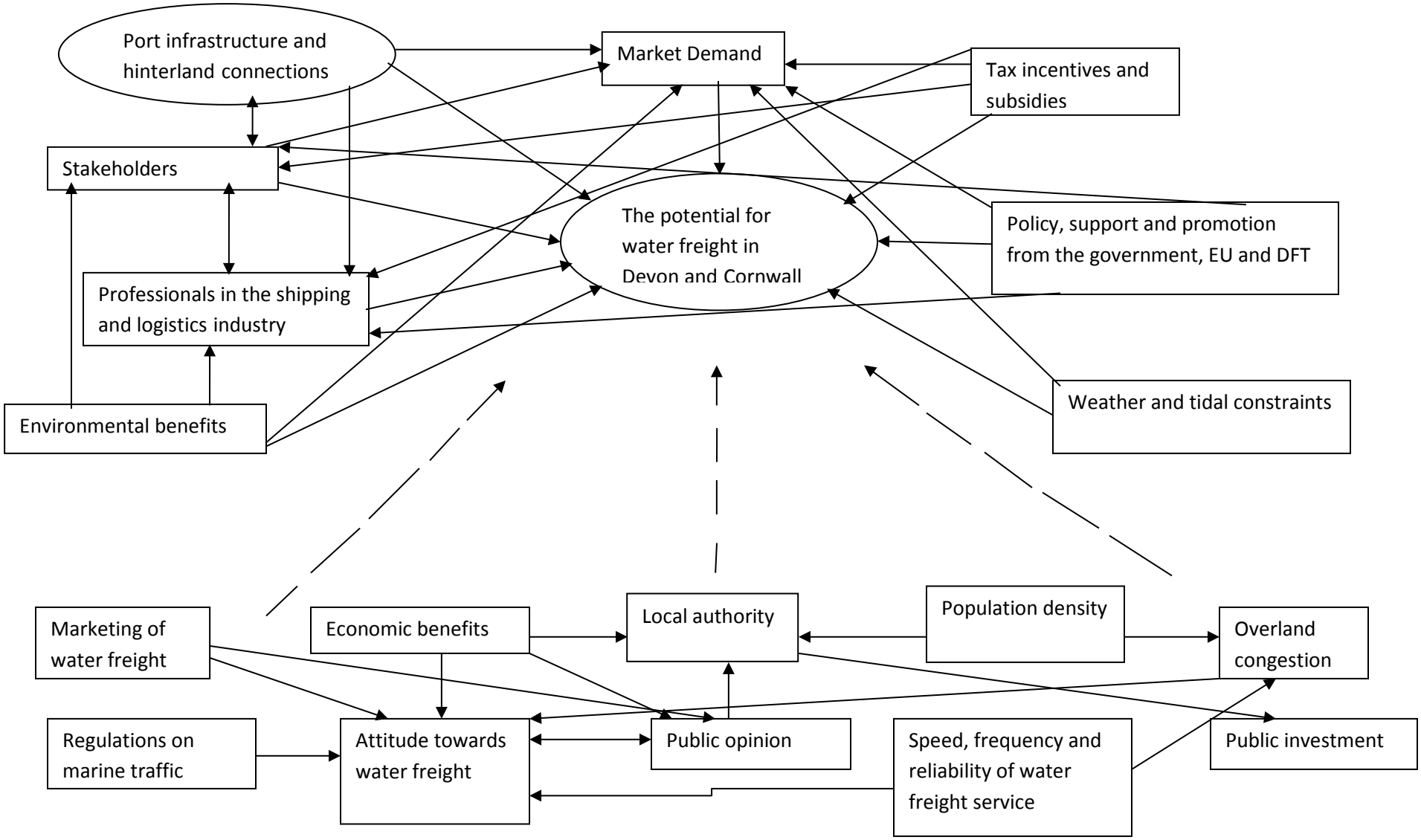
Following this a focus group with the members of the Maritime and Waterborne Innovation Group in the South West UK was conducted to measure the trustworthiness of the Delphi findings. Participants were asked to discuss the results of the Delphi study. The significance and trustworthiness of the findings were debated. Their discussion extended the initial findings of the Delphi study with detailed explanations of the current practises, issues and challenges water freight is facing in the region.

Findings

The Delphi study achieved a total of eight statement consensuses among the expert panel members. The consensuses revealed that presence of extensive coast line and accessibility to a number of ports along the coast of the South West UK are supportive for water freight movements in the region. Water freight is a sustainable green alternative to road and rail which is more labour, energy and fuel efficient than road transport. As an efficient and sustainable mode of transport, water freight will reduce the cost of transportation of bulk products over long distances, overland congestion, negative impacts on the environment, and external costs. It provides competitive cost, integration across all regions, economic progress and sustainability compared to road transport. At present ports in Devon and Cornwall lack investments in infrastructure and poor hinterland connectivity blocks the development of water freight in the region. As a result, the integration of water freight in the logistics chain is difficult.

Figure 1 Conceptual framework showing the potential for water freight in Devon and Cornwall and major influences on it

Source: authors



Meanwhile the focus group participants collectively upheld the significance of the Delphi results. According to them the results of the study could apply and assist almost to anywhere especially places where there are regional hiccups and areas with complicated issues. They opined that professionals related to the industry need more information about the possibilities of water freight and they have to work for the betterment of water freight in Devon and Cornwall. With the help of improved resources, water freight in the region can support transfer of road freight movements to water and will be beneficial to the economy of Devon and Cornwall. As per the findings and suggestions of the Delphi study and the focus group, the conceptual model formed in the beginning of the study showing the potential for water freight in Devon and Cornwall is modified into two new conceptual models. Figure 2 presents current water freight in CAD in accordance with the findings of the Delphi study and focus group. Figure 3 represents future water freight in CAD based on the suggestions and findings of the Delphi study and focus group, once they are accepted and implemented by the industry and respective governing bodies.

Discussion and conclusion

The three rounds of Delphi surveys and the focus group together brought a large amount of information on water freight in the South West UK especially in Devon and Cornwall. Water freight is best suited to transport non-time critical bulk cargoes. Small and medium ports in the region can be used for small quantities of single bulk cargo movements. With the integration of local water freight into intermodal transportation, links between the existing port facilities, better hinterland connections, infrastructure and operational systems, and the door to door delivery of goods will improve and be more reliable to conduct. Water freight in an intermodal transportation will be profitable to the entire logistics chain if the overall multimodal cost is lower than road transport and frequency and the reliability of water transport is competitive. With improved port infrastructure, subsidies and investment for essential facilities and a reduction in duty/taxes water freight in the region can support transfer of road freight movements to water. Better water freight movements will reduce road congestion, increase port employment, and local jobs and local distribution opportunities which could be beneficial to industry and society. The use of water freight will produce a better environment, congestion free roads, integration of remote locations, less price for goods, and a better economy.

The information collected during the Delphi study helped to realize the importance of using water freight and possibilities of it in South West UK. It was identified that water transportation is a sustainable mode of transport and offers many benefits to industry, society and environment. However the usage of water freight in the South West UK is low due to low usage is the lack of infrastructure at the ports and hinterland connectivity. The findings of the study will be useful for the government departments working for freight transportation, shipping and logistics industry and any groups working for the development of waterborne freight.

The focus group discussion presented a very good interpretation of the Delphi results. The focus group participants' experiences, knowledge, expectations, visions and concerns about water freight in the South West UK have contributed to the justification of the Delphi results. Their suggestions for policy formulation for the development of water freight in the region, barriers to policy formulation and implementation, and issues need further investigation for the development of water freight in the region were clearly identified in the focus group. They pointed out many issues in the progression of water freight, factors favorable for water freight development, opportunities available in the region and role of local, regional and national authorities in promoting water freight in the South West UK. Proper marketing of the benefits of water freight compared to other modes of transport and a strategic approach to educate professionals in the industry are prerequisites to increase the use of waterborne transport. DFT has a key role in promoting water freight. DFT can develop innovative ideas through funding mechanisms. An effective policy to overcome cost and significant investments

requirements can only be achieved at government level. DFT has the responsibility to provide substantial support in the form of policies, grants, tax reductions, subsidies and incentives to promote and develop waterborne transportation in the country.

A discussion on the policies for the development of water freight recognized that there is a little bit open attitude from the government side in the promotion of maritime activities. At the same time stereo thinking and inertia from local authorities create problems in the increased usage of water freight. An analysis of the barriers to policy implementation in promoting water freight in the region recognized the lack of understanding of the sector at the regional level, lack of entrepreneurial activities in the South West UK and limited commercial knowledge about exactly how much money the freight could be generated, prevent proper implementation of policies. As a result of an in-depth focus group discussion generated new insights on the early findings of the Delphi study and helped to strengthen the Delphi results generalizability and transferability.

The results of this research also have many implications to the rest of the world where water freight is in the developing stage or aiming to increase the usage of it. The suggestions, observations and information collected during the Delphi study and from the focus group participants could be used for forming better management strategies to improve the efficiency and effectiveness of water transportation in a region or country. Consequently, the economic and environmental benefits of using water freight would be more real in the shipping and logistics industry and society.

Figure 2 Conceptual framework showing current water freight in CAD Source: authors own

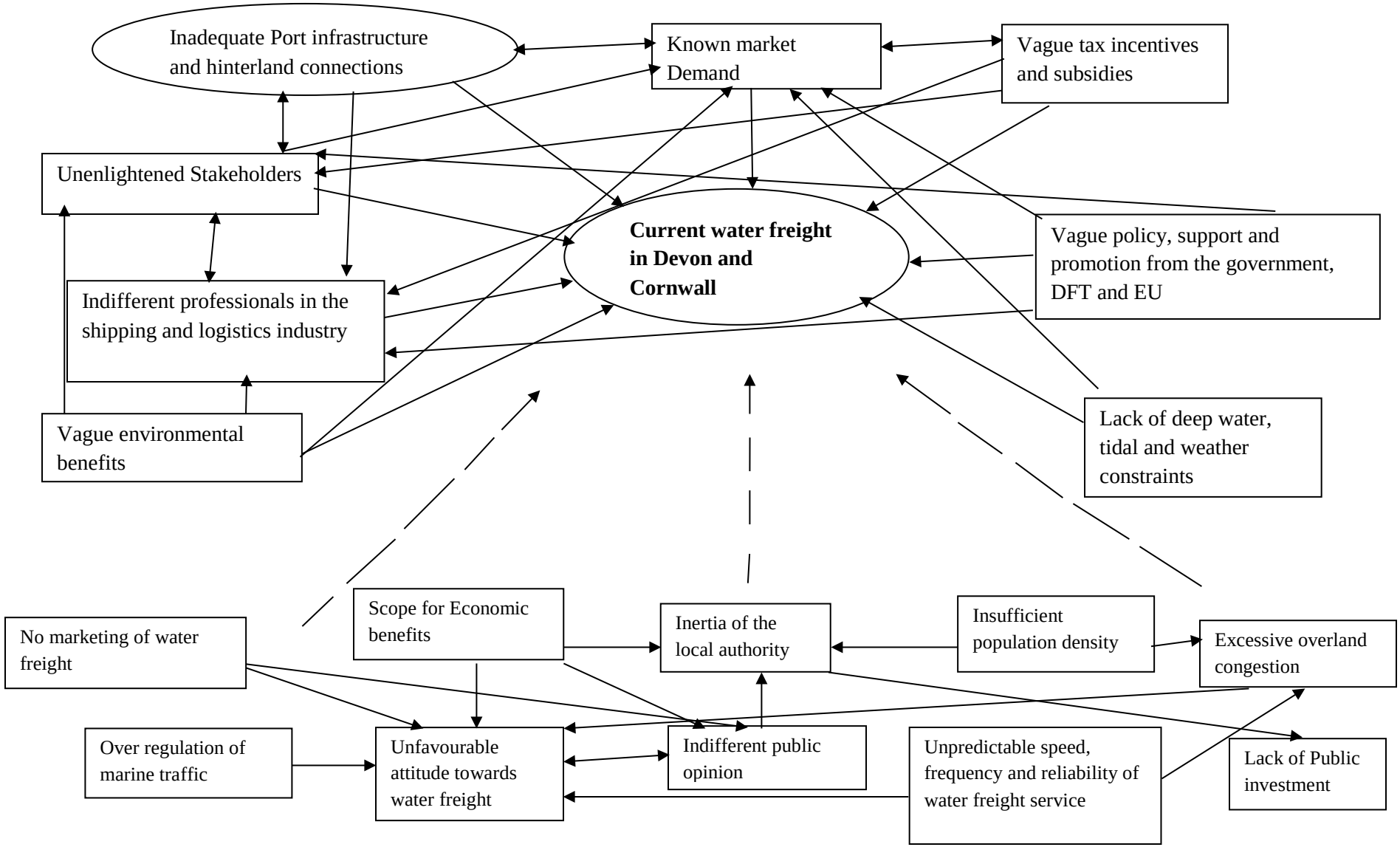
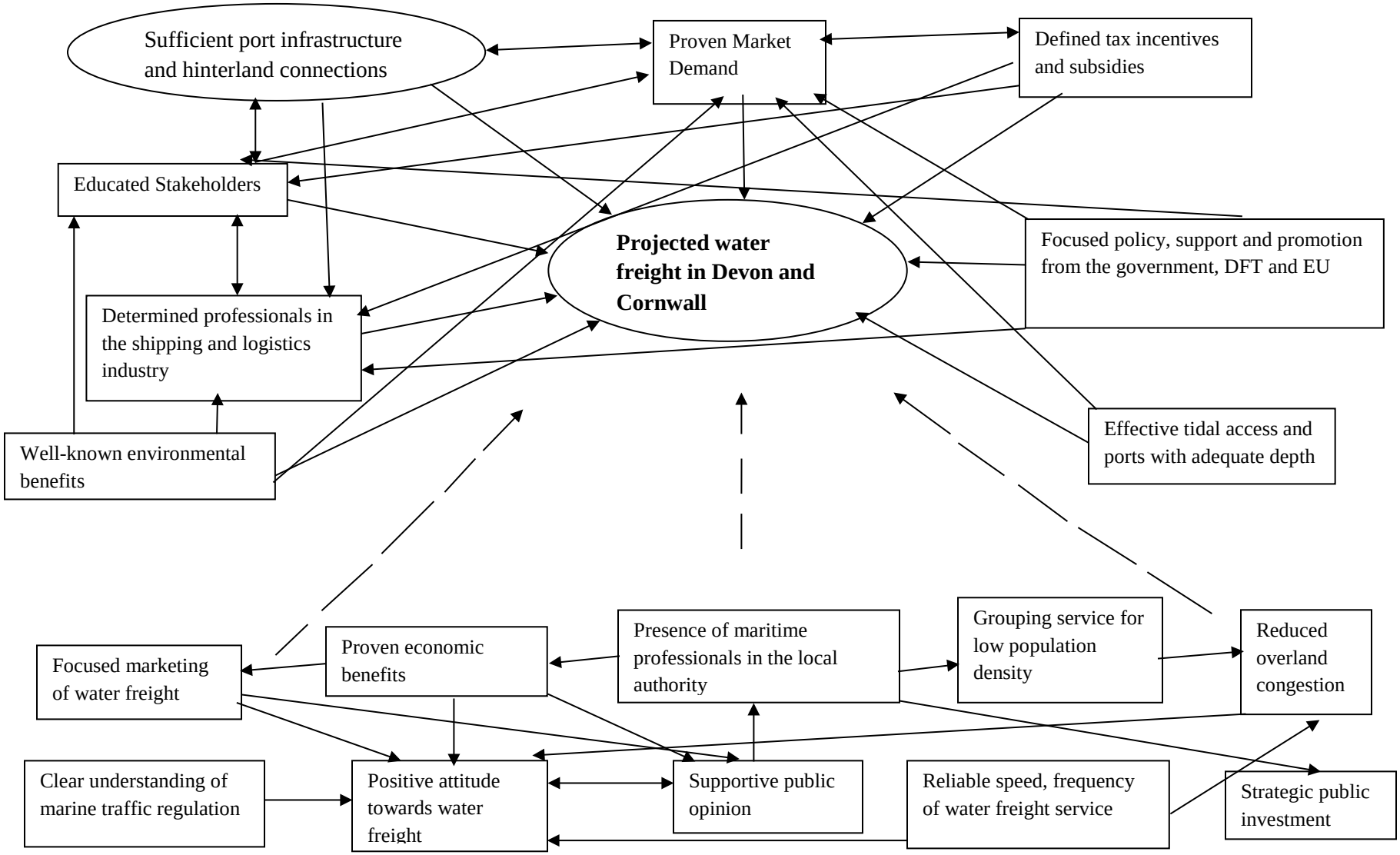


Figure 3 Conceptual framework showing projected water freight in CAD Source: authors own



References

- Chang, Y. C., (2011) Maritime clusters: What can be learnt from the South West of England. *Ocean and Coastal Management*. Volume 54, pp. 488-494.
- Delbecq. A. L, Van de Ven. A. H, and Gustafson. D. H, (1975). *Group Techniques for Programme Planning: A Guide to Nominal Group and Delphi Processes*. Illinois, Scott, Foresman and Company.
- DFT, (2010). *Freight Best Practice Choosing and developing a multi-modal transport solution*. London: DFT.
- DFT, (2016). *Domestic waterborne freight* 2015, London: DFT.
- Kuznetsov, A, (2014) Port Sustainability Management System for Smaller Ports in Cornwall and Devon, PhD Thesis, University of Plymouth, UK
- Miles. M. B, Huberman. A. M and Saldana. J, (2014). *Qualitative Data Analysis*. Sage Publications, 3rd Edition, London
- North West Freight Advisory Group., (2003). *North West Regional Freight Strategy*, Leeds: North West Freight Advisory Group.
- Sea and Water, (2008). *A vision for UK freight trends towards 2018 and beyond*, London: Sea and Water.
- Tailor, J., (1993). Remove barriers to intermodal, *Transportation and distribution*, 34(4), p. 34.
- Yassin, S. M., Shaffril, H. A.M., Hassan, M. S., Othman, M.S., Samah, A.A., and Samah, B. A., (2010), Prospects of Waterway Development as a Catalyst to improve Regional and community Socio-Economy Level, *American Journal of Economics and Business Administration*, 2(3), pp. 240-246.

BARRIERS OF INVENTORY MANAGEMENT IN HUMANATARIAN LOGISTICS: A SYRIAN SUPPLY CHAINS STUDY

Bashar Khoury[1] and Nasiru Zubairu[2]
[1]Independent Researcher of Humanitarian Logistics, Syria
[2]Department of International Shipping, Logistics and Operations, Plymouth Business School, University of Plymouth, UK

Introduction

The basic task of humanitarian logistics comprises acquiring and delivering requested supplies and services at the places and times where needed, whilst ensuring best value for money. In the immediate aftermath of any disaster, these supplies include items that are vital for survival, such as food, water, temporary shelter and medicine, amongst others (IFRC.org, 2018). The role of inventory management in humanitarian supply chain is to deliver goods efficiently. This involves timely and cost effective delivery of goods across the supply chain from suppliers to ultimate beneficiaries or consumers (Fritz Institute, 2012). Logistics cluster organisations activate in Syria, Yemen, Sudan, and other disaster affected-areas have experienced wide range of humanitarian inventory management challenges which hinder the attainment of optimal inventory management within humanitarian supply chains.

Inventory represents a large cost to the humanitarian supply chains. This made up of the cost of the inventory itself, cost of transporting the goods, storage or ware house cost, cost of managing the goods which involves labour, fumigation, repackaging costs. The inventory manager's job is to make inventory available at the lowest possible cost. In order to achieve this, the inventory manager must ensure a balance between supply and demand by establishing minimum holding stocks to cover lead-times. The inventory manager must constantly liaise with the programs to keep abreast of changing needs and priorities. The warehouse must always have sufficient stocks to cover the lead-time for replacement stocks to avoid stock-outs. Furthermore, inventory management in an emergency is more 'project based', matching supply with demand in a rapidly changing environment. This requires building a supply chain that has a high level of flexibility and adaptability, speed in identification of need and rapid order fulfilment through the supply chain. Optimisation comes from having logistics systems that can configure, procure and consolidate these packages quickly and a distribution chain that is flexible and can adapt to changing requirements quickly and at least cost. Information systems that facilitate transparency of the supply chain inventory levels, location, and demand provide the necessary visibility to facilitate good planning and effective decisions that maximize services and reduce costs. (White, 2015).

Literature review

Many resources are utilised as reference points such as publications, reports, and official studies that are published by activated international organisations in Syria that have prolonged experiences in terms of relief, emergency, and recovery operations within Syria since 2012. World Food Program reported that there are 3.5 million people that require humanitarian assistance, 9 million people in need of food assistance, and 6.3 million people are displaced inside Syria (WFP Syria, 2016). United Nations High Commissioner for Refugees (UNHCR) stated that there is 13.1 million people in need in Syria, 6.6 million internally displaced persons, and 2.98 million people in hard-to-reach and besieged areas inside Syria at the end of April 2018 (UNHCR Syria, 2018). This research paper considered UN agencies' publications, reports, official studies, and their experts opinion as references with high level of reliability, accountability, inclusivity, and objectively. Second group of references would be the publications, reports, and official studies issued by international NGOs and their local partners. Many international NGOs have served Syrian crisis honestly and honourably regardless of unsavoury circumstances, threats, political tensions and other challenges. Some of these are renounced

international NGOs such as Oxfam Organization, Norwegian Refugee Council (NRC), Danish Refugee Council (DRC), International Committee of the Red Cross (ICRC), Syrian Arab Red Crescent (SARC) and others. Relevant academic publications were utilised as third group of references. This include academic research papers, case studies, and similar resources that issued by academic institutes, academic researchers, research projects, and freelance researchers. Noticeably, overseas Development Institute (ODI) has published numerous of academic research papers related to Syrian emergency operations that is considered as professional, transparent, and honest.

Inventory management barriers among Syrian humanitarian supply chains

In addition to review of industry publications and extant literature, this study further conducted interviews with industry experts from different organisations in an effort to identify existing logistics gaps and bottlenecks in terms of inventory management within humanitarian organisations peculiar to Syria.

Logistics Cluster (2017) has identified major inventory management gaps in Syria which are shortlisted below:

1. Access and security constraints remain the biggest impediment faced by the humanitarian community in reaching vulnerable communities with life-saving relief supplies inside Syria.
2. Restrictions on movement of humanitarian cargo and the need to increase inter-agency humanitarian facilities such as convoys transport services to reach the difficult-to-access locations.
3. Need for the coordination of cross-border transhipment services from Jordan and Turkey to Syria.
4. Limited storage capacity for prepositioning across Syria.
5. Lack of a reliable fuel supply chain.
6. Lack of facilities for coordination and circulation of logistics information.
7. Increasing need for dedicated logistics training

IFRC (2015) argued that safe access to those in need inside Syria must be guaranteed by all sides for SARC, ICRC and IFRC staff, volunteers, and humanitarian workers in general who frequently put their lives at risk while on duty. The ability to respond to the increasing needs of the most vulnerable in both urban and rural areas, whether internally displaced, residents, host families, refugees, or people who have simply become poverty stricken during years of conflict and suffering. All sides need to allow humanitarian aid to be delivered impartially and with neutrality across front lines, and in particular into besieged areas (IFRC, 2015).

IFRC experts further argued that funding is an important issue in humanitarian inventory management, because of delays and interruptions in terms of funds means delays and interruptions in humanitarian supply chains regardless of other factors such as logistics capacity, safe access, availability of transportation services, transparency, and geopolitical factors (IFRC, 2015).

Findings show many barriers to inventory management within humanitarian supply chains inside Syria. These barriers could divided to few categories as below.

1. Safety and security issues that poses threat to humanitarian aid workers and the entire humanitarian operations.
2. Socio-political issues including government regulations, heavy conflicts, and conflict of interest.
3. Funding problem due to lack of funds, interruption of funds, or conflict in the allocation of funds.
4. Logistics issues including logistics capacity, logistics expertise, transportation, local markets capability, logistics information, and logistics systems and structures.

This study focuses on the relevance logistics challenges facing inventory management within humanitarian supply chains in Syria and attempt to find out the appropriate solutions for these barriers systematically.

Analysis

The main aim of this paper is analyse the barriers in terms of logistics functions especially inventory management that could hinder aid workers in fields, and attempt to propose solutions to this challenges objectively. Propositions from researchers and humanitarian relief experts has been taken into consideration extensively. This paper presents solutions that could enhance inventory management within humanitarian logistics especially in Syrian case.

Deployment electronic supply chain system is crucial step to manage inventory management effectively and efficiently. This include tracking different logistics functions which will facilitate control of procurement orders, collection of goods and services, organise storage system, efficient delivery to end user.

Most of humanitarian experts proposed using of HELIOS system which is open-source complete IT solution for the humanitarian supply chain. This is largely due to successful implementation of HELIOS at Oxfam organisation. HELIOS solution can radically cut the time and cost of paperwork in half due to the following features presented by (Fritz, Institute, 2018):

1. Provides tactical supply chain visibility from mobilization to warehouse. Whether in the field or the headquarters office, online or offline. The HELIOS platform provides macro and micro views and reports from a variety of angles. HELIOS tactical visibility improves coordination across all operating units of an organisation, improving accountability and ensuring that donor funds, goods and services have maximum impact on those in need.
2. HELIOS is the first and only application to automate logistics processes at both the headquarters and field levels and provide tactical visibility from each of these perspectives.
3. Offers supply chain visibility from the donor perspective, enabling organisations to monitor and report on donations, improve donor communications, and engage donors more deeply in the work of the organisation.
4. HELIOS web-based application is available to humanitarian organisations for an affordable monthly charge to cover the software maintenance and support of the project.

Storage capacity development that enhances humanitarian organisations options and increases their ability to quick emergency responses across Syria. With increasing number of items for delivery to the warehouse, there is urgent need to expand storage capacity. Wiik Hall which is a mobile storage unit could erected at the rear of the existing warehouse. This solution is suitable and practical for most of humanitarian organisations across Syria.

Training local logisticians is a solution to cut costs of outsourcing services and avoid import external logistics experts from out of Syria. Most of humanitarian originations adopt this policy in Syria. For example, UN agencies submit online courses, online educational platforms, and on-site training courses to their national employees. UN agencies are also working to improve capacity of local cooperating partners through employee training in order to build their logistics know-how.

There is increasing trend worldwide to enhance human resources for emergency preparedness by offering open-source online training courses such as online training in Ready Disaster platform, IFRC platform, Kaya platform and other similar platforms. This will increase awareness about humanitarian operation, humanitarian logistics and build the local capacity.

Findings

There are many stern barriers affecting inventory management in humanitarian logistics which leads to huge expenditures and loss of time and resources. Lack of transparency and accountability of activated humanitarian organisations in fields has resulted into stern relationships and collaborations due to miss-trust between donors and humanitarian aid workers.

This paper has analyse barriers to inventory management of Syrian humanitarian logistics which are highlighted below:

1. Limited storage capacity for prepositioning across Syria. In addition, there is misuse of available storage capacity and that leads to minimum stockpile and inflation of storage prices for personal interest.
2. Lack of a reliable fuel supply chain which makes humanitarian supply chains unreliable in Syria.
3. Lack of expertise necessary to optimise inventory management in case of Syrian humanitarian supply chains. According to researchers and experts, lack of specific experiences have resulted in escalating the number disaster casualties which could have been minimise if attended to properly.
4. Restrictions on movement of humanitarian cargo and weaknesses of transport services that resulted in delays as a result of incessant postponements.
5. Experts argued that apart from the bad circumstances due to prolonged crisis, the geopolitical factors has side effects on humanitarian supply chain at most times according to most experts.
6. Hidden cooperation between activated workers, independents or organisations, to exchange necessary information, resulting in moving unnecessary cargo to Syria, which overwhelm storage facilities and unsatisfactory congestions in Syrian humanitarian supply chains.
7. Unavailability of electronic solutions. Only few of organisations have IT system that facilitates tracking of inventory movements in details to demonstrate precisely the inventory specifications such as expected order, current orders, warehouse inventory, stockpiles, inventory movements, and their locations.

Recommendations

This work offers the following recommendations based on analyses of data that was collected from experts, aid workers and academic researchers in the field of inventory management within humanitarian supply chain with especial interest to Syria:

1. Employment of electronics solutions that support humanitarian supply chains functions especially inventory management such as HELIOS discussed in this paper and other as appropriate solutions. HELIOS has low cost implication as it is open-source based and it is user friendly for users with low IT literacy. IT permits access to information in real-time, leading to timely planning, accuracy in resource allocation, accountability, information sharing between relevance parties, enhancing transparency and access for donors to monitor activities (Fritz Institute, 2018)
2. Deploying of temporary storage units such as WIIK hall tents; as appropriate solution in emergency. This will help in addressing the challenge of Limited storage capacity for prepositioning across Syria. When a crisis first arises, response time is of the essence, emergency aid halls and tents built for rapid assembly under tough conditions and have strategically warehoused in advance in locations around the world will minimise this impact (O.B.Wiik, 2018).
3. Building local humanitarian logistics experts that fit our current and future needs in terms of humanitarian operations especially inventory management. Most of experts proposed the logical solution that is using online platforms for training local aid workers and increasing their capacity as possible. Kaya org, Disaster Ready org, and others consider as the good examples of open-learning resources. This will address the challenge of lack of expertise fundamental for any optimal inventory management.

References

- IFRC.org (2018), *Humanitarian Logistics,* The International Federation of Red Cross and Red Crescent Societies. [online] available from: http://www.ifrc.org/en/what-we-do/logistics/ [accessed on 16.05.2018].
- Fritz Institute (2012), *Warehousing & Inventory*, Fritz Institute, San Francisco, United States of America.
- White, Justin (2015), *Warehousing and Inventory Management*, Logistics Cluster, [online] available from: http://dlca.logcluster.org/display/LOG/Warehousing+and+Inventory+Management#WarehousingandInventoryManagement-ManagingInventoryLevels [accessed on 16.05.2018].

TOWARDS A TAXAMONY OF SUPPLY CHAIN FINANCIAL PERFORMANCE

Nasiru Zubairu, John Dinwoodie and Lise Hunter
Maritime and Logistics, Business and Policy Group (MLBP), Institute for Social, Policy and Enterprise Research (iSPER), Plymouth Business School, University of Plymouth

1. Introduction

Since the 2008 global financial crisis, substantial reductions in issuance debt and increased financial costs have squeezed corporate liquidity. Subsequent solutions and programmes to optimise financial flow have embraced supply chain finance (SCF) strategy (Caniato *et al.*, 2016). Businesses are continually seeking strategies to improve their supply chain financial performance (SCFP) to reduce costs and downtime, to improve their productivity and customer base, and become more sustainable. As executives realise that supply chain (SC) competition has now supplanted corporate competition, a well-managed SC offers a gestalt in which the value of the whole exceeds the sum of its parts. Optimising SCFP should be the ultimate goal of any supply chain management (SCM) strategy (Shi and Yu, 2013). Managers need to know whether SCM practices contribute to financial performance (FP), and how to direct SC investments to enhance competitive advantages and maximise financial gains. To justify SC strategy, managers are obliged to show how SC capabilities contribute to FP (Shi and Yu, 2013). Strategy formulation incorporates important performance measurement but few studies have investigated SCFP drivers and measures. Fragmented prior studies have considered drivers or performance measures, but not both. This paper devises an explicit taxonomy of SCFP to guide practitioners and researchers in the design and implementation of SCM strategies.

2. Literature review

2.1 The problem context: supply chain financial performance

Emerging studies strengthen the link between SCM and corporate FP (Martin and Patterson, 2009). SC practices are increasingly complex and strategically important processes for creating and maintaining firms' competitive advantage (Ellinger and Ellinger, 2014). Modern SC design and management generates a major source of competitive advantage for companies (Okongwu *et al.*, 2015), and improving SCM practices impacts FP positively (Johnson and Templar, 2011). Firms now realise the strategic significance of SCM and appreciate the unique competitive advantages that a well-managed SC brings (Stevens and Johnson, 2016). SCM plays an important role in creating or destroying shareholder value due to its influence on FP (Ellinger *et al.*, 2011). Managers need to identify SC initiatives that create the most value for shareholders (Losbichler *et al.* 2008). SC managers are duty-bound to demonstrate how SCM contributes positively to FP, to justify associated investment (Shi and Yu, 2013). This need for enterprise efficiency is compelling executives to identify, review and adopt SC initiatives and strategies that drive corporate FP.

2.2 Supply chain management strategies and financial success

Previous studies show that SCM practices strongly influence corporate financial success. Studies by Stevens and Johnson (2016); Zhang and Huo (2013); Marquez *et al.* (2004) show that SC integration (SCI) and information sharing positively impact SCFP. The work of Blankley (2008) imply that SC information technology (IT) impacts SC financial success. Articles by Shi and Yu (2013); Oke and Kach (2012) show how SC sourcing strategy is linked to FP. Ntabe *et al.* (2015); Ortas *et al.* (2014) show that sustainable SC, jointly including social and environmental practices is positively associated with corporate FP.

SC practices that drive FP must be supported by other factors to optimise SCFP. Zhang and Huo (2013) argue that although SCI significantly improves FP, trust significantly influences SCI. Marquez *et al.* (2004) showed how adoption of e-collaboration in SCI enhanced FP of the entire SC. Yu *et al.* (2013)

show that customer satisfaction is positively related to FP and fully mediates the relationship between customer integration and FP. Oke and Kach (2012) indicate that operational innovation mediates the influence of sourcing strategy on FP. Blankley (2008) proposed that FP improvements from SCM technology investments are derived from improvements in knowledge-intensive capabilities, which lead to improvements in operational capabilities, and financial benefits. The ability to recognise benefits is also influenced by a firm's position within the SC and exogenous economic market forces.

2.3 Supply chain financial performance measurement

FP measurement is a vital strategic tool which helps organisations to appraise their target objectives, but few articles were identified which provide clear measurement tools for SCM strategies and practices. In studies which explored key performance (PM) criteria, different approaches generated differing results, due to differing perspectives. Studies by Elgazzar *et al.* (2012); Hahn and Kuhn (2012); Johnson and Templar (2011) measure FP using traditional financial metrics or hard measures which are all tied profitability. The bottom-line financial effect of SCM has been of continuing interest, however, there are arguments that the traditional cost-based measures are inadequate as they fail to incorporate non-financial performance such as continuous improvement, customer service and other intangible aspects of performance (Sriyogi, 2012). Recently sustainability has become a popular measure of FP, which argues FP should be accessed using social and environmental PMs (Ortas *et al.,* 2014). Researchers such as Ntabe *et al.* (2015); Okongwu *et al*. (2015); Sriyogi (2012) utilise combined approaches to empirically investigate the linkages through which SCM practices impact on financial and non-financial performance, and consequently to achievement a firm's strategic objectives. Diverse debate obfuscates a uniform approach, and confuses practitioners seeking appropriate FP measures to evaluate SCM strategy performance.

The literature reviewed implies that all approaches to PM strive for competitive business survival and growth assessed using traditional FP measures because all intangibles, social and environmental factors incur associated financial benefits and costs implication for SCs. Ortas *et al.* (2014) show the relationship between sustainable SC performance and companies' margins, revenue, profitability. FP is closely related to SCM effectiveness, important SC performance drivers such as IT, system integration and external relationships play important roles in enhancing PF, which are measurable using aspects of FP, revenue, cost and working capital (Shi and Yu, 2013; Ellinger *et al.,* 2011). However, other studies argue that fixed assets should be included as a FP measure taking into consideration all the components of economic value added (EVA), revenue growth, cost efficiency and fixed asset utilisation (Elgazzar *et al.,* 2012; Losbichler *et al.,* 2008).

3. Description of problem

This study found only one prior statement of SCM competencies that drive PF, sourcing strategy, IT, system integration and external relationships (Shi and Yu, 2013). All other qualifying articles studied the relationship between SC strategy and SCFP using disjointed SC drivers. Considering the importance of SCM strategies and competencies to business survival and growth, in this study, template analysis (TA) utilises existing literature to identify key drivers that enhance FP, to propose an explicit taxonomy. Considering how essential PM is in evaluating the efficiency of SCM practices, in this study, TA explores FP measurement metrics to propose a taxonomy for SCFP.

4. Research work

4.1 Systematic literature search for supply chain financial performance

Systematic searches for publications between January 2000 and December 2017 encompass the 2008 economic downturn which stimulated interest in SCF (Caniato *et al.,* 2016). Extended search criteria revealed no relevant literature pre-2000. To ensure that only papers addressing the study objectives were captured, the exclusion of articles devoid of content related to SCFP drivers, practices, strategy, measures or the linkages through which SCM practices impact on FP.

4.2 Template Analysis

TA was utilised to ensure replicability, using hierarchical coding to balance a structured process of analysing textual data with the flexibility for modification where needed. A coding template is developed based on a subset of data, which is subsequently revised and refined as further data emerge (King and Brooks, 2017; 2016; Brooks *et al.,* 2015). In this study, predetermined categories for SCFP were established deductively as higher-order themes, subsequently, TA identified various SC drivers of FP. Typically TA is applied to interview transcripts but any kind of textual data is appropriate. Further, TA does not suggest in advance a set sequence of coding levels but rather encourages the development of themes extensively where the richest data in relation to the research objective are found. Equally, TA does not insist on an explicit distinction between descriptive and interpretive themes, nor on a particular position for each type of theme in the coding structure (Brooks *et al.,* 2015).

4.2.1 Initial template

Themes for the initial template were derived deductively from a sub-set of qualifying articles. Initial higher-order themes for SCFP practices included sourcing strategy, IT, system integration and external relationships, and revenue growth, operating cost reduction and working capital efficiency for SCFP measures (Shi and Yu, 2013) (Table 1).

Supply chain financial performance drivers	Supply chain financial performance measures
Sourcing strategy	Revenue growth
Information technology	Operating cost reduction
System integration	Working capital efficiency
External relationships	

Table 1: Higher-order themes for initial template

4.2.2 Development of final template

After identifying a base definition from the initial template, further SCFP data items from qualifying literature extracts were applied to develop the final template (Table 2). Iteratively modifications were applied where weaknesses appeared relating to how well data was captured, relevant and potentially important (King and Brooks, 2017).

Supply chain financial performance drivers	Supply chain financial performance measures
Sourcing strategy	Revenue growth
Information technology and automation	Operating cost reduction
Integration and collaboration	Working capital efficiency
Sustainability	Fixed asset utilisation

Table 2: Higher-order themes for final template

5. Results and discussion

5.1 SCFP drivers

The final template (Table 2) identified sourcing strategy, IT and automation, collaboration and integration, and sustainability as higher-order themes that drive SCFP. Sourcing strategy and IT remain similar to the initial template, but integration and collaboration combine both system integration and external relationships. Sustainability is a new higher-order theme which develops as further data emerges from qualifying literature.

5.1.1 Sourcing strategy

TA established sourcing strategy as a higher-order theme for SCFP. In conformity with TCE, efficient SC sourcing strategy should lead to improved FP. Sourcing strategy allows SC partners to focus on their key competitive advantages which result in win-win situations for all SC participants (Shi and Yi, 2013). There is strong support for the relationships between strategic purchasing and supply management (PSM), customer responsiveness, and FP such as ROI, profit margin, and average net income before tax (Chen *et al.,* 2004). Sourcing strategy makes positive contributions to SCFP. Sourcing strategy is more efficient when there is collaboration and integration with suppliers. However, to sustain the financial benefits, participants have to constantly weigh the costs of a make-or-buy decision.

5.1.2 Information technology and automation

In the final template, IT and automation as a higher-order SCFP theme. IT-based SCM systems make positive contributions to FP (Dehning *et al.,* 2007). However, the financial benefits could be affected by IT implementations, bargaining power and financial strengths of the leading company, market unpredictability, regulations and imitations by competitors. Integration and collaboration fosters technology adaptation and implementation.

5.1.3 Integration and collaboration

Table 2 depicts integration and collaboration as the dominant driver of SCFP. An integrated SCM increases a company's capability to coordinate all business processes within and beyond its boundary to enhance FP (Shi and Yu, 2013). Integration and collaboration is vital to optimise SCFP. SCI fosters SC flexibility which improves financial benefits especially during market unpredictability. However, the performance of SCI and collaboration could be affected by the level of trade digitalisation, concentration and duration of the SC, product and market complexities, and mutual trust.

5.1.4 Sustainability

In the final template, SC sustainability is a higher-order SCFP driver. Sustainability in competitive global SCs extends beyond Brundtland's definition of sustainable development that "…meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987). SC sustainability now includes business survival in a risky and competitive environment, pursuing social and environmental performance, while simultaneously aiming for financial benefits. Increasing interest in SC sustainability reflects concerns with climate change and ecosystems which necessitate environmentally friendly practices as a competitive SC strategy (Ntabe *et al.,* 2015). Social and environmental sustainable SC practices have positive effects on the economic dimension of sustainable SC, which is strongly linked to FP. Whilst the sustainable SC has a two-way positive relationship with margins and revenue, its link with profitability is one-directional. Sustainability in SCs is more efficient when implemented jointly by all SC participants. The financial benefits of sustainable SCs hence vary between regions and industries. Additionally, economic challenges such as a financial crunch could affect sustainable SCFP.

5.2 SCFP measures

Studies show how SCM practice drives firm FP, revenue, operating costs, and working capital. These are employed as higher-order themes in the initial template (Table 1). In the final template (Table 2), data from qualifying articles highlights fixed assets utilisation as an additional measure for SCFP. Assets utilisation is a major medium-term strategy for increasing shareholders value creation (Hahn and Kuhn, 2012). Whilst cost reduction remains a major objective of SCM initiatives, companies view SCM as a strategy to increase shareholders value and enhance competitive advantages (Losbichler *et al.,* 2008).

5.2.1 Analysis of SCFP measures

Leading SC firms outperformed the industry average in compound average growth rate of market capitalisation (Shi and Yu, 2013). Elgazzar *et al.* (2012) established that linking SC processes' performance to corporate strategic objectives enables companies to formulate strategies to improve

SCM by channelling those strategies to enhance FP. As a measure of FP, the components of EVA fit well with Du Pont analysis, which is a financial ratio to measure an organisation's profitability and operating efficiency. This examines revenue, cost and total assets, which measure how much profit a firm generates relative to assets employed (Elgazzar *et al.,* 2012).

Dehning *et al.* (2007) examined the change in FP before and after IT-based SCM adoption controlling for industry median changes in performance, and showed that IT-based SCM systems increase gross margin, inventory turnover, market share, return on sales (ROS), and reduce selling, general and administrative expenses (SG&A). A major SC challenge is for firms to manage costly inventories, reduce cost and improve operating performance. A multinational corporation's sales penetration into emerging markets is associated with less inventory and FP in terms of return on asset (ROA) and ROS (Han and Dresner, 2013). Inventory and cycle time are most useful for measuring the performance of SC companies (Martin and Patterson, 2009). However, Losbichler *et al.* (2008) studied cash-to-cash cycle time (C2C) amongst European companies, finding that although certain SC companies and industries were able to minimise their C2C, the general improvements were marginal.

To explore whether and how SC strategies affect performance, Qi *et al.* (2009) established that manufacturing companies' SC strategy that consists of lean, agile, and lean/agile approaches perform better in terms of product characteristics, financial and operational performance. Moreover, lean/agile and lean strategy performed significantly better than agile strategy with respect to operating cost. In a period of SC disruptions and glitches, where a companies are unable to match demand and supply, companies report on average lower sales growth, and higher growth in cost and inventories. Further, firms do not recover quickly from the adverse financial consequences of glitches (Hendricks and Singhal, 2005). The foregoing discussion proposed components of revenue growth, costs reduction, working capital efficiency and fixed asset utilisation as SCFP measures (Table 2).

5.3 Taxonomy for SCFP

A SC comprises many value chains across different locations which aim to add value at every chain level to achieve financial and non-financial performance across the entire SC. Because SC participants are rarely in the same location and most interact and make decisions using communications technology, each SC partner has a mandate or strategy to make or implement decisions that have performance implications. The strategies are calculated, competitive, robust, costly and highly complex. Although strategy plays an increasingly important role in SC growth and survival, little is known about strategies that drive SCFP, its dynamics and effectiveness. Using TA (King and Brooks, 2017; Brooks *et al.,* 2015), this study developed a taxonomy for SCFP deductively by extracting explicit constructs from literature. Published SCFP related findings are retained to analyse the texts and avoid data elimination, and prevent researcher bias. The taxonomy defines PF drivers logically, for example, "sustainability" includes "social and environmental" factors, and business growth and survival.

The final template (Table 2) defines the "drivers for SCFP" with higher-order themes encompassing sourcing strategy, IT and automation, integration and collaboration, and sustainable SCM. The challenge for both practitioners and researchers is that SCFP is relatively difficult to measure as there are no established measurement criteria. The template for SCFP measures incorporates conventional FP measures as surrogates for SCFP. The template defines "SCFP measures" themes which include revenue growth, operating cost reduction, working capital efficiency, and fixed asset utilisation as higher-order themes. These categories show the rationale behind SCFP in case the taxonomy is incomplete, empowering SCs to identify sub-categories and develop the taxonomy.

6. Conclusions, Implications and directions for future research

SCM contributes significantly to business performance, including FP. This study proposes an explicit taxonomy of SCFP based on systematic literature reviews undertaken using TA, and suggests that effective SCF outcomes are a function of appropriate SC strategy. The drivers for SCFP strategy include

sourcing strategy, IT and automation, integration and collaboration, and sustainability. The level of performance between these strategies depends on the extent of the interconnectivity between each strategy, explaining why integration and collaboration are integral to optimising SCFP. Additionally, the FP of these phenomena can be measured using traditional financial measures such as ROA, profitability, and liquidity, which are a function of revenue growth, cost reduction, working capital efficiency and fixed asset utilisation.

6.1 Practical impact

This study contributes to SCM and FP research by developing a taxonomy based on clearly defined theoretical and methodological foundations and identifies a novel combination of SCFP drivers and measures to guide SC participants. Findings underline the need to incorporate SCM as part of corporate strategy, because SC capabilities affect FP in both the short-run and long-run. The study identifies conditions that may impede the performance of these strategies.

A novel methodology is presented, applicable where variables are tentatively defined in advance and typically carried out on a sub-set of data derived from theoretical or pragmatic interest which is relevant to a given problem. The methodology offers the potential for organisations or networks to gain SC competitive advantages. The method assists practical identification and application of SCFP strategies, which if prioritised and safeguarded will result in gestalt SC financial benefits.

Study findings are derived from rigorous review and analysis of qualifying articles from different sectors. Researchers with access to a wide range of specific industry data can replicate the approach. The results of such study offer an initial template which can be refined by applying data collected to capture practitioners' tacit knowledge, reality, and values to develop a final template to define SCFP in a particular industrial context.

6.2 Research impact

A new taxonomy for SCFP emerged, grounded in an extensive review of explicit extant research findings. This provides a better understanding relating to how SCM practices make positive contributions to FP by outlining explicit SCFP drivers alongside established FP measures.
The generic taxonomy presented here can be applied to other sectors where no reliable taxonomy for SCFP drivers and measures are available. A novel methodology for taxonomy development is presented based on systematic selection and analysis of published texts, guided by TA.

TA was deployed to guide exploratory research by analysing secondary data concerning FP in an area where explicit knowledge is scant and theoretical development trails applications. TA is suited to developing an SCFP taxonomy using previous literature because TA is typically based on a sub-set of data, which is subsequently modified as further data emerges to undertake bespoke SCM research where strategy drives performance. This process can be applied in research where additional primary data collection would attempt to apprehend the expertise, intuition and know-how of professionals and embed it into corporate FP. This combination of methods can be utilised to analyse unstructured, scarcely available secondary data to enhance understanding of certain phenomena.

This paper represented SCM practices as an iterative organisational SC strategy whereby each SC participant is analogous to a value chain. Optimum SCFP assumes that all actors implement strategies which include sourcing strategy, IT and automation, integration and collaboration, and sustainability practices.

Acknowledgement

This study was carried out as part of the PhD scholarship granted Nasiru Zubairu by Petroleum Technology Development Fund (PTDF), Nigeria. We hereby gratefully acknowledge their support.

References

- Blankley, A. (2008), 'A conceptual model for evaluating the financial impact of supply chain management technology investments' *The International Journal of Logistics Management*, Vol. 19 No. 2, pp. 155-182.
- Brooks, J., Mccluskey, S., Turley, E. and King, N. (2015), The utility of template analysis in qualitative psychology research, *Qualitative Research in Psychology*, Vol. 12 No. 2, pp. 202-222.
- Caniato, F., Gelsomino, L.M., Perego, A. and Ronchi, S. (2016), 'Does finance solve the supply chain financing problem?' *Supply Chain Management: An International Journal*, Vol. 21 No. 5, pp. 534-549.
- Chen, I.J., Paulraj, A and Lado, A.A. (2004), 'Strategic purchasing, supply management and firm performance' *Journal of Operations Management*, Vol. 22 No. 5, pp. 505-523.
- Dehning, B., Richardson, B.J. and Zmud, R.W. (2007), 'The financial performance effects of IT-based supply chain management systems in manufacturing firms' *Journal of Operations Management,* Vol. 25 No. 4, pp. 806-824.
- Elgazzar, S.H., Tipi, N.S. and Hubbard, N.J. (2012), 'Linking supply chain processes' performance to a company's financial strategic objectives', *European Journal of Operational Research*, Vol. 223 No. 1, pp. 276-289.
- Ellinger, A.E and Ellinger, A.D. (2014), Leveraging human resource development expertise to improve supply chain managers' skills and competencies', European Journal of Training and Development, Vol. 38 No. 1/2, pp. 118-135.
- Ellinger, A.E., Natarajarathinam, M., Adams, F.G., Gray, J.B., Hofman, D. and O'Marah, K. (2011), 'Supply chain management competency and firm financial success', *Journal of Business Logistics*, Vol. 32 No. 3, pp. 214-226.
- Hahn, G.J. and Kuhn, H. (2012), 'Simultaneous investment, operations, and financial planning in supply chains: A value-based optimization approach', *International Journal of Production Economics*, Vol. 140 No. 2, pp. 559-569.
- Han, C. Dong, Y. and Dresner, M. (2013), 'Emerging market penetration, inventory supply, and financial performance', *Production and Operation Management*, Vol. 22 No. 2, pp. 335-347.
- Hendricks, K.B. and Singhal, V.R. (2005), 'Association between supply chain glitches and operating performance', *Management Science*, Vol. 51 No. 5, pp. 695-711.
- Johnson, M. and Templar, S. (2011), 'The relationships between supply chain and firm performance: The development and testing of a unified proxy', *International Journal of Physical Distribution and Logistics Management*, Vol. 41 No. 2, pp. 88-103.
- King, N. and Brooks, J.M. (2017), *Template Analysis for Business and Management Students.* London: Sage.
- Losbichler, H., Mahmoodi, F. and Rothboeck, M. (2008), 'Creating greater shareholder value from supply chain initiatives', *Supply Chain Forum: An International Journal,* Vol. 9 No. 1, pp. 82-91.
- Marquez, A.C., Bianchi, C. and Gupta, J.N.D. (2004), 'Operational and financial effectiveness of e-collaboration tools in supply chain integration', *European Journal of Operational Research.* Vol 159 No 2, pp. 348-363.
- Martin, P.R. and Patterson, J.W. (2009), 'On measuring company performance within a supply chain' *International Journal of Production Research*, Vol. 47 No. 9, pp. 2449-2460.
- Ntabe, E.N. LeBel, L. Munson, A.D. and Santa-Eulalia, L.A. (2015), 'A systematic literature review of the supply chain operations reference (SCOR) model application with special attention to environmental issues', *International Journal of Production Economics,* Vol. 19 No. 169, pp.310-332.
- Oke, A. and Kach, A. (2012), 'Linking sourcing and collaborative strategies to financial performance: The role of operational innovation', *Journal of Purchasing and Supply Management*, Vol. 18 No. 1, pp. 46-59.

- Okongwu, U., Brulhart, F. and Moncef, B. (2015), 'Causal linkages between supply chain management practices and performance: A balanced scorecard strategy map perspective,' *Journal of Manufacturing Technology Management*, Vol. 26 No. 5, pp. 678-702.
- Ortas, E., Moneva, J.M. and Álvarez, I. (2014), 'Sustainable supply chain and company performance: A global examination,' *Supply Chain Management: An International Journal*, Vol. 19 No. 3, pp. 332-350.
- Qi, Y., Boyer, K.K and and Zhao, X. (2009), 'Supply Chain Strategy, Product Characteristics, and Performance Impact: Evidence from Chinese Manufacturers,' *Decision Sciences*, Vol. 40 N. 4, pp. 667-695.
- Shi, M. and Yu, W. (2013), 'Supply chain management and financial performance: literature review and future directions,' *International Journal of Operations and Production Management*, Vol. 33 No. 10, pp. 1283-1317.
- Sriyogi, K. (2012), 'Internal benchmarking of supply chain performance measures evidence from selected organizations,' *The IUP Journal of Supply Chain Management*, Vol. 9 No. 1, pp. 40-71.
- Stevens, G.C. and Johnson, M. (2016), 'Integrating the Supply Chain …25 years on,' *International Journal of Physical Distribution and Logistics Management*, Vol. 46 No. 1, p. 19-42.
- United Nations (1987), *Report of the World Commission on Environment and Development: Our Common Future*. [online] available from: www.un-documents.net/our-common-future.pdf, [Assessed on 01 April 2018].
- Yu, W., Jacobs, M.A., Salisbury, W.D. and Enns, H. (2013), 'The effects of supply chain integration on customer satisfaction and financial performance: An organizational learning perspective,' *International Journal of Production Economics,* Vol. 146 No. 1, pp. 346-358.
- Zhang, M. and Huo, B. (2013), 'The impact of dependence and trust on supply chain integration,' *International Journal of Physical Distribution & Logistics Management,* Vol. 43 No. 7, pp. 544-563.

THE AMBIVALENCE OF EMPLOYEE EMPOWERMENT: THE CASE OF THE SHIPPING INDUSTRY

Lijun Tang
School of Business, Plymouth University, UK

Introduction

Shipping is a vital part of the global economy by providing cost effective transportation and carrying 90 per cent of the global trade. With the awareness that human error underlies the majority of maritime accidents, there is a recent shift in regulatory focus from technical matters (e.g. SOLAS, MARPOL) to the 'human element' (e.g. STCW Convention and ISM Code). Good management and education and training are recognised to be key to the industry. Furthermore, while education and training initially focussed on individual competency, nowit expands to include inter-personal skills such as leadership and teamwork. As a result, the discourse of employee empowerment is gaining foothold in shipping, and seafarers are required to participate in, or at least contribute information to, decision making.

Social practices are shaped by, and at the same time reproduce and modify, social structures (Giddens 1984). As such, effective employee empowerment requires enabling structures. The question arising here is how employee empowerment is affected by the various structures in the shipping industry and by their interactions. Drawing on Sewell's (1992) theory of structure, this paper aims to address this question by taking stock of existing research evidence, revealing paradoxes and contradictions, and drawing out conclusions and implications.

Structure

Sewell's (1992) theory of structure is based on a critical reformulation of Anthony Giddens'(1984) notion of the duality of structure. Following Giddens, Sewell argues that structures have dual components: schemas (or 'rules' in Giddens' terminology) andresources. Unlike Giddens who sees structure as virtual in the sense that it does not have a material existence, Sewell argues that while schemas as 'generalizable procedures applied in the enactment/reproduction of social life' are virtual, resources (consisting of both human and non- human resources that can be employed to maintain and enhance power) can only be actual. The duality of structure also denotes that the two components are interdependent: on the one hand resources are effects of schemas, and on the other schemas are effects of resources. Schemas would be abandoned and disappear if no resources are mobilised to maintain them.

Sewell further points out that many types of structures co-exist in societies, for example, religious structures, educational structures, political structures, and kin structures. These structures intersect and interact with each other in both the schema and the resource dimensions. This view of structure implies agency: social actors have the ability to apply schemas creatively in new contexts and in so doing they have the capacity to reinterpret and mobilize an array of available resources.

Structures of the shipping industry

Organisational structure

Shipping companies are characterised by hierarchical organisational structure (Dutt 2015; Sampson 2013). In this organisational structure the onshore managers possess varying degrees of authority, skills and employing power. A rough layout of a shipping organisation involves the CEO supported by a board of directors who control organisational budget allocation and policy making. They are supported by senior managers who have some input in the above functions but are more involved with the external liaison in the company business. The lowermost layer of onshore managers is made up of ship superintendents who look into the daily operation of the ships and whose influence in the employer-type functions is limited. On ships, seafarers have specific roles with very few overlapping responsibilities. Each of themis known byhis or her rank which corresponds with his or her job description and position in the shipboard hierarchy

Operational structure

Shipping is a global industry and shipping companies routinely optimise their operations by spreading their businesses across several countries. It is a common practice that ship owners/managers from traditional maritime nations register ships in Flag of Convenience countries (e.g. Panama and Liberia) and outsource seafarers from cheaper labour supply countries (e.g. the Philippines). As such, the operational structure of the industry is global in scope. The underlying logic or schema is to achieve cost-effectiveness. Thus the majority of seafarers are drawn from low cost labour supply countries. Many ship managers invest considerable resources to ensure a stable and adequate supply of seafarers from those countries.

Regulatory structure

In accordance with the global nature of shipping, its regulatory structure is global, involving individual States and industry stakeholders together engaging in multilateral deliberations in worldwide forums such as the International Maritime Organisation (IMO) and the International Labour organisation (ILO). The aim is to adopt internationally agreed regulations, which are implemented by individual flag states and enforced by various stakeholders including flag states, port states, classification societies, shipping insurance companies, and national and global labour unions, major shipping customers.

Two regulations are specifically related to employee empowerment. One is Manila Amendments to the STCW, which specify rules on leadership and teamwork, which include:

- Questionable decisions and/or actions result in appropriate challenge and response
- Operations are planned and resources are allocated as needed in correct priority to perform necessary tasks
- Necessary team member(s) share accurate understanding of current and predicted vessel status and operational status and external environment

The other is the ISM Code, which requires seafarers participate in safety management by identifying and assessing risks and reporting deficiencies. To make sure that companies comply with these, enforcement agencies, such as classification societies, flag states, and port states conduct regular inspections. The question is how effective these regulations are.

Assertive or obedient?

In terms of crew resource management, research suggests that shipping companies provided training even before it became mandatory (Tang and Sampson 2011). Maersk, the biggest shipping company in the world, introduced Bridge Resource Management (BRM) training in their company in 1994. According to Byrdorf (1998), between 1992 (before the introduction of BRM training) and 1996 (after the introduction), incidents and accidents in the Maersk shipping company decreased by a third. As a result, all its insurance premiums were reduced by 15 per cent by 1998. Thus, BRM training enhance safety. It consists of resource management, assertiveness, communication, team work, and stress coping, and emphasises encourages group decision making (Flin et al. 2002; Hetherington 2006). Individuals inevitably have biases; by involving two or more people in the decision making process, the influence of individual biases and thus the chances of a mistake can be reduced (CHIRP 2018).

The research findings about UK seafarers (Oxford Economics 2016) reveal that employers have high regard for them, not only for their technical skills but also because they are capable of thinking independently and not afraid to challenge senior ranks when they see issues. Research evidence about Filipino seafarers however strongly suggests that they are deliberately trained to be obedient and submissive. The following quotations are messages given by crewing managers in Manila to Filipino seafarers during pre-departure training sessions (Pia 2016):

"It is necessary that the behaviour you bring along with you is the attitude of someone who have masters. Observe, submit and obey!"
"You have to be submissive there. It is necessary that you know how to follow."
"Your work in the ship needs you to observe, submit and obey."

These quotations clearly demonstrate that Filipino crewing managers see obedience is a competitive edge of Filipino seafarers. In fact being submissive and subservient is seen by the industry to make Filippo seafarers ideal workers on-board ships, especially cruise ships. The case of Filipino seafarers indicates a rather different reality, that is, ship managers favour and implement an authoritarian and hierarchical management structure on their ships. Why Filipino seafarers are trained not to be assertive despite the regulation and the safety benefit? I would argue that these two views reflect the ambivalent position of ship managers. To demonstrate this argument, it is necessary to look into the relationships between seafarers and ship managers ashore and the relevant structures.

Hierarchy and control between seafarers and the management

Research evidence suggests a strong hierarchical power relation between seafarers and ship managers ashore. In a large scale study (including eight ship-board field trips, shore-based interviews with 303 seafarers, and a further questionnaire study with 2,500 seafarers) about relationships between seafarers and shore-side personnel (Sampson et al. 2016), it was noted that the hierarchy between seafarers and management ashore was so profound that seafarers shared the opinion that, 'as a rule, you cannot say no to superintendents'. This indicates control rather than empowerment. The research also indicates a blame culture in the industry. The majority of the questionnaire respondents believed that seafarers were sometimes (50%) or 'often' (25%) blamed for incidents that were not their fault. Consequently, only one third of the questionnaire respondents mentioned that they could tell the management 'the full truth about the situation on board'.

These findings point to the issues of safety management. In compliance with the ISM Code, shipping companies have policies and procedures in place enabling and encouraging seafarers to report deficiencies and near-misses. Some companies even provided financial incentives. Nevertheless, under-reporting remains a serious problem in the shipping industry as indicated above. In this context, Oltedal and McArthur (2011) did a questionnaire survey on the Norwegian merchant fleet, and Kongsvik et al. (2012) conducted another one on offshore service vessels operating on the Norwegian continental shelf. Both studies found that poor quality feedback on reporting, and perceived demand for cost-effectiveness and efficiency were negatively associated with the level of reporting. To illustrate the issue of under-reporting further, Bhattacharya (2009) went on board four oil tankers manned by multinational crew and Xue (2012) boarded four chemical tankers manned by Chinese crew to examine safety reporting in practice.

On the chemical tankers manned by a Chinese crew, Xue noted that even though shipping companies had procedures encouraging seafarers to report safety deficiencies, superintendents told their seafaring colleagues either explicitly or implicitly not to report two types of deficiencies. The first type was those too expensive to rectify; and the second type would indicate that superintendents or other shore-based managers were responsible for the deficiencies. In this regard, ship managers encourage obedient seafarers, who work as told without complaint even though their health and safety is jeopardised.

The question is why seafarers do not complain. The answer lies in the organisational structure. In line with the structure is the hierarchical appraisal arrangement: captains appraise the performances of chief officers and chief engineers who in turn appraise their direct subordinates, and captains are appraised superintendents. Appraisal outcomes are linked to seafarers' promotion and income (bonus). If an officer receives bad remarks in the appraisal report, he/she is unlikely to get promoted to the next rank and his/her bonus would be deducted (Xue et al. 2017). Furthermore, appraisal reports are likely to be confidential and seafarers may not know what is reported there. As such, seafarers are reluctant to make complaints and offend their superiors and managers.

This reluctance is not limited to Chinese seafarers. Bhattacharya's study further revealed seafarers of other nationalities were also reluctant to make deficiency reports. They fears that they might get blamed for any reported incidents. Both Bhattacharya and Xue noted a blame culture in shipping - managers regarded reported deficiencies as problems which were often attributed to incompetency or lack of training of seafarers. If found responsible for reported incidents, a seafarer may not get promoted, or even worse, may get employed in the future (Bhattacharya 2011).

These findings suggest a few types of feedback detrimental to reporting. First, no feedback. When the report is about equipment deficiencies that require costly repair or spare parts, managers ignore such reporting. Second, negative feedback. Managers either explicitly or implicitly discourage seafarers from reporting issues that are costly to dealt with or reveal negligence of managers. Third, punitive feedback. Seafarers are blamed for causing the reported incidents.

On top of discouraging feedback, prioritisation of productivity over safety is also common in the industry. Thus, captains are pressurised to sail despite adverse weather conditions (Sampson et al. 2016; Xue et al. 2017). The conflicts between safety and productivity at workplace are not new (Carayon et al. 2015; Woods 2007). Carayon et al. (2015) point out, 'what is espoused by senior management in terms of safety priorities does not reflect how safety-productivity trade-off decisions are actually made in the normal course of operations.' Although there are policies and procedures in place in the shipping industry, it seems that little resources are mobilised to enact them. On the contrary, the management invests resources in monitoring seafarers and coerces seafarers not to report or to disobey orders. This structural deficiency not only affect safety management, but also serves to disempower employees.

Control and disempowerment is further reinforced by the global structure of the industry. The global seafarer market is characterised by flexible employment – international ship managers recruit seafarers from labour supply countries through local crewing agencies on tour-of-duty contracts (ILO 2001). Ship managers have no obligation to seafarers' future employment and have the power to sack seafarers as they wish. As such, the global structure reinforces the hierarchical structure of shipping companies and makes power disparity between managers and seafarers wider.

To be sure, organisational structures are inevitably hierarchical even though some organisations have flatter structures than others. As such, employee empowerment needs enabling organisational structure which reduces power disparity between workers and managers. The European Union's European Works Councils (EWC) Directive (1994) for example stipulates that multinational companies under certain conditions should establish transnational employee consultation structure (in the form of EWC representing workers) covering their European operations. Research literature suggests that to voice their concerns and be able to participate in organisational decision making, workers need to be part of an organised workforce and have collective representation (Nichols et al. 2007).

In shipping, representative consultation structure does not work on shipboard level for many reasons. First, the workforce is scattered at the seas, which limits workplace based solidarity and representation. Second, the global labour market weakens the power of national maritime unions as ship managers can source seafarers from countries where trade unions are weak. As a result, although seafarers' unions do a good job representing seafarers at global forums, such as the ILO and IMO and lobbying for improving seafarers' working and living conditions, at shipboard level, they do not have much influence (Bhattacharya 2009; Dutt 2016; Kahveci and Nichols 2006; Lillie 2006).

Nevertheless, there is also a regulatory enforcement structure and regulatory enforcement agencies put resources in inspection. Therefore, though seafarers are reluctant to make deficiency reports that would reveal either their own or shore-managers' mistakes, they still need to make some reports to pass inspections. In this context, they are selective, choosing not to disclose those events which could indicate their (or their managers') professional failures, but instead happy to report personal injuries or such other untoward events caused by technical problems or mechanical breakdowns (Bhattacharya 2007; 2009).

Also they like to report trivial near misses which could be easily addressed, such as a fire exit blocked by a box (Xue et al. 2018). Despite their effort, regulatory inspections are largely documentation based. In other words, in terms of safety management, inspectors could only check paper records which are routinely manipulated and fabricated by seafarers (Xue et al. 2018). This means that the regulatory structure cannot mobilise sufficient resources to make the rules/policies work as they should be.

The rule of cost-effectiveness thus underlines the structures of the industry, and resources are mobilised by managers to control seafarers and to enact this rule. Complaints from seafarers are silenced and submission is demanded. By contrast, the empowerment policies as per safety management requirements are largely confined to paper, and no resources are invested to sustain them. In the context, it is not difficult to understand why Filipino crewing agencies have developed formal procedures to deliberately and systematically disempower seafarers (Pia 2016). They know that ship managers do not want troublemakers or assertive seafarers who report labour rights violations; they believe that obedience and subservience is the shield that Filipino seafarers have to protect not only their career but also the reputation and business of the agencies (Pia 2016). This of course does not explain why UK seafarers are also respected for their assertiveness. To explain this, I move on to discuss shipboard operations.

Hierarchy on ships: formal structure vs. informal mechanism

Needless to say, the ship management controls the shipboard workplace through the hierarchical structure. On ships, the hierarchy is strong (Bhattachary and Tang 2013; Dutt 2015), the captain has dominant power on the ship and is often regarded as 'king' (Sampson 2013). Pressure is cascaded down from the management to senior officers and then to juniors on ships (Dutt 2015). As mentioned earlier, the appraisal system makes ratings and junior officers reluctant to offend their seniors. They follow orders without overt complaining even though they are not happy (Dutt 2015; Xue et al. 2017). It is in the context that Filipino seafarers are systematically trained to be obedience and submissive. This serves to avoid tension building up on ships and ensures undisrupted work processes (Dutt 2015).

This hierarchy also means that senior officers may find it difficult to accommodate different views. One senior manager described how hierarchy on ships influenced a group of superintendents who used to be senior officers on ships:

> I have a room full of people who can make immediate decisions but they see any alternative view as a challenge to them personally.

Unsurprisingly, in formal settings on ships, such as safety meetings, junior seafarers are cautious in communicating with senior officers and reluctant to offer any opinions or raise any concerns related to safety management. They fear that such action may render them trouble makers in the perception of senior officers (Bhattacharya 2007; Bhattacharya and Tang2013). This is not to say that there is no room for employee participation. Research suggests that some senior officers make effort to engage them in informal settings, such as talking with them during breaks and working with them on deck (Bhattacharya and Tang 2013). In these settings, junior seafarers feel less threatened, and senior officers are able to break the hierarchical barrier and elicit opinions from them. Why should senior officers be bothered about this? The reason, as mentioned above, lies in the benefit of group decision making which pools information, knowledge, and experience from group members and mitigate individual biases. Furthermore, it does not require resource support from the company. In other words, it is good for safety management without extra cost, which is obviously in the interest of everybody and does not violate the cost-effectiveness rule.

The same can be said of crew resource management. It is confined to shipboard operations and does not require any input of resources from the company other than training. In fact, in many cases training fees are paid by seafarers themselves for their certificates (Sampson and Tang 2016; Tang and Sampson 2017). The training make seafarers see the benefit of group decision making and train them to contribute to decision making regardless of their ranks and position in the hierarchy. Such training is reported by trainees to be useful and help them understand the importance of and contribute to group decision making (Espevik et al. 2017).

Thus empowerment practices that do not violate the general rule of cost-effectiveness are allowed and encouraged. It is in this context that the industry appreciates British seafarers who are more willing to challenge their seniors. Being assertive has a virtue in this context. But can the industry have both, obedient seafarers and assertive seafarers at the same time?

There has not been much research on the real practice of CRM on-board ships. Nevertheless, senior officers are of the opinion that democratic procedures and a culture of challenging senior ranks are unlikely to emerge on-board ships in the foreseeable future (Loynd 2018). Such a view is understandable given the structure of the industry discussed above. If seafarers are systematically trained to be submissive, it would be difficult for them to make the effort and switch to an opposite attitude. The evidence that UK seafarers are highly regarded for their willingness to challenge senior ranks perhaps serves to reflect that such quality is rare in the global seafarer market.

Conclusion

The regulatory structure has been put in place to counteract the negative externalities associated with the global structure of the industry. It aims to foster a safety culture in which seafarers would be empowered to actively participate in safety management. However, research evidence suggests that it has failed to do so, because the industry is structured as such that managerial control leaves very little room for empowerment. Control has its structure and resources, and managers have all the resources to activate and reinforce these structures. Empowerment structure, however, is not there. There are procedures for sure, but structural resources are not there for seafarers to activate them. As control disempowers seafarers and serves to manufacture obedience in seafarers, a safety culture remains below the horizon. Although managers wish to empower seafarers for group decision making given that the short- term profit is not compromised, it is doubtful that without a safety culture, seafarers who have learned and be trained to be submissive would be able to be assertive.

References

- Bhattacharya, S. (2009). *Impact of the ISM Code on the Management of Occupational Health and Safety in the Maritime Industry*. Cardiff University (United Kingdom).
- Bhattacharya, S. (2011). Sociological Factors Influencing the Practice of Incident Reporting: the Case of the Shipping Industry, *Employee Relations*, 34(1) pp.4-21.
- Bhattacharya, S. (2012) The Effectiveness of the ISM Code: A Qualitative Enquiry. *Marine Policy,* 36, pp.528-535.
- Bhattacharya, S. and Tang, L., 2013. Middle managers' role in safeguarding OHS: The case of the shipping industry. Safety science, 51(1), pp.63-68.
- Byrdorf, P. (1998). Human factors and crew resource management: an example of successfully applying the experience from CRM programmes in the aviation world to the maritime world. paper presented at the 23rd Conference of the European Association for Aviation Psychology, Vienna, October
- Canadian Transportation Safety Board. (1995). A safety study of operational relationship between ship masters/watchkeeping officers and marine pilots.
- Dutt, M. (2015). Indian Seafarers' Experiences of Ill-Treatment Onboard Ships (Doctoral dissertation, Cardiff University).
- Espevik, R., Saus, E. R., & Olsen, O. K. (2017). Exploring the core of crew resource management course: speak up or stay silent. International maritime health, 68(2), 126-132.
- Flin, R., O'Connor, P., & Mearns, K. (2002). Crew resource management: improving team work in high reliability industries. Team performance management: an international journal, 8(3/4), 68-78.
- Giddens, A. (1984). The constitution of society: Outline of the theory of structuration. Univ of California Press.
- Hetherington, C., Flin, R., & Mearns, K. (2006). Safety in shipping: The human element. Journal of safety research, 37(4), 401-411.
- Kahveci E and Nichols T (2006) The Other Car Workers: Work, Organisation and Technology in the

Maritime Car Carrier Industry. New York: Palgrave Macmillan.
- Kongsvik, T., Fenstad, J. and Wendelborg, C. (2012) Between a Rock and a Hard Place: Accident and Near-miss Reporting on Offshore Service Vessels. Safety Science, 50(9), pp.1839-1846.
- Lillie N (2006) A Global Union for Global Workers: Collective Bargaining and Regulatory Politics in Maritime Shipping. New York: Routledge.
- Loynd, A. (2018) What you see is not always what you get – CHIRP Maritime. Seaways, April.
- Nichols T, Walters D and Tasiran AC (2007) Trade Unions, Institutional Mediation and Industrial Safety: Evidence from the UK. Journal of Industrial Relations 49(2): 211-225.
- Oltedal, H.A. and McArthur, D.P. (2011) Reporting Practices in Merchant Shipping, and the Identification of Influencing Factors. Safety Science, 49, pp.331-338.
- Pia, J. (2016). "nangangamuhan": an analysis of the standard employment contract (POEA- SEC) for Filipino seafarers(Doctoral dissertation, Cardiff University).
- Sampson, H. (2013). International seafarers and transnationalism in the twenty-first century.
- Manchester University Press.
- Sampson, H., Acejo, I., Ellis, N., Tang, L., & Turgo, N. (2016). The relationships between seafarers and shore-side personnel: an outline report based on research undertaken in the period 2012-2016.
- Sewell Jr, W. H. (1992). A theory of structure: Duality, agency, and transformation. American journal of sociology, 98(1), 1-29.
- Tang, L., & Sampson, H. (2011). Training and technology: Findings from the questionnaire study. In Seafarers International Research Centre Symposium Proceedings.
- Xue, C. (2012). Communication and its role in influencing shipboard occupational health and safety management in Chinese shipping (Doctoral dissertation, Cardiff University).
- Xue, C., Tang, L., & Walters, D. (2017). Who is dominant? Occupational Health and Safety management in Chinese shipping. Journal of Industrial Relations, 59(1), 65-84.
- Xue, C., Tang, L., & Walters, D. (2018). Decoupled implementation? Incident reporting in Chinese Shipping. Economic and Industrial Democracy.

MEGATRENDS SHAPING THE FUTURE OF THE SUPPLY CHAIN AND LOGISTICS

Dimitra Kalaitzi[1], Aristides Matopoulos[1], Irene Marchiori[2], Victoria Muerza[3], Kerley Pires[4] and Saskia Sardesai[5]

[1]Aston Logistics & Systems Institute, School of Engineering and Applied Science, Aston University, Aston Triangle, Birmingham, B4 7ET, UK

[2]Institute of Industrial Technologies and Automation (ITIA-CNR), Via Alfonso Corti, 12 - 20133 Milano, Italy

[3]MIT International Logistics Program, Zaragoza Logistics Center, C/ Bari 55, Edificio Náyade 5 (PLAZA) 50197, Zaragoza, Spain

[4]INESCT TEC Institute for Systems and Computer Engineering, Technology and Science, Campus da FEUP, Rua Dr. Roberto Frias, 4200 - 465 Porto, Portugal

[5]Fraunhofer Institute for Material Flow and Logistics, Joseph-von-Fraunhofer-Str. 2-4, 44137 Dortmund, Germany

Introduction

Megatrends can be observed over decades (see Figure 1) and each can have different implications for businesses, society affecting different aspects of the supply chain. The terms trends and megatrends are used interchangeable; however, megatrends are non-sector specific factors that drive trends whereas a trend is the general direction in which something is going to move, develop or change. For example, increasing floods in the USA is a trend whereas a worldwide increase in number and intensity of floods would be a megatrend.

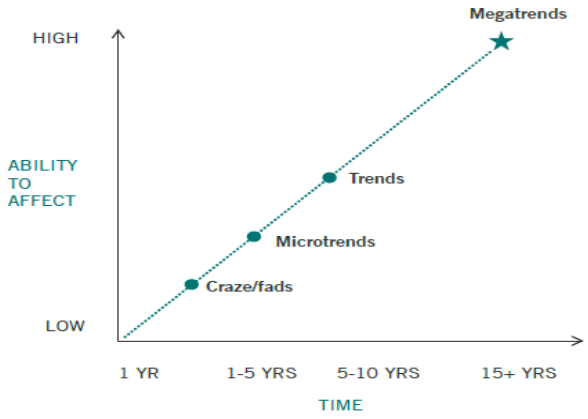


Figure 1: Impact and time horizon of megatrends (Pictet asset management, 2017)

Companies need to have a good understanding of the megatrends in order to derive future scenarios and hypotheses about how specific industries might evolve (Gernandt, 2012); a lack of understanding could have a severe impact on the future and strategic setting of their supply chain. The literature related to current megatrends and trends is scant and encompasses several concepts originating from different areas (e.g. climate change, urbanisation).

In the field of supply chain management and logistics, there are some studies that are exploring trends e.g. electric vehicles, efficient multi-modal networks (e.g. Speranza et al., 2018), training to knowledge based development to talent management (e.g. Bowersox et al., 2000; Stank et al., 2015; Sweeney, 2013), but only a few have focused on the logistics industry (e.g. Gernandt, 2012; Seppälä, 2016). Current literature seems to lack a comprehensive study on the megatrends and associated trends in the sector and therefore the goal of this research is to identify and provide a comprehensive list of megatrends and associated trends that address critical aspects of several domains of analysis (e.g. political). The remainder of the paper is organised with a section on the systematic literature review

methodology that was applied in this research. This is followed by a description and a discussion on the findings. The paper closes with a conclusion and further research opportunities.

Methodology

This research is based on two complementary phases: a systematic literature review and a workshop with experts. During the first phase, megatrends and trends were identified by reviewing existing information with a focus on recent publications (i.e. international journals, conference papers) and mainly on grey literature (i.e. unpublished reports and other documents). The grey literature enables to capture a large amount of information that has not yet been discussed in the academic discourse (Mahood et *al.*, 2014). This study builds upon the feedback of multiple researchers and experts with long standing expertise in the area of supply chain management from Germany, the United Kingdom, Italy, Netherlands, Portugal and Spain who contributed with relevant articles to minimise bias. Thus, multiple databases were used. Five steps are followed in this systematic literature review: 1) process question formulation, 2) locating literature, 3) study selection and evaluation, 4) analysis and synthesis, and 5) finally reporting and using the results (Denyer and Tranfield, 2009).

In the first step, the primary review question is as follows: "What are the megatrends and trends that are shaping the future of the supply chain and logistics?" The second step contains an online search of relevant reports and journal papers from major scientific databases namely Science Direct, Emerald and Google Scholar. Some of the main keywords and phrases that were used to identify the relevant papers for review are: (logistics) OR (supply chain management) OR (manufacturing) OR (process manufacturing) OR (distribution) OR (transportation) AND (trends or megatrends) OR (future supply chain) OR (next generation supply chains) AND (trends or megatrends). Only articles and reports written in English were included. After the elimination of articles or reports that do not match the above criteria and do not specifically answer the research question, 349 reports, grey literature and papers are selected and analysed.

A PESTLE analysis is used to identify and characterise different megatrends and trends. PESTLE analysis enables to capture the macro environment i.e. external forces. NVivo software was used to analyse these documents that helps to draw out themes emerged from the data. Thematic analysis was adopted. The analysis began by using 'open coding' to collect trends from the chosen sources in order to create the first-order themes. "The codes are labels which enable the qualitative data to be separated, compiled and organised" (Collis and Hussey, 2009; p. 179). Then first-order themes were connected to create the second-order themes, which are the megatrends by axial coding (i.e. more abstract coding of data into theoretical categories). The final step linked the various concepts that emerged from the data by choosing the aggregate dimension (i.e. PESTLE dimensions) to be the core category and relating all other second-order themes to that category.

Regarding phase two, a workshop, which brought together 18 experts from both the academic and practitioner domains (see table 1), discussed, refined, and extended the findings and insights gained from the literature review. Participants were asked to identify trends/megatrends for each dimension of the PESTLE analysis. Then, individuals were assigned to work in a group to discuss the megatrends and trends in the field of supply chain management. The megatrends and trends identified through the systematic literature and the workshop are discussed in the section below.

Domains	Role and expertise	Country
Academics	Researcher in supply chain development and strategy, Senior researcher with expertise in logistics and supply chain management	Germany
	Researcher working in the area of supply chain management, mass customization, innovation management, Researcher with expertise in industrial engineering information systems (business informatics) and human-computer interaction, Researcher with expertise in logistics and supply chain management	Italy
	Professor with expertise in 3D printing	Netherlands
	Senior researcher with expertise in supply chain management	Portugal
	Research Fellow with expertise in logistics and supply chain management	Spain
	Senior lecturer in logistics and supply chain management, Research associate in manufacturing supply chains	United Kingdom
Practitioners	Project manager with expertise in environment, climate change and energy management	Belgium
	Supply chain and reverse logistics engineer, Senior consultant across the spectrum of process and discrete manufacturing industries, Policy and patron advisor, Chief technology officer with proven expertise in international automotive management, Senior project manager in transport and logistics services , Director of sustainable engineering solutions with extensive experience in the electric vehicle industry, Partner of the council of supply chain management professionals with experience on engineering, manufacture and operational transformations	United Kingdom

Table 1: Workshop participants

Findings and discussion

22 megatrends and 66 trends were identified (see Table 2) through the literature review and the workshop (Kalaitzi et al., 2018), which are discussed in the following sub-sections.

Dimension	Megatrends	Trends
Political	Protectionism, Political stability, Supranationalism	Import tariffs, Quotas, Different tax structures, Subsidies, Terrorism/conflict, Social unrest, Trade agreements, Free movement
Economic	Global trade shift, Digital economy, Financial innovation	Economic growth in emerging economies, Export growth, Investment, Globalisation, Glocalisation, Emergence of born-global firms, Sharing economy, From an economy of goods to an economy of services, Digital currencies, Cashless payment, The financial technologies (Fintech) revolution

Social	Population growth, Demographic change, Urbanisation, Changes in consumption pattern, Individualism, Digital natives, Knowledge based economy	Population boom in the developing countries, Growing demand of resources (e.g. land), Ageing population boom in developing countries, Young population boom in developing countries, Migration flows, Labour shortages, Megacities, Smart cities, Middle-class explosion, Healthy diets and lifestyles, Consumerism, New customer relationship, New shopping experience, Increase of customisation, Change of communication patterns, Change of purchasing patterns , Reshaping the workplace, Increased demand for high-qualification jobs, Emerging skills required, Continuous learning culture
Technological	Digital transformation, Technology development and automatization, Electrification of transport, Renewable energy sources	Big data analytics, Artificial intelligence, Cloud based computer systems, Blockchain, Internet of Things, Robots, Cyber-physical system, Augmented reality and virtual reality , 3D printing/additive manufacturing , Drones, Autonomous systems, Automated guided vehicles , Wearable devices, Battery electric vehicles, Hydrogen fuel cell electric vehicles, Hybrid vehicles, Production and storage of clean energy and application to transportation and industry, Renewable energy for industrial processes
Legal	Consumer protection laws, Intellectual property law, Social and environmental regulations	Cross-border payments, Return products free of charge or under warranty, Product safety regulations, Privacy Patents, Data sovereignty, Corporate social responsibility, Emissions control regulations, Waste and resources management regulations
Environmental	Climate change, Resource scarcity	Pollution, Lack of resources such as water, Land, energy, Food and rare earth elements, Waste increase

Table 2: Megatrends and trends in the field of supply chain management and logistics.

Political dimension

Protectionism, political stability, and supranationalism are the megatrends that emerged under the political dimension. Regarding protectionism, it has been boosted by political events across the world that may lead to supply chain disruptions. For example, Brexit will have a direct impact on supply chains as it is supported that 32 % of European Union (EU) suppliers will be substituted by national ones and 46 % of business will not use many UK suppliers (McKevitt, 2017). Recently, the US announced import tariffs of 25% on steel and 10% on aluminium and manufacturing companies with plants overseas (e.g. Mexico, China) may be affected by increasing import duties and tariffs (PwC, 2017).

Regarding political stability, the second megatrend, terrorism/conflict lead to more cross-border security regulations, which in turn affects supply chain flows. For example, the attack in the twin towers of New York City on September 11, 2001 disrupted the Mexico–USA trade namely increased the time of border-crossing and affected the in transit inventory (Bueno-Solano et al., 2014). In 2016, 38% more countries suffered supply chain terrorism attacks, even so, the top 10 countries for supply chain terrorism incidents accounted for $664 billion worth of global exports (Hines, 2017). Finally, supranationalism is associated with trade agreements and free movement and can affect supply chain decisions regarding the number and location of the production facilities, and supplier selection.

Economic dimension

This dimension comprises of the megatrends: *global trade shift, digital economy and financial innovation*. High economic growth in emerging economies such as China and the MINT (Mexico, Indonesia, Nigeria, Turkey) countries could result in global trade shift (Francesco and Ardita, 2015). By 2030, China will be the largest economy in terms of Gross Domestic Product (GDP) (PwC, 2015) that will influence the demand, and the design of the supply chain networks respectively. Another trend with high impact on supply chain and product structure is 'glocalisation', which aims at adaptating products to local cultures while globalisation continues (Hong and Song, 2010).

The second megatrend, digital economy, includes the trend sharing economy, which support to pay for assets or services by consumption or on demand (Deloitte, 2016). The biggest sector of Europe's industrial sharing economy is peer-to-peer transportation, facilitating transactions totalling €5 billion in 2015 (PwC, 2016a). Both developments demonstrate a shift from an economy of goods to an economy of services with respective impact on the supply chain (Deloitte, 2015). Last, financial innovation is another megatrend that can affect and improve in terms of security the financial transactions in the supply chains e.g. cashless payments and digital currencies (including cryptocurrencies). Moreover, B2C transactions are increasingly digitised and there is a shift from physical money to digital payments (Bons et al., 2012). These financial innovations support the emergence of Financial technology (Fintech) firms that revolutionise supply-chain finance.

Social dimension

The megatrends emerged under the social dimension are *population growth, demographic change, urbanisation, changes in consumption pattern, individualism, digital natives* and *knowledge-based economy*. Regarding population growth, world population is estimated to reach 8.5 billion in 2030 and most of the people will be 60 years or over as it is projected to account 56% of the total population in 2030 compared to 2015, mainly in the developed regions (United Nations, 2015). Ageing population can lead to a lack of available labour pool such as truck drivers in the logistics industry that it is estimated to be almost 25,000 by 2020 in Canada (Millington, 2017). However, between 2015 and 2030, 35 million people will move from less developed countries to developed ones (Rolland Berger, 2017), expanding the workforce and consequently increasing demand and investment. Specifically, new megacities and smart cities will grow, and the related investments will require $1.8 trillion by 2030 (OECD, 2015). The enhancement of smart cities will force companies to implement new distribution strategies and find alternative transportation modes for urban centres to respond faster to changes in consumer demand (Öberg and Graham, 2016).

Further to the above megatrends, consumption pattern will change due to various trends such as middle-class explosion, on-line shopping. For example, rising incomes and increasing urbanisation change the dietary needs e.g. cereals account for 37% of the total caloric intake in developed countries while they provide 71% of caloric intake in less developed (OECD–FAO, 2017). Moreover, healthy eating is considering an important aspect that change the patterns of consumption especially for nearly half (47%) of millennials (18-34 age-group) who over the past year changed their eating habits towards a healthier diet, as compared to just 23% of those aged over 55 (PwC, 2016).

According to Nielsen (2016), 62% of customers will buy more and/or more often when they receive a personalised retail. Human Centred design companies can offer their product and services that meet in a better way users' evolving needs. Moreover, the customisation of the products and services will become an added value, while technologies such as 3D printing will enable customers to involve directly in the design phase (Kudus et al., 2016). Thus, new business models and flexible manufacturing systems capable of producing will be introduced (UNIDO, 2016, p.17). These models have to consider increasing the social media engagement e.g. 68% of millennials will buy specific products or services based on friends' social media (Emarketer, 2014). Moreover the demand for high-qualification jobs will increase; for example, in the manufacturing sector, it is projected that by 2025 the number of jobs

requiring high-level qualifications will increase by 1.6 million (21%) whereas in the automation of production processes the number of low-and medium-skilled jobs will decrease by over 2.8 million (Schröcker, 2017).

Technological dimension

The main megatrends within this dimension are *digital transformation, technology development and automatization, transport electrification and renewable energy sources*. Digital transformation is driving companies to rethink what customers value most in order to create operating models which could achieve competitive advantages. Some of the digital technologies with higher impact in supply chain are artificial intelligence, big data analytics, blockchain, internet of things and cloud-based computer systems. Regarding the first two technologies mentioned above, the direct and indirect application of artificial intelligence will generate a revenue of more than $36 billion by 2025 (Tractica, 2016) while it is expected that banking, discrete manufacturing and process manufacturing companies will invest approximately $15 billion in big data analytics in 2020 (IDC, 2017). Regarding blockchain, it is expected that 36% of financial services firms will make substantial investments in blockchain in the next three years (Harvey, 2017). Blockchain can be used in supply chains for ease paperwork processing in ocean freight, identification of counterfeit products, and origin tracking (Hackius and Petersen, 2017). Moreover, the use of augment reality will increase and it is expected to be used in manufacturing for projecting assembly instructions, picking optimization, facility planning, etc. (Merlinoa and Sproǵeb, 2017). Concerning, internet of things and cloud-based computer systems, it is expected that Internet of Things will provide the connection of approximately 20 billion of devices in 2020 while it is expected the worldwide spending on public cloud computing will be $162 billion in 2020 (IDC, 2017).

Regarding the megatrend technology development and automatization, the use of robots in factories and cyber physical systems will affect manufacturing companies in terms of production systems (Leitao et al., 2015). Additive manufacturing is also useful for prototyping and product development, create innovation (Columbus, 2015), producing after-market parts or products (PwC, 2016) and reduce design-to-manufacturing cycle times (Boon and van Wee, 2017). Moreover, the annual growth rate of drones is expected to be 19% until 2020 (Business insider, 2016).The main use will be in infrastructure, transportation industry and agriculture (PwC, 2017) and it will be used mainly for internal delivery, tracking inventory and in order to minimise the traffic in the roads (DHL, 2014). Automated vehicles will impact logistics and it is projected that $500 millions of it will be in use worldwide until 2025 (KPMG, 2015). Transport electrification is another megatrend that is influenced by regulations regarding emissions and fuel efficiency. The main impacts on supply chain and logistics industries will be the use of battery electric vehicles, hydrogen fuel cell electric vehicles and hybrid vehicles. It is expected that 1 in 12 cars sold in Japan, California, South Korea and Germany would be powered by hydrogen by 2030 (Hydrogen Council, 2017). Last, renewable energy sources as a megatrend has several impacts on supply chain and logistics industries, such as the production and storage of clean energy and the application to transportation and other industries (e.g. companies such as Apple aim to procure 100% of their electricity from renewable sources to minimise emissions from supply chain operations) (Apple, 2018).

Legal dimension

Consumer protection laws, intellectual property law and social and environmental regulations are megatrends emerged under the legal dimension. As for the consumer protection laws, the policies tend to provide customers the right to return products free of charge or under warranty while companies also have to recall their products in case of problems towards customer's safety influencing the return process of supply chain. In addition, privacy topics gain increasing importance (e.g. new EU privacy regulations) with the expanding amount of regular Internet shoppers (European Commission, 2016). Regarding the second megatrend, intellectual property law, along with the exchange of data, companies and private entities fear security risks and loss of control when exchanging data (PwC,

2016b). To create clarity, data sovereignty concepts need to be established. Similar concepts are required for the protection of intellectual property with fast evolving technologies. There is a trend towards the establishment of patents granting exclusive rights to promote utility objects and innovative processes for a limited period (Menell et al., 2017). Last, the megatrend social and environmental regulations, is related to corporate social responsibility that. Those legal settings influence the supply chain especially in terms of data management, but also regarding process and product settings. For example, the vehicle electrification market is driven by stringent emission and fuel efficiency regulations across the globe.

Environmental dimension

Climate change and resource scarcity are the megatrends emerged under the environmental dimension. Regarding climate change, supply chain emissions are being targeted by many multinationals such as Walmart. The US retailing giant has recently launched a program to reduce the CO_2 emissions from its Chinese suppliers by 50 million tonnes by 2030 (Reuters, 2018). Furthermore, increasing CO_2 levels are linked to atmospheric changes which lead to accidents, cancelation and delays and thus impact the supply chain network. Resource scarcity, the second megatrend, is influenced by the global population, and the increasing demand for resources from consumers (Balatsky et al., 2015). For example, land scarcity rises in densely populated cities. In the logistics industry, solutions are focused on maximising land productivity with e.g. the construction of an innovative logistics hub such as in Singapore. This hub will be completed in 2019 and it will integrate a multi-level inland container depot, warehouses and a heavy vehicle park (Mizar, 2016).

Apart from land scarcity, rare earth elements scarcity is a crucial issue in the manufacturing supply chains. Rare earth elements are used in high technology-based products for different sectors, e.g. medical, defence, clean energy. The EU is self-sufficient in construction minerals. However, China dominates the market of these elements (35 % of global supply) (Zhou et al., 2017), also affecting the availability, supply and prices, due to the implementation of tax and export quotas (Humphries, 2003). Water scarcity also is a high risk especially for some regions such as India or Europe where some countries face sporadic or local water stress e.g. Cyprus, Belgium, Spain and Malta (Morrison et al., 2009; Roland Berger, 2016; Walsh et al., 2015). Companies especially the ones that use water as a primary ingredient in their productions plants faced disruptions e.g. Coca-Cola has been forced to shut down factories in India due to social forces that support that Coca-Cola used water resources from the community to feed its own plants and destroyed the local agriculture industry (Chilkoti, 2014).

Conclusions

Based on a systematic literature review and an expert's workshop, 22 megatrends and 66 related trends were identified. These megatrends and trends are critical for the generation of future industrial scenarios. The main contribution of this literature review is that it brings together not only scientific publications, but also sectoral studies, governmental reports. Further insights on the megatrends/trends have been collected and merged within an interactive session. Future research can formulate scenarios of the possible evolution and implications of the identified megatrends/trends on future supply chains. In fact, this study gives a glimpse into the opportunities and challenges that supply chain managers may face in the future. It provides an opportunity to prepare and respond to a broad range of potential disruptions in the future and to create more resilient supply chains. Future research can consider other megatrends/trends given the dynamic, complex and fast evolving nature of modern supply chains.

Acknowledgements

We are grateful to all contributors of the Next-Net project team and the experts participating in the workshop. This work was financially supported by the European Union's Horizon 2020 Research and Innovation Program under the Grant Agreement No. 768884.

Indicated list of references (full list available upon request)

- Apple (2018). 'Climate Change'. Available at: https://www.apple.com/uk/environment/climate-change/, (accessed 20 June 2018).
- Balatsky, A., Balatsky, G. and Borysov, S. (2015). 'Resource Demand Growth and Sustainability Due to Increased World Consumption', *Sustainability*, Vol. 7, pp. 3430-3440.
- Bowersox, D.J., Closs, D.J. and Stank, T.P. (2000), 'Ten mega-trends that will revolutionize supply chain logistics', *Journal of Business Logistics*, Vol. 21, No.2, pp. 1-16.
- Bons, R.W.H., Alt, R., Lee, H.G. and Weber, B. (2012), 'Banking in the Internet and mobile era', *Electron Markets*, No. 22, pp. 197–202.
- Bueno-Solano, A. and Cedillo-Campos, M. G. (2014). 'Dynamic impact on global supply chains performance of disruptions propagation produced by terrorist acts', *Transportation Research Part E*, Vol. 61, pp. 1–12
- Öberg, C. and Graham, G. (2016). 'How smart cities will change supply chain management: a technical viewpoint', *Production Planning & Control*, Vol. 27, No. 6, pp. 529-538.
- Collis, J. and Hussey, R. (2009), *Business Research: A Practical Guide for Undergraduate and Postgraduate Students*, 3rd ed., Palgrave Macmillan, London.
- Deloitte (2015), 'Digital Media: Rise of On-demand Content'. Deloitte (ed.).
- Deloitte (2016), 'The rise of the sharing economy: Impact on the transportation space'. Available at: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/consumer-business/us-cb-the-rise-the-sharing-economy.pdf, (accessed 31 October 2017).
- Denyer, D. and Tranfield, T. (2009), *Producing a systematic review*, in Buchanan, D.A. and Bryman, A. (Eds.), The SAGE handbook of organizational research methods, SAGE, London.
- Emarketer, (2014). 'Millennials' Social Media Posts Influence Peers to Buy New Products.' Available at: https://www.emarketer.com/Article/Millennials-Social-Media-Posts-Influence-Peers-Buy-New-Products/1010576, (accessed 31 October 2017).
- European Commission (2016), Consumers: Putting the consumer first. European Commission (ed.), Luxembourg.
- Francesco, S. and Ardita, T. (2015), 'Market's Globalization and Emerging Economies. The MINTs Economic Growth: Developments and Prospects', *International Journal of Business and Commerce*, Vol. 5 No. 2, pp. 38–55.
- Gernandt, K. (2012). 'Megatrends and their impact on logistics', available at: http://www.tliap.nus.edu.sg/pdf/whitepapers/12_Nov_SCI05_Megatrends_and_%20their%20impact%20on%20Logistics.pdf, (accessed 27 October 2017).
- Hackius and Petersen (2017).' Blockchain in Logistics and Supply Chain: Trick or Treat?', available at: https://tubdok.tub.tuhh.de/bitstream/11420/1447/1/petersen_hackius_blockchain_in_scm_and_logistics_hicl_2017.pdf, (accessed 31 October 2017).
- Harvey, C. (2017). 'Blockchain's Future: Nine Predictions', Available at: https://www.datamation.com/applications/blockchains-future-nine-predictions.html, (accessed 25 October 2017).
- Hines (2017). 'Terrorism and Supply Chain: A Growing Threat of Supply Chain Terrorism', available at: http://cerasis.com/2017/10/26/supply-chain-terrorism/, (accessed 11 June 2018).

SUPPLY CHAIN ANALISYS THROUGH BIG DATA – DRIVING AN INTEGRATED DECISION MAKING PROCESS

Luiza Cunha de Menezes and Otacilio José Moreira
Administration, Federal University Niteroi, Brazil

Introduction

In Supply Chain 4.0, it´s crucial for any Organization to identify, select and use many technical applications, which allow data analysis in the logistics environment. The importance of this analysis intensifies as the increasing accumulation of knowledge in the areas of artificial intelligence and data mining provides a great competitive potential to modern organizations by increasing information visibility, resilience capacity and organizational performance (Gunasekaran et al., 2017).

Therefore, the central objective of this paper is to evaluate and identify the main tools of Big Data Analytics, i.e. great amounts of data that can be collected, organized, analyzed, shared and monitored to extract value information; that points out to the possible narrowing of conceptual relations between business intelligence mechanisms and the process of decision-making in the supply chain management both intra and inter-company. As a secondary view, this paper aims to answer the following question: which different techniques are used in a logistics management architecture system based on big data sources?

Due to the exploratory nature of the addressed topic, the research developed uses a literature survey approach. Articles, white papers, researches and journals published between 2000 and 2017, based on IEEE, Springer and Elsevier publishers, as well as studies published by some of the main business consultancies in the areas of engineering, logistics and information technology were considered.

Review of literature

Supply Chain Management

According to Francesco Constantino et al. (2015), a supply chain is a system of suppliers, distributors, retailers and customers connected through the flow of goods, services, information and finance. In this way, the proper functioning of this system depends on the coordination and integration between all the present modules.

The longer the processes flows throughout the chain, the greater the complexity in establishing efficient communication channels between the system modules to extract information that may facilitate the precision of demand forecasting. Considering the moment each of the partners in the supply chain makes a request for supply, countless variables must be evaluated. For example, supplier delivery time, consumer demand, current stock, security stock level, price changes, and others. When some of this information is suppressed in the decision process, uncertainty and instability in forecasting supply chain demands increases.

The inherent reflects of disruptions and lack of collaboration in the flow of information are known as bullwhip effect, a term introduced by Jay Forrester in 1961 (Disney and Towill, 2003), whose purpose is to establish the concept of amplification of the distortions between real demand and the perception of demand along the chain. The impacts of the bullwhip effect are related to excessive or short inventory, loss of product quality, increased production and logistics costs (Towill et al., 2007, Disney and Lamrecht, 2008 apud Francesco Constantino et al., 2015).

Constantino et al. (2015) was able to investigate the consequences of information sharing for inventory forecasting processes in order to reduce bullwhip effect using mathematical model simulation

methods in a supply chain restricted to a single product with four partners i.e. retailer, wholesaler, distributor and factory. For the tests presented, he verified that the implementation of an information sharing policy, in which each partner in the chain receives the demand from the consumer and the inventory adjustment to the next process, produces higher performance indexes rather than traditional demand policy.

Hence, the growth of supply chain processes synergy is related to flexibility and response time to demand volatility.

Big Data

Since the appearance of the first electronic computer and due to the possibility of greater speed in the information process, the interest for data analysis arises as an intrinsic necessity to the evolutionary technological process. Additionally, as storage capacity and system efficiency increases, physical barriers to data collection, storage, and processing ceased to be a limiting factor for the development of new algorithms (Eeckhout, 2015).

In this way, once an enormous amount of data is available in a structured form or not, from the most varied sources, with the possibility of real-time or near real-time treatment, the ability to analyze and aim strategic decisions have the potential to become even more agile and accurate.

The concept described above is nothing more than the Big Data concept that emerged in the 2000s, through a definition of the three Vs by Doug Laney (Fan and Bifet, 2013), i.e. volume, velocity and variety of data.

Victor Mayer et al. (2014) define big data as things one can do at a large scale that cannot be done at a smaller one, to extract insights and create new forms of value, in ways to change markets, organizations, the relationship between citizens, governments and more.

Considering Ankit Singh et al. (2016) study, the main points of differentiation among organizations which adopt Big Data solutions into their supply chain management system are directly related to the increase of cohesion of the chain through improving visibility and traceability of the processes. The points described by Ankit Singh et al. (2016) are summarized below.

(1) Reduction of delivery time: one of the major problems of modern logistics is the latency between traceability information and actual cargo location. Big Data tools allow monitoring data to be transmitted to organizational systems and consumer systems in real time, so that it is possible to identify and correct possible deviations or errors in transport. In addition, Big Data tools provide companies the opportunity to develop algorithms that can predict maintenance needs of the entire logistics network, thereby saving corrective maintenance costs that can occur on a timely basis and affect delivery time.

(2) Warehousing costs savings: intelligent mechanisms are used to transform historical series of data into information that can predict demand, periods of scarcity of raw materials, and productivity rates. Therefore, it is possible to reduce storage costs considering greater predictability of business operations

(3) Operational costs savings: Once the operational cost of a business is calculated through multiple cost function variables and that such variables are dependent on each other, small changes in costs impact in a complex way throughout the supply chain. A Big Data analysis approach uses prioritization and balancing techniques that facilitate decision-making on issues such as optimization of employees' work hours, outsourcing planning and others.

Problem description

Even though there are many discussions about the importance of advanced supply chain management and many resources available for data collection, storage and processing, only 17% of executives operate with some data analysis technique in the management of the supply chain in the workplace, according to recent studies (Pearson, 2014). The same research points out that there is a great resistance on Executives side to implement such improvements, not only due to initial implementation costs, but also due to information security and privacy issues.

As Stephen Kaisler et al. (2013) points out one of the biggest challenges regarding Big Data for researchers and developers is the ability to design appropriate systems to use data efficiently and relevantly in the decision-making process. It is a waste of time and resources to extract value information in data without quality, meaning or with low alignment to proposed subject.

In consonance to the research conducted by KPMG (2017), 85% of organizations have difficulty evaluating the quality and reliability of data, and only 14% of organizations believe they have the skills to conduct Big Data analyzes. In addition, according to a survey conducted by MIT and made available by KPMG (2017), which involved more than 3000 executives, managers and analysts in 108 countries across 30 different industries, the three main obstacles to effective application of Big Data solutions are: (1) lack of knowledge about Big Data to improve the business; (2) managerial problems in the interpretation of the information extracted and (3) lack of alignment between the business and the available Big Data skills.

These problems mainly occur because of the difficulties in identifying Big Data professionals or properly trained Data Scientists. Since it is a relatively new area, there is not a high availability of skilled professionals in the market, besides the professionals may not have specific knowledge in the segment of the business they are going to operate.

According to Gang Wang et al. (2016), recent studies on Big Data focuses more on presenting definitions of analysis and perspectives. Therefore, there is an intrinsic demand for more scientific exploration on the practical process of integrating main business intelligence mechanisms with the systems related to supply chain decision-making process. This article aims to reflect the state of art of some of the main applications of Big Data into supply chain management in the current scenario.

Research work

As technologies for data extraction and storage are developed; it becomes increasingly interesting for companies focused on supply chain management to process these large amounts of information to ensure greater transparency and agility in managerial decision-making processes.

Companies that define and execute planning for supply chain management usually add value to the service and/or final product by shortening the distances and noise in the communication channels of the supply chain. In this way, one of the key elements for business success is the establishment of logistic partnerships, which act in a predictable and safe way.

According to Oracle Corporation whitepaper (Oracle, 2015), it is a fact that logistics and transportation management companies use databases and business intelligence devices for advanced development of route and operations.

The first step for a company to define a system of large amounts of data is to ask itself what kind of pertinent information to the business they are willing to discover. Some examples of questions would be: which products are best sold at certain times of the year? What is the profile of the customer who buys each product? How many customers buy that particular product? What are the direct and indirect costs of each product?

Once the relevant issues are defined, it is possible to structure the information processing capacity by defining data sources and tools to be used, considering inherent costs.

In reviewing the material presented by Divakar Mysore et al. (2014), when in operation, the architecture of a system focused on large amounts of data consists of five macroprocesses:

1. Collection: this step consists of reading data through different sources.
2. Treatment: this step consists on properly mapping and categorizing data. It should be defined which are the key fields that make relationships between data tables and what are the data types.
3. Storage: once data is obtained and properly processed, it should be stored in a physical or cloud structure.
4. Analysis: at this stage, data is transformed into high value-added information. This can be used to present historical performance of business operations (descriptive analysis) and/or to identify patterns or systematic relationships between variables to implement models that describe possible future behavior (predictive analysis). Due to high degree of complexity involved in the precise and assertive processing of these data, there are numerous mechanisms developed and to be developed that involve artificial intelligence, statistical and data modeling techniques.
5. Visualization: from the information provided by the analysis step, it is possible to construct panels for faster visualization of the information as an auxiliary tool to business decision-making process.

In the next subsections of the Analysis section, the main mechanisms used for each of the macroprocesses mentioned above are explained in more details.

Analysis

Collection

Considering a logistics environment, one of the main sources of data collection occurs through automated sources, i.e. sensors (Oracle, 2015). The advent of wireless sensors applied to transport and storage promoted easier traceability of products and/or services.

With greater traceability, the impacts of problems related to cargo location, number of items available in a distribution center, delivery time, and many others were significantly reduced.

According to Silva and Cugnasca (2011), "one of the most promising technologies for the future of traceability is called RFID", this mechanism allows the object to be identified by transmitting signals through a tag. The reading of the transmitted signal is performed by a specialized device, which converts the radio frequency waves into information to the user. In transportation, RFID can also be used for vehicle tracking and performs better than GPS in urban areas (Vaidya and Mouftah, 2012).

Another important technology exposed by Silva and Cugnasca (2011), is the use of wireless sensor networks (WSNs). According to the authors, this technology allows the sensors arranged in a certain range to communicate with each other, so that they transmit information to intermediate sensors. In this way, speed increases in traffic and data collection, because the number of sensors that communicate with the final device for reading and storing the data is reduced. On the other hand, one of the main limitations of this tool regards high-energy consumption for data processing, communication and storage.

As Mysoreet al. (2014) points out other sources for extracting available data are:

- Corporate systems: these are the computational tools developed as a solution to automate business processes in an integrated way with the purpose of facilitating management and planning of the business. It is worth mentioning that depending on the way systems' architecture is implemented and documented, data extraction may become more complex. Examples of enterprise systems are ERPs (Enterprise Resource Planning) and web applications where information is stored in the cloud.
- Data management systems (DMS): corresponds to the set of applications for storing information through files. Examples of DMSs are Microsoft Excel® spreadsheets and Microsoft Word® documents.
- Databases: databases can be relational or non-relational. As discussed by Jignesh M. Patel (2016), relational databases present structured records that are stored as tables. In general, Structured Query Language (SQL) is used to manage data held in a relational database management system. Non-relational databases are those that contain unstructured or semi-structured data, because of that, they are called NoSQL.
- Smart Devices: these devices allow you to extract, process and communicate information in real time with an integrated network of devices. Some examples are smartphones, smart sensors and intelligent engine controls.
- Aggregated data providers: these are electronic data managers, or Data Providers, which store data and metadata, collected through cookies.

Treatment

As mentioned by Ishwarappa and Anuradha (2015), data presents characteristics of volume, velocity, variety, veracity and value. In this way, data can originate from different media with different characteristics. As mentioned in Oracle (2015), it is important to map each of data input sources in terms of:

- Variety: in order to characterize data format. It is subdivided into structured (binary, integer, character, string ...), unstructured (non-standardized string, i.e. text) and semi-structured (hybrids of structured and unstructured data);
- Velocity and Volume: in order to determine the update rate of existing database, from its periodicity of data changing, as well as the amount of data available.
- Veracity: in order to held the source directory of data extraction.
- Value: in order to assume the storage utility of data in the system.

An important tool created to handle and process large amounts of data is Hadoop® system. Hadoop® is part of an open source solution developed by nonprofit organization ASPF Software Foundation® (ASF), which aims to increase data processing and storage capacity through MapReducing technique (Ishwarappa and Anuradha, 2015).

As postulated by Ishwarappa and Anuradha (2015), MapReduce technique allows performing the scheduling of parallel processes between several interconnected machines (or cluster nodes) through a distributed file system (HDFS). In this way, thousands of machines can process various data locally in order to achieve a common purpose.

Unlike common data warehouses, Hadoop® system provides unprocessed data, allowing the user to process all the data at the same time without using sampling techniques (Awadallah and Graham, 2011). It is interesting to note that data warehouses work in conjunction with tools called ETL (Extraction, Transformation and Loading). These tools are used to consolidate data straight from data source into a single processing environment.

Both data warehouses and Hadoop® platform offer advantages depending on the type of data entry. As discussed in Oracle (2015), in logistics and transportation management, companies must use these two environments in order to build an integrated architecture, due to the need of processing both structured and unstructured data. Walmart® network, for example, uses a search tool called Polaris®, which indicates potential products to its virtual shoppers, based on their interests (structured data) and behavior (unstructured data) on the virtual store page (Jayanandet et al., 2014).

Analysis

According to logistics management principles, i.e. assertively delivery of the product and/or service to the customer in the right place and time (Oracle, 2015); analysis layer can be considered the most critical layer in a logistics system architecture for differentiation of the level of experience perceived by the final consumer. Depending on the accuracy and efficiency of the analysis from received data, different outputs could be generated. For example, one output can result in the guidance of following a certain route or not, promoting a particular type of product or not, fueling a distribution center or not, and others.

In this layer, artificial intelligence and machine learning tools could be used to identify possible relationships between data in different scenarios through data mining. Data mining is the act of searching for patterns through the inference and generalization of possible facts and correlations not perceived or easily deduced (Xuet et al., 2014). Depending on the mining strategy chosen, different algorithms and specific computational techniques can be used. Some of them are neural networks, genetic algorithms, clustering algorithms, decision trees, Bayesian networks and nebulous logic, or fuzzy logic.

There are several tools for analyzing business data, and an organization could use a combination of tools to support decision-making process to gain a more general or specific view of the business. Some of the main methods used for supply chain management, as mentioned by KPMG (2017), are statistical methods of estimation and sampling, qualitative and quantitative forecasting methods, numerical and analytical optimization methods, and data simulation models.

Visualization

Once data is stored, structured and analyzed, obtained results are displayed throughout the visualization layer. This layer is responsible for producing the interface between the final user and analysis outputs.

Business intelligence tools are much applied in creating dashboards, which allow the decision-making user to interact with data displayed as tables, graphs or key performance indicators (KPIs).
A great advantage of a BI dashboard is the user self-service possibility to select business relevant dimensions through filters that update all the elements of the dashboard (tables, graphs and KPIs) at the same time.

Some of the tools that can provide an interactive dashboard are Power BI®, Tableau®, QlikView® e TIBCO Spotfire®.

An interesting structure to generate comparative analysis through different perspectives in an integrated way is the OLAP tool. OLAP or Online Analytical Processing uses the concept of data organization in cubes. As shown at the image below, each of the three dimensions of the cube can be seen as a different business viewpoint, such as customer, product, department and time. Inside each dimension, it is possible to establish the level of detail to be perceived by the model, i.e. the granularity of the model. A place dimension, for example, can present levels of city, state, region, country …

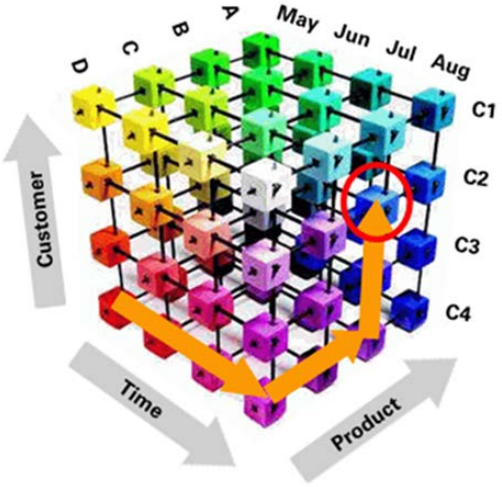


Image 1: Data Organization in a cube referring to the OLAP technique. Source: Arup Nanda, (2008)

As postulated by Mansmannet al. (2013), once the cube is structured, it can be used to identify measures, which are business-related facts that consider two or more dimensions of specific points or plans within the cube.

It should be noted that some important measures in the supply chain management process, as discussed in Chan et al. (2006), are the lifetime of an order, total cost of a service, return on investment, and so on.

One of the great advantages of this method lies in an efficient access to business-relevant data. However, as stated by Mansmannet al. (2013), even though it provides a high standard of universality and high performance, this method presents limitations regarding unstructured or semi-structured data.

Discussion and conclusions

In view of presented tools and considering the active technological evolution in terms of processing and storing information capacity, it becomes clear that new techniques and methods that can reduce the complexity of decision-making process in relation to supply chain management are emerging at every moment.

In terms of system architecture, the surveyed information was structured in five macroprocesses considering a logistics environment, which were described in details in the Analysis section of this paper. The macroprocesses concepts and techniques presented considered a more practical approach of some of the most discussed applications when the theme of Big Data is addressed.

It is important to notice that the topics considered here are constantly improving with respect to security, research and development, and they must be updated when addressing support to a business process. In addition, companies and organizations should be aware of the importance of adding value to their end-activities to stay ahead in terms of the competitiveness levels of the market in which they operate. At the same time, they should be able to adapt to changing work patterns, leaving aside traditionalist views that tend to limit the visibility of opportunities and improvements.

References

- Anuradha, J. (2015), 'A brief introduction on Big data 5Vs characteristics and Hadoop Technology'. *Procedia computer science*, Vol. 48, pp. 319-324.
- Awadallah, A., E Graham, D. (2011), 'Hadoop and the data warehouse: When to use which'. *White Paper, Cloudera. Inc. and Teradata Corporation*, pp. 1-19.
- Costantino, F., Di Gravio, G., Shaban, A., E Tronci, M. (2015), 'The impact of information sharing on ordering policies to improve supply chain performances', *Computers & Industrial Engineering*, vol. 82, pp. 127-142.
- Disney, S. M., E Towill, D. R. (2003), 'The effect of vendor managed inventory (VMI) dynamics on the Bullwhip Effect in supply chains', *International journal of production economics*, vol. 85(2), pp. 199-215.
- Eeckhout, L. (2015), 'The Structure of Computer Architecture (R) evolution', *IEEE Micro*, vol. 35(5), pp. 2-3.
- Fan, W., E Bifet, A. (2013), 'Mining big data: current status, and forecast to the future'. *ACM sIGKDD Explorations Newsletter*, vol. 14(2), pp. 1-5.
- Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S. F., Childe, S. J., Hazen, B., E Akter, S. (2017), 'Big data and predictive analytics for supply chain and organizational performance', *Journal of Business Research*, vol. 70, pp. 308-317.
- Jain, A. D. S., Mehta, I., Mitra, J., E Agrawal, S. (2017), 'Application of Big Data in Supply Chain Management', *Materials Today: Proceedings*, vol. 4(2), pp. 1106-1115.
- Jayanand, M. Et Al. (2014), 'Big data computing strategies', *Handbook of Research on Securing Cloud-Based Databases with Biometric Applications*, pp. 72.
- Kaisler, S., Armour, F., Espinosa, J. A., E Money, W. (2013), 'Big data: Issues and challenges moving forward', *System Sciences (HICSS)*, pp. 995-1004
- Mansmann, S., Rehman, N. U., Weiler, A., E Scholl, M. H. (2014), 'Discovering OLAP dimensions in semi-structured data'. *Information Systems*, vol. 44, pp. 120-133.
- Nanda A. (2008), 'Oracle Database 11g: The Top Features for DBAs and Developers – Data Warehousing and OLAP', *Oracle Corporation*. Available at: <http://www.oracle.com/technetwork/ articles/sql/11g-dw-olap-100058.html>.
- ORACLE (2015), 'Improving Logistics & Transportation Performance with Big Data. Architect's Guide and Reference Architecture Introduction', *White Paper*, Oracle Enterprise Architecture.
- Patel, J. M. (2016), 'Operational NoSQL Systems: What's New and What's Next?', *Computer*, vol. 49(4), pp. 23-30.
- Pearson, M., Gjendem, F. H., Kaltenbach, P., Schatteman, O., E Hanifan, G. (2014), 'Big Data Analytics in Supply Chain: Hype or Here to Stay?', *Munich: Accenture*.
- Rowe, S. E Pornader, M. (2017), 'Supply Chain Big Data Series Part 1 - How big data is shaping the supply chains of tomorrow', *KPMG*.
- Silva, R. F., E Cugnasca, C. E. (2011), 'Wireless Sensor technology network and Logistics'. *XVII International Conference on Industrial Engineering and Operations Management,* pp. 1-15.
- Siu, N. Y. M., Zhang, T. J. F., Dong, P., E Kwan, H. Y. (2013), 'New service bonds and customer value in customer relationship management: The case of museum visitors', *Tourism Management*, vol. 36, pp. 293-303.
- Vaidya, B., Makrakis, D., E Mouftah, H. T. (2012), 'Robust RFID Authentication for Supply Chain Management', *Vehicular Technology Conference IEEE,* pp. 1-5.
- Wang, G., Gunasekaran, A., Ngai, E. W., E Papadopoulos, T. (2016), 'Big data analytics in logistics and supply chain management: Certain investigations for research and applications', *International Journal of Production Economics*, vol. 176, pp. 98-110.
- Xu, L., Jiang, C., Wang, J., Yuan, J., E Ren, Y. (2014), 'Information security in big data: privacy and data mining', *IEEE Access*, vol. 2, pp. 1149-1176.

AN EMPIRICAL REVIEW OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT SKILL REQUIREMENTS: A STAKEHOLDER PERSPECTIVE IN OMAN

Ahmed Aykour and Maurice Brady
STC Group and International Maritime College, Oman

Introduction

Due to their inherent focus and capability to manage the various functions of the business simultaneously, the disciplines of logistics and supply chain management have evolved from an administrative function into a strategic role (Giunipero et al., 2006). What once was looked upon as an activity for the management of operations, especially trucking and warehousing, is now accepted as a strategic level function (Murphy and Poist, 1994).

Whilst the importance of logistics and supply chain is not disputed, the question then must be asked as to how to appropriately design, implement, adapt and manage supply chains to the fullest of their capabilities in accordance with an ever changing business environment. The answer lies in the people who will undertake these roles. Many authors including Van Hoek, Chatham and Wilding were clear in their assertion that the 'people dimension' is the critical factor in the on-going success of a supply chain (Van Hoek, Chatham and Wilding, 2002). Authors such as Gammelgaard and Larson (2001), Ozment and Keller (2009), Christopher and Mangan (2005), Myers, Griffith, Daugherty and Lusch (2004), to cite some examples, have all researched logistics and supply chain in the context of the need to consistently enhance the skills of logistics and supply chain practitioners.

All the authors came to the same conclusion in that it was found that the logistics and supply chain industries lack adequately prepared personnel, there is no consensus on the contents of a logistics and supply chain third level course and subsequent teaching methodology and most importantly if the logistics and supply chain sector has access to better prepared staff, major improvements could be seen for the various stakeholders in the sector. This research endeavors to build upon previous studies, within the context and needs of the Sultanate of Oman in order to measure logistics and supply chain stakeholder views regarding the most valuable skills within their respective industries.

Problem statement

The economy of Oman is primarily driven by the hydrocarbon sector. Between 2011 and 2015, 44% of the GDP is derived from the oil sector (Tanfeedh, 2017). In addition, 46% of the population in the Sultanate are expatriates (TimesofOman, 2016). These two developments have led to two strategic initiatives. First, the Tanfeedh program to diversify the economy. It is envisaged that the oil sector will reduce to 26% of GDP by 2020 (Muscat Daily, 2016). Second, a workforce nationalization program, Omanisation, has been implemented to increase the share of Omani employees (Kemp and Madsen, 2014).

Whilst the expected rate of Omanisation varies from role, position and sector, the SOLS 2040 committee were clear in their assertion that currently "most logistics related posts are primarily held by expatriates" [MOTC, (2015), p 59] and that "the current high level of expatriates employed in this sector [logistics]" could be detrimentally affecting the career choice of local Omani's [MOTC, (2015), p 58]. Furthermore, the report goes on to say that in the 'short to medium' future this high level of expatriate will continue. This high level of expatriate staff amongst the logistics sector is such that one of the 3 key issues within the report is to ensure that there are enough adequately trained and experienced staff available locally for the industry.

Many economies suffer from difficulties in attracting employees in the sector. McKinnon et al. (2017) found that all respondents to their global survey noted potential issues concerning the availability of adequately qualified employees but differences occurred between developed and emerging economies. Developed economies noted most difficulties in recruiting staff at the blue-collar level whereas the area with least problems was that of manager. In contrast emerging economies (including the Sultanate of Oman) were directly opposite to their developed counterparts, whereby the area of most concern is at the manager level. The emerging regions exhibited a linear correlation to attracting staff where it could be seen that 35% of respondents noted very low or low availability of suitably qualified staff at the blue collar level, 36% at the administrative staff level, 39% at the supervisor level and 50% at the manager level. The findings demonstrate that emerging economies exhibit greater staff challenges as they move up the skills ladder.

This research will identify the specific gaps and mismatches between the industry requirements and educator perception of skills requirements. Furthermore, the research will take the theme of the Omanisation program and seek to analyze the influence of the expatriate labor force on the perceived gaps and mismatches.

Literature review

Despite the fact that is accepted that people with high levels of competency add value to the supply chain (Sweeney, 2013; Bowersox et al. 2000; Kirby, 2003), debate and confusion still exists as to what exactly are the skills and competencies in question. Many authors have researched this area with slight variances in their approach and results. As the industry evolves researchers have failed to agree upon a set of universally accepted set of criterion for personnel. Table 1 outlines prominent authors and researchers in the area of logistics and supply chain management skills. As can be seen, the area has been growing in momentum and research results demonstrate that potential personnel in the logistics and supply chain sector are required to have a wide spectrum of skills.

Author	Paramount Skills
Ginunipero & Pearcy (2000)	*decision making skills, teamwork, analytical, negotiation & communication skills*
Johnson et al. (2003)	*technical skills, soft skills*
Handfield & Nichols (1999)	*people skills, technological skills & functional skill*
Rahman & Qing (2014)	*environmental skills, decision making skills, teamwork, analytical, negotiation & communication skills*
Murphy & Poist (2007)	*business, logistics & management*
Gammelgard & Larson (2001)	*teamwork, problem solving, supply chain awareness, ability to take strategic view & listening*
Myers et al. (2004)	*social skills, decision making skills, problem solving & time management*
Lutz & Birou (2013)	*general knowledge, social skills, decision making skills, problem solving & time management*
Okongwu (2007)	*general management, business skills (engineering & operations) & supply chain management*
Jordan & Bak (2016)	*strategic, behavioral, process management, quantitative, people management, negotiation& decision making*
Sohal (2013)	*communication and teamwork, technology, initiative and enterprise & compliance and legal knowledge*
Derwik & Hellstrom (2017)	*functional, relational, behavioral & managerial*

Table 1: Review of previous research into logistics and supply chain skills

Although numerous studies have been conducted, two in particular are at the forefront of the subject area. In their seminal research, Murphy and Poist surveyed just under 250 logistics and supply chain management stakeholders seeking their opinion on the most valuable skills required in the logistics sector. The respondents to their survey were asked to rank 83 different skills under Business Skills, Management Skills and Logistics Skills; namely the BLM Framework. The authors updated their research in 2007. In both studies, whilst there were fluctuations in terms of specific skills, in a general sense management skills were ranked as number 1, followed by logistics skills and then business skills (Murphy and Poist, 2007). Of note from the studies is the relative stability of the skills under the logistics umbrella as they experienced much less fluctuation compared to those in the business and management skill sets in the intervening years between the first and second study.

Derwik and Hellstrom developed previously academically accepted research to the point that in their 2017 research on competence in supply chain management the authors categorized competence under four headings, namely; Functional, Relational, Managerial and Behavioral. The categorization of competence into four distinct skills sets, is based upon a review of 98 peer-reviewed journal articles. Renowned authors in the field of competence in supply chain such as Mangan, Christopher, Bowersox, Closs, Stank, Keller and van Hoek, to cite some examples, were all included in the study which give the research further credence. The study noted that 76 of the articles focused on Functional skills, 62 on Relational skills, 66 on Managerial skills and 45 on Behavioral skills.

As can be seen there are many views on what constitutes the required skill set of a logistics and supply chain professional and "there is no consensus in literature on how logistics capability should be disaggregated into specific skills nor is there any consensus about which skills to place in which skills sets", [Kovacs et al., (2012), p 247]. Adding to this confusion, the terms of logistics and supply chain management are used interchangeably. Many of the academic articles based in the logistics and supply chain management discipline first define what are both logistics and supply chain management, and then make an argument that the topics will be treated either mutually inclusive or exclusive (Globerson and Wolburn, 2014). Authors such as Mangan and Christopher (2005), Ozmet and Keller (2011), Heyns and Carstens (2012) and Yen-Chun (2007) are clear in their assertions that logistics and supply chain are treated in the same context within their work. In direct contrast researchers such as Okongwu (2007) and Ballou (2007) clearly identify the differences between the subject matter and make no illusions as to the differential in treatment of the subjects.

Methodology

In the autumn of 2017 an online survey was sent to companies with an interest in logistics and supply chain management performance in the Sultanate of Oman. The respondents were asked to rank given logistics and supply chain management skills on a 10 point Likert scale. The authors categorized the skills under Derwik and Hellstroms research, i.e. relational, business, management and logistics. The authors utilized the relational, business and behavioral skills sets as per Derwik and Hellstrom but felt it prudent to use the logistics skills as previously identified in Murphy and Posits previous work as their findings were more exhaustive and comprehensive in terms of logistics skills. Similar to authors such as Thai et al. (2011), the authors tested and adapted the structure and wording within the skill sets where needed. Following the pilot surveys, it was considered necessary to include confidence as a relational skill and change management as a business skill. As a result, respondents were asked to rank 33 skills under four categories. 18 skills are functional, 6 are behavioral, 5 are managerial and the remaining 4 skills are relational.

The online survey was distributed to 111 logistics and supply chain companies trading in the Sultanate of Oman as well as a leading higher education institute offering training and education within the logistics

and supply chain sector. An official list of logistics and supply chain companies was obtained from the Omani Chamber of Commerce. The list comprised of 111 registered logistics and supply chain companies and all registered were asked to participate in the online survey. The survey was emailed direct to the respondents with an email outlining the primary objectives and potential benefits. After 6 weeks and 2 email reminders, the survey was closed for public submission. The response rate was 33%.

Results and analysis

The survey resulted in 37 respondents. Two third of the respondents are Omani and one third are expats. Eighteen respondents work in logistics, 10 in supply chain management, seven in education and the remaining two respondents did not state where they work.

Table 2 indicates that *Teamwork* has the highest mean score of 8.86. The expats have ranked this skill as the highest while Omani employees consider it as the fourth most important skills. Further analysis reveals that employees in the Supply Chain Management rank this skill the 8th most important. Furthermore, all relational skills are ranked in the top 10 most important skills, with the lowest ranking assigned to *Communication* skills. This skill has been ranked by Omani's as 14th most important skills and by employees in Logistics as the 18th most important skill.

The Omani employees assigned the highest rating to *Customer Service,* while the expats consider this skill, with a ranking of 19, not as important. *Customer Service* scores the highest in the functional skills and is the only functional skill in the top 10. *Customer Service* is also ranked the most important skill by employees who work in Logistics.

There is consensus with all respondents regarding most of the functional skills. For example, *Return Goods Handling* and *Parts and Service Support*. These skills are ranked 32nd and 33rd respectively and there is no significant difference in how different independent variables rank these skills. In contrast, *Purchasing* is ranked the most important skill by staff employed in Supply Chain Management, while overall the skill is ranked 23rd. Similarly, *Salvage and Scrap Disposal* is ranked 4th by Supply Chain Management and ranked 24th overall. Furthermore, *Facilities Location* is ranked 21st by the Omani's and 32nd by the expats.

As can be seen in Table 2, *Self-Management*, with a ranking of three, is considered very important by expats, while Omani's ranked this skill very low at 24th. This skill shows the highest difference between groups for the behavioral skills. Employees who work in education rank *Creativity* as the most important skill. Employees in supply chain management and logistics have ranked it 16th and 2nd respectively. In addition, it is ranked the highest behavioral skill. In the category Managerial skills, *Company and Industry Experience* is considered the least important and *People Management* the most important with a ranking of 18 and 7 respectively.

Table 2 also shows that the category *Relational Skills* are considered the most important, while *Functional skills* are considered least important. Further analysis reveals that there is a high standard deviation for the *Relational Skills*, which could be accounted to mainly two skills, namely *Self-management* and *Empathy*.

ANOVA tests are conducted to test whether there are effects of independent variables on assigning scores to skills. A One-way ANOVA is conducted to compare the effects of the independent variable "*Omani or Expat*" and of the independent variable "*what best describes your company*" on the rating of the skills. Whilst there is a difference on how skills are viewed, the results imply that there is no statistical significant difference for most of the skills. For some of the skills however, there is an effect of the nationality on the rating of the skills.

Skills		Overall	Omani or Expat		What best describes your company		
	Mean	Rank	Omani	Expat	Supply chain management	Logistics	Education
Functional Skills	7.6186						
Material Handling	7.5135	25	26	24	11	23	32
Inventory Management	7.4865	26	29	22	12	30	21
International Logistics	8.1622	17	25	11	30	6	17
Forecasting	7.4595	27	22	27	21	32	15
Data and Information Management	8.2703	14	11	18	23	10	15
Purchasing	7.7027	23	19	25	1	28	21
Parts and Service Support	6.7027	33	33	29	33	28	31
Production Scheduling	7.1892	31	30	28	26	32	19
Return Goods Handling	6.7297	32	32	32	32	31	32
Facilities Location	7.1892	30	21	32	29	24	29
Transport and Traffic Management	8.1892	16	16	17	25	10	21
Warehouse Management	7.8919	20	14	21	22	15	25
Personnel Movement	7.2973	29	20	29	23	27	27
Order Management	8.0541	19	7	23	10	10	27
Packaging	7.3784	28	27	26	30	21	30
Data and Information Regulation	7.7568	22	22	20	28	21	21
Customer Service	8.4865	10	1	19	19	1	19
Salvage and Scrap Disposal	7.6757	24	8	29	4	25	25
Relational	8.7432						
Communication	8.6216	6	14	4	2	18	3
Teamwork	8.8649	1	4	1	8	3	3
Cultural and Cross-functional Awareness	8.8378	2	5	1	3	3	9
Confidence	8.6486	5	6	6	4	7	3
Managerial	8.4000						
Business Analysis	8.4865	9	12	12	8	9	14
Business Management	8.5676	8	9	9	4	10	13
People Management	8.5676	7	12	5	14	7	2
Company and Industry Experience	8.0811	18	28	10	26	18	17
Change Management	8.2973	12	17	12	16	16	9
Behavioral	8.3874						
Self-Management	8.2973	13	24	3	18	20	7
Self-Motivation	8.2162	15	18	14	14	10	12
Empathy	7.8108	21	31	16	19	26	9
Leadership	8.7568	4	3	6	7	3	6
Creativity	8.7838	3	2	8	16	2	1
Cognitive Skills	8.4595	11	9	15	12	16	8

**The skills in Italics are discussed in further detail.*

Table 2: Overall means, ranking by independent variables

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Facilities Location	Between Groups	33.347	1	33.347	4.424	.043
	Within Groups	256.292	34	7.583		
	Total	289.639	35			
Salvage and Scrap Disposal	Between Groups	45.125	1	45.125	6.946	.13
	Within Groups	220.875	34	6.496		
	Total	266.000	35			

Table 3: ANOVA Omani or Expat: Customer Service, Facilities Location and Salvage & Scrap Disposal

As can be seen from table 3, the effect of nationality on *Facilities Location* is significant, F (1,34) = 4.424, P = .043. P is below 0.05; therefor it is statistically significant at 95% confidence interval. Post Hoc comparisons using the Turkey HSD test indicates that the mean score for Omani (M = 7.9) is significantly different from the Expats (M= 5.8). These results suggest that Omani's and Expats have a different view on the importance of this skill. The effect of nationality on *Salvage and Scrap Disposal* is also significant. This skill scored a mean of 8.5 with the Omani, while it has a score of 6.1 with the expats.

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Creativity	Between Groups	16.471	1	8.236	4.356	.021
	Within Groups	60.500	32	1.891		
	Total	76.971	34			

Table 4: What best describes your company: Purchasing and Creativity

Table 4 shows the effect on *Creativity* on the other hand is significant at a confidence interval of 95%. F (2,32) = 4.356, P = .021. The Turkey HSD test indicates that the mean score of Educators (M = 10.0) is significantly different from the mean scores of Supply Chain employees (M = 8.0) and Logistics employees (M = 8.83). These results indicate that there is a significant difference on how educators regard the importance of this skill.

Discussion and conclusion

The overall results of this study show similarities with previous research completed by authors such as Murphy and Poist (2007) and Rahman and Qing (2004). Through the unique blending of previous research, the study provides an exclusive insight into stakeholder perceptions of skill requirements in the logistics and supply chain sector in Oman.

When comparing the results from Murphy and Poist's 2007 research with this work, it can be seen that respondents maintain that it is the 'soft' skills which are of significance for supply chain and logistics personnel. A direct comparison to Murphy and Poist is difficult due to the fact that they utilized business,

logistics and management skill sets whereas this research utilized relational, managerial, behavioral and functional skill sets, but a note must be taken of parallels. Respondents to Murphy and Poist signaled logistics skills as second in terms of importance when compared to management skills. Likewise, this research found that stakeholders deem hard skills such as functional skills as being of lesser importance when compared to relational, managerial or behavioral skills. With regard to the functional/logistics skills specifically (which can be analyzed in tandem) 6 of the top 10 skills correlate between the two pieces of research. A similar correlation was found in the bottom 6 skills, as 4 of the bottom 6 were repeated between the two pieces of research.

A similar likeness is confirmed when these results are compared with those from Rahman and Qing's research into supply chain skills. Although different terminology and skill sets were utilized in the two pieces of research, 50% of the top ten found by Rahman and Qing can be directly correlated with the top ten functional skills found in this research.

Whilst comparisons of functional skills to those of Murphy and Poists logistics skills is plausible and provides reliability and credence to the research, such comparisons of the relational, managerial and behavioral skills would be invalid. This research was the first time that these skills were ranked and rated by stakeholders in depth in this format. It is believed that this research is unique in its adoption of Derwik and Hellstroms framework in primary research practice and as such the results are of significance for all stakeholders.

Although previous studies into skills and aptitude recognition have been cited throughout the research, this study is unique in that it has specifically explored how expatriates and non-expatriates view the importance of skills with in the supply chain sector. The paper clearly showed that there is no consensus on how different nationalities perceive the importance of skills. Not only do expatriates and Omani's have a different view on the importance of skills, but also within the expatriate group there is a high variance suggesting that the importance of the skills is not homogenously viewed. Despite the fact that culture can be an influencing factor in determining and utilizing logistics skills (McKinnon et al. 2017), the cultural aspect was not within the scope of this study. However, the results do indicate that perception of importance of skills are culturally driven. From the results, it is deduced that Omani's are more task oriented rather than people oriented. This warrants for further research as the expatriate community is not a homogenous group, but a multiplicity of nationalities and a deeper analysis is required.

The diverse nature of the sector and the difficulty in alignment between educators and the industry itself is clearly identified when the results are analyzed, as this study has shown that differences exist between the opinions and experiences of educators and practitioners whereby both sectors have a different view on the importance of skills sets.

Additionally, the results showed that logistics and supply chain respondents rank the skills sets required by personnel in the industry differently. The research has demonstrated that the way in which a person perceives themselves within the scope of logistics and supply chain management has a direct effect on their view regarding what skills are required within their sector. The literature review has shown that the terms logistics and supply chain are used interchangeably in previous research papers. This research has confirmed the need for future researchers to treat the subjects independently if a comprehensive and deep analysis is required.

Similar to any other piece of research, this research suffered from limitations which must be acknowledged by the authors. The primary concern of the authors was that of the response rate, whereby it was deemed possible that the fact that the survey was conducted in English could have had an adverse effect on the response rate. As noted earlier, the Sultanate of Oman relies heavily on expatriate labor and as such,

numerous nationalities and languages are apparent. On the basis that English is the internationally accepted business language and the survey was designed for middle to top managers it was deemed sufficient to offer the survey in English format only as it was deemed impracticable to offer the survey in all possible languages that exist in the Omani business environment.

The fact that respondents were requested to rate a total of 33 competencies was of additional concern to the authors as it presented a disquiet over the time required to complete the survey and thus the response rate could have been affected. However, considering the exploratory nature of the research, it was deemed that the authors would be negligent to limit or edit the competencies any further. Additionally, the concerns of the authors were mitigated with the feedback from the pilot surveys.

The findings in this paper have implications for educators, regulators and practitioners. For educators the results can be used to bridge the identified gaps on the skills required and design curricula that will meet industry requirements. However, this will prove a challenge, as there is no consensus on how different practitioners, i.e. logistics and supply chain, view the importance of the skills required. For regulators the results can serve as a catalyst to successfully implement workforce nationalization programs such as the Omanisation program. For the practitioners the results will proof useful for the identification of training and educational needs for both expatriates and non-expatriate employees and can be used as a catalyst for staff training and retention.

References

- Ballou, R. (2007), 'The evolution and future of logistics and supply chain management', *European Business Review*, Vol. 19 Issue 4, pp. 332-348.
- Bowersox, D., Closs, D., Stank, T., and Keller, S. (2000), 'How Supply Chain Competency Leads to Business Success', *Supply Chain Management Review*, Vol. 4 Issue 4, pp. 70-78.
- Derwik, P. and Hellstrom, D. (2017), 'Competence in supply chain management: A systematic review', *Supply Chain Management: An International Journal*, Vol. 22 Issue 2, pp. 200-218.
- Dubey, R. and Gunasekaran, A. (2015), 'Shortage of sustainable supply chain talent: an industrial training framework', *Industrial and Commercial Training*, Vol. 47 Issue 2, pp. 86-94.
- Gammelgaard, B. and Larson, P. (2001), 'Logistics skills and competencies for supply chain management', *Journal of Business Logistics*, Vol. 22 Issue 2, pp. 27-50.
- Giunipero, L., Handfield, R. and Eltantawy, R. (2006), 'Supply managements evolution: key skill sets for the supply manager of the future', *International Journal of operations and Production Management*, Vol. 26 Issue 7, pp. 822-844.
- Globerson, S. and Wolburn, G. (2014), 'Logistics management and supply chain management: A critical evaluation', *International Journal of Business and Economics Research*, Vol. 3 Issue 2, pp. 82-88.
- Handfield, R. and Nichols, E. (1999), *Introduction to Supply Chain Management*. Prentice-Hall, Upper Saddle River, New Jersey.
- Heyns, G. and Carstens, S. (2012), 'The skills sets required for supply chain management in Southern Africa', *International Carpathian Logistics Congress*, 4 – 6 November 2015. Jesenik, Czech Republic.
- Johnson, J., Wood, D., Wardlow, D. and Murphy, P. (2003), *Contemporary Logistics, 8th Edition*, Prentice-Hall, Upper Saddle River, New Jersey.
- Jordan, C. and Bak, O. (2006), 'The growing scale and scope of the supply chain: a reflection on supply chain graduate skills', *Supply Chain Management: An International Journal*, Vol. 21 Issue 5, pp. 610-626.
- Kemp, L. and Madsen, S. (2014), 'Oman's labour force; an analysis of gender management', *Equality, Diversity and Inclusion: An International Journal*, Vol 33 Issue 8, pp. 789-805.

- Kirby, J. (2003), 'Supply Chain Challenges' *Harvard Business Review* [online] https://hbr.org/2003/07/building-relationships (Accessed 6 July 2017).
- Kovacs, G. Tatham, P. and Larson, P. (2012) 'What skills are needed to be a Humanitarian Logistician?' Journal of Business Logistics, Vol. 33 Issue 3, pp. 245-258.
- Lutz, H. and Birou, L. (2013), 'Logistics education: a look at the current state of the art and science', *Supply Chain Management: An International Journal*, Vol. 18 Issue 4, pp. 455-467.
- Mangan, J. and Christopher, M. (2005), 'Management development and the supply chain manager of the future', *The International Journal of Logistics Management*, Vol. 16 Issue: 2, pp. 178-191.
- McKinnon, A., Flothmann, C., Hoberg, K. and Busch, C. (2017), *Logistics Competencies, Skills and Training: A Global Overview – A World Bank Study*, International Bank for Reconstruction and Development/The World Bank.
- Ministry of Transport and Communications. (2015), *Sultanate of Oman Logistics Strategy, 2040*, Ministry of Transport and Communications, Muscat, Oman.
- Muscat Daily. (2016), *National Programme, Tandfeedh to Enhance, Diversify Economy*. http://www.muscatdaily.com/Archive/Oman/National-programme-Tanfeedh-to-enhance-diversify-economy-4u61 (Accessed 15 Sept 2017).
- Murphy, P. and Poist, R. (1994), 'Educational Strategies for Succeeding in Logistics: A Comparative Analysis', *Transportation Journal*, Vol. 33, pp. 36-48.
- Murphy, P. and Poist, R. (2007), 'Skill requirements of senior level logisticians: a longitudinal assessment', *Supply Chain Management: An International Journal*, Vol. 12 Issue 6, pp. 423-431.
- Myers, M. B., Griffith, D. A., Daugherty, P. J., & Lusch, R. F. (2004), 'Maximizing the human capital equation in logistics: education, experience, and skills'. *Journals of Business Logistics*, Vol. 25 Issue 1, pp. 211-232.
- Okongwu, U. (2007), 'An Innovative supply chain management programme structure: Broadening the SCM skill set', *International Journal of Learning and Change*, Vol. 2 Issue 2, pp. 192-212.
- Ozment, J. and Keller, S. (2009), 'The Future of Logistics Education', *Transportation Journal*, Vol. 50 Issue 1, pp. 65-83.
- Rahman, S. and Qing, N. (2014), 'Graduate student's perceptions of supply chain skills for supply chain managers', *Benchmarking: An International Journal*, Vol. 21 Issue 2, pp. 276-299.
- Sohal, A. (2013), 'Developing competencies of supply chain professionals in Australia: a collaboration between businesses, universities and industry associations', *Supply Chain Management: An International Journal*, Vol. 18 Issue 4, pp. 429-439.
- Sweeney, E. (2013), 'The People Dimension in Logistics and Supply Chain Management – its Role and Importance', in Passaro, R. and Thomas, A. (Eds), *Supply Chain Management: Perspectives, Issues and Cases*, McGraw-Hill, Milan, pp. 73-82.
- Tanfeedh. (2017), *The National Program for Enhancing Economic Diversification; Tanfeedh Handbook*, Tanfeedh, Muscat, Oman.
- Thai, V., Cahoon, S. and Trab, H. (2011), 'Skills requirements for logistics professionals: findings and implications', *Asia Pacific Journal of Marketing and Logistics*, Vol. 23 Issue 4, pp. 553-574.
- The Times of Oman. (2016), *Population of Oman is now more than 4.55 million*. http://timesofoman.com/article/98816 (Accessed 16 Dec 2017).
- van Hoek, R., Chatham, R. and Wilding, R. (2002), 'Managers in supply chain management, the critical dimension', *Supply Chain Management: An International Journal,* Vol. 7 Issue: 3, pp. 119-125.
- Yen-Chun, J. W. (2007), 'Contemporary logistics education: an international perspective, *International Journal of Physical Distribution and Logistics Management*, Vol. 37 Issue 7, pp. 504-528.

BEING GREEN IS BEING SUSTAINABLE: THE ROLE OF CRITICAL ENABLERS

Augustine K Bempong[1], Ming Lim[1] and Jialun Hu[2]
[1]Centre for Business in Society, Coventry University, UK
[2]Coventry Business School, Coventry University, UK

1. Introduction

As a consequence of increased in environmental awareness and interest in environmental protection, there is a growing pressure on manufacturing industries to adopt a manufacturing philosophy that seeks to apply environmental sound practices in their operations to help reduce impact of their operations on the natural environment (Wycherly 1999). In order to respond to the growing concern of environmental pollution, GSCM been adopted by manufacturing firms as a potential machinery to restore sustainability to the natural environment (Noci 1997). Recent growing awareness and the pressures on manufacturing industries create a necessity for industries to restructure and reshape their operational process to enhance their strategy to sustain their business and profitability while also staying competitive in the market (Zailani et al 2012). To achieve this enhancement in business strategy, manufacturing firms must go beyond their internal operations, monitoring, auditing their supplier's environmental objectives, and meet the environmental demands of their customers (Porter and Kramer 2006).

GSCM demands that practices, such as eco design, green manufacturing, green purchasing and reverse logistics enhance the achievement of sustainability (Zhu et al 2005). However, there are certain critical enablers that need to be present to support successful implementation of GSCM (Diabat et al 2014).

This paper is interested in investigating the need to adopt GSCM by manufacturing industries and some key GSCM practices. The study then identifies and clarifies various potential enablers that ensure successful implementation of GSCM practices and how they relate to firm performance.

2. Literature Review

2.1 Green supply chain management

Green supply chain management according to Srivastava (2007) is the integration of environmental consciousness into the traditional supply chain management, including product design, material sourcing and selection, manufacturing process, delivery of the final product to the consumers as well as end-of-life management of the product. Beamon (1999) defines green supply chain management as the extension of traditional supply chain management that integrates processes such as reuse, remanufacturing, green design and reduction of raw material usage with the aim at minimizing operational impact on the environment.

GSCM is considered to be the elimination and minimization of negative environmental effects on air, water, and land degradation; waste of resources such as energy, materials, product and management of the end –of-life of the product (2005; Eltayeb et al., 2011).

Roa and Holt (2005) describe GSCM as environmental improvement strategy that comprises inbound logistics, production or internal supply chain, outbound logistics and in some cases reverse logistics including materials suppliers, service contractors, distributors and end user.

2.2 Need for GSCM implementation

GSCM has emerged as an important business strategy that many industries are using to enhance their corporate profit and achieve environmental objective by reducing waste generation while improving ecological efficiency (Azevedo et al., 2011; Ruiz-Benitez 2017). Dou et al (2018) indicate that the integration of suppliers in product development results in reduced cost and time, improved environmental image and achievement of competitive advantage. GSCM implementation improves differentiation thereby increasing the market share and significant financial improvement of the firm (Porter 1995). Many manufacturing firms such as automobile firms engage in GSCM implementation in order to reduce pressures and for building better corporate image. GSCM implementation results in reduction or eradication of environmentally hazardous materials such as lead, mercury, chromium and cadmium (Zsidisin and Siferd, 2001; Singhal, 2013).

2.3 GSCM Practices

In this research, the main activities involved in GSCM are eco design, green manufacturing, green purchasing and reverse logistics. **Eco design** is a very crucial operational level in supply chain management. This is the stage where decision of the environmental impact of the product is taking. Whether a product would have a positive or negative repercussion on the environment is determined by the decisions taking at the designing of the product stage. Eco design therefore is an approach to design a product to have enhanced biological quality through reduction of hazardous substances that affect the environment negatively throughout the life cycle of the product (Sharma et al., 2017). This stage involves designing the product to avoid hazardous substances, excessive use of energy, excessive use of raw materials and design to encourage recycling, reuse and remanufacturing to perpetuate the life cycle of the product (Green et al., 2012). **Green manufacturing** includes application of proper technology and waste management strategy in production process with the aim to reduce environmental burden lower raw material usage, production efficiency, reduced environmental safety cost and improved public image (Ninlawan et al., 2010). Zhu et el (2005) posit that green manufacturing demands practitioners to design product that enable the reuse, recycle, recovery of materials; avoid the use of hazardous substance in production, reduced consumption of materials and energy.

Green purchasing can be described as integrating environmental consciousness into purchasing activities that certifies the products and materials purchased do satisfy the environmental objective of the buying company (Min and Galle 1997; Kafa et al., 2013). In other words, green purchasing consists of activities aim at reducing, reusing and recycling of materials. The process of engaging in green purchasing includes selecting suppliers based on the environmental objectives of the buying company, collaborating with suppliers and ensuring that the purchased materials could be re-used, recycled and above all reduced the consumption of materials (Kafa et al., 2013).

Reverse logistics

Reverse logistics is opposite of traditional forward logistics (Beamon, 1999). Dowlatshahi (2000) and Carter and Ellram (1999) posit that revers logistics is a process where a manufacturer takes back previously shipped products sent from the point of production to a point of consumption with the aim to remanufacture, recycle reuse or resell. If reverse logistics concept is effectively and efficiently implemented, it leads to cost saving for possible enhancement of the firm's profitability and customer satisfaction (Balon et al., 2016). Research indicates that reverse logistics has been widely been used by automobile such as BMW, and General Motors (Lakshmimeera and Palanisamy, 2013).

2.4 Analysis of Enablers of GSCM practices

Industries are under intensive pressure from government regulations, customers, suppliers and global competitions on their environmental strategies; this pressure has forced many industries to implement GSCM to enhance their business performance (Lpez-Gamero et al., 2009). However, for industries to implement GSCM, certain potential enablers must be identified and analysed (Diabet et al., 2014). In the past three decades researchers have published several papers on GSCM practices, pressure, barriers and performance (Zhu and Sarkis, 2004; Green et al., 2012; Chiou et al., 2011) but very little studies have investigated the potential enablers of GSCM implementation (Diabet et al., 2014). For this reason, the focus of this research is to analyse major enablers for GSCM implementation.

Enablers are variables that enhance the capacity and capability of firms to implement green supply chain management (Diabet et al., 2014). According to Grzybowska (2012), enabler is one that enables another to achieve an end. This means that enabler refers to the ability of one variable giving the other the power and competence to function to attain the sustainable development. Diabet et al (2014) posit that enablers in practice are not the same regarding their impact on sustainable adoption. The study further explains that it is essential that industries identify the best practices suitable for their sustainable objectives. It is in this respect that industries can have full fledge and successful GSCM implementation (Santos et al., 2013). Based on literature review, this study has classified potential enablers as discussed below.

Enablers	References
Supplier relationship/support	Dubey et al. (2015) ;Pauli (1997; Dubey et al. (2014); Kumar et al (2014); Vachon and Klassen (2006); Hsu and Hsu (2009); Zhu et al. (2006)
Top management commitment	Zhu et al (2005); Dou et al. (2018); Dubey et al. (2015); Jabbour and Jabbour (2015); Sharif and Irani, (2012); Berkel (2007)
Customer relationship management	Dubey et al. (2015); Li et al. (2006); Jayram and Avittathur (2015); Seuring et al. (2004); Zhu et al. (2008); Lee and Klassen (2008)
Information sharing	Li et al. (2006); Towell (1997); Mentzer et al (2000); Childhouse and Towell (2003); Balsmeir and Voisin (1996); Chizzo (1998); Holmberg (2003); Muduli (2013)
Government regulations	De Britol et al (2002); Chan et al 2016; Lee (2010); Diabet et al. 2014); Hoffman (2000)
ISO 14001 certification	Frankel (1998); ISO (2015); Hoffman (2000)

Table 1: Enablers of GSCM practices

Supplier relationship and support

For a firm to implement green supply chain management successfully to achieve the desire sustainable development, alignment of suppliers and their preparedness to adhere to focal company's environmental objectives is very essential. Recent research findings have indicated that customers are unable to dichotomise the relationship or the role of a supplier and a manufacturer and therefore any environmental liability of a supplier is borne by the manufacturer. The constant training, auditing and monitoring of suppliers is essential to enable these them to understand how to become cleaner and greener. Supplier relationship has therefore been identified as the most dominant and relevant enabler of GSCM (Bai and Sarkis, 2010; Ku et al 2010; Van Hoof and Lyon, 2013; Kumar et al., 2014; Dubey et al., 2015). Therefore, a long-term relationship between focal firm and its suppliers leverages the strategic and operational efforts and capacities of the supply chain partners and this helps them to achieve their business objectives.

Top management commitment

Management commitment is a vital variable for successful implementation of GSCM (Zhu et al., 2005; Dou, Zhu and Sarkis, 2018). According to Dubey et al (2015), top management of supply chain partners must always align their business objective to the direction of customer's interest, therefore ensuring the environmental factor in their business strategic decisions. Management beliefs, practices and commitments are pivotal for GSCM implementation (Abdulrahman et al., 2014; Jabbour and Jabbour 2015). If top management due to their commitment to GSCM implementation spells out environmental policy, it makes every employee aware of the focal company environmental strategies. Further, GSCM implementation would be successful if top management set aside special fund for green technology investment. Top management ought to show positive attitude towards green practices (Dubey et al., 2015). Management commitment is all about establishing environmental policies and goals to provide materials, resources and training to stimulate improvement (Sharif and Irani, 2012; Dubey et al 2015).

Customer relationship management

Over the last three decades, customers have become more aware and informed of the environmental impact of the product they purchase. They want to ensure that the final disposal of the product is done in a way that will not negatively affect the natural environment. More especially, customers in developed world are more conscious on environmental impact of the product they buy hence firms must be more proactive in adopting practices that seek to protect the natural environment (Dubbey et al., 2015). Customer relationship for the purpose of GSCM implementation comprises the overall

practices that ensure the management of customer complaint, building long-term relationships with customers and improving customer satisfaction (Li et al 2006). According to Dubey et al (2015), the interface with customers by firms provides valuable input, which helps to implement GSCM. Study by Jayram and Avittathur (2015) that focused on Indian manufacturing sector linked environmental policies to customer actions and sustainability strategies.

Information sharing

The extent to which appropriate information is communicated to supply chin partners is very crucial for successful implementation of GSCM (Li et al., 2006). For GSCM to be successfully implemented partners in the supply chain should operate in an environment in which information relevant to effectively operating the total environmental management systems on time and in undistorted form is available (Towell, 1997). Information within an organisation could be either strategic or tactical in nature and could include information about logistics activities to general marketing and customer information (Mentzer et al., 2000; Li et al., 2006). Research available supports the notion that the key to successful GSCM implementation is making available undistorted and up-to-date data to every member of the supply chain (Childhouse & Towill, 2003; Balsmeier & Voisin, 1996). While information sharing is appropriate, the extent of the impact on GSCM implementation depends on what information is shared, when and how it is shared, and with whom (Chizzo, 1998).

Government Regulations

Government Regulation is one of the key enablers that influences successful implementation of GSCM (De Brito et al., 2008; Chan et al., 2016). Global environmental and social concerns have caused governments to enact laws regulating the operations of industries. Manufacturing industries are held accountable for their environmental liabilities such as air pollution, greenhouse gas emission, water pollution and toxic waste generation (Lee 2010). Due to government regulations and, many Indians textile-manufacturing companies have started to adopt green supply chain management to sustain and maintain their business position in the competitive market (Diabet et al., 2014). In a national survey on environmental protection conducted in United State of America, many respondents believe that without government regulations many corporations would not attend to environmental issues and possible implement environmental protection strategy (Hoffman, 2000

ISO 14001 Certification

Established by International Organisation for Standardisation (ISO), based in Geneva Switzerland, ISO 14001 is a set of voluntary standards that integrate environmental responsibility into firm's management procedure (Frankel, 1998). Achieving the balance between environment, society and economy is very crucial in order to achieve sustainability. Societal expectations from sustainable development, transparency, and accountability have evolved with introduction of strict legislations, pressure from pollution and waste, inefficient use of resources, climate change deforestation and degradation of the ecosystems (ISO, 2015). These difficulties have influenced organisations to adopt a systematic approach to environmental management by implementing a set of green GSCM practices with the aim of protecting the natural ecology (ISO, 2015). By 1998, more than 5500 organisations worldwide had obtained certification (ISO, 1998). Many banks and insurance companies in Europe including Deutsche Bank AG have made it a policy to give preferential treatment to organisations with ISO 14001 certification. Major focal companies such as Daimler-Chrysler are demanding all their suppliers be certified (Hoffman 2000).

2.5 Significance of the sector considered in this study

Manufacturing sector plays a very significant role in UK economy and therefore the reason for it consideration in this study. Various industries make up the manufacturing sector in UK such as; food, tobacco and beverage, metal and metal product, furniture and wood related product, pharmaceutical, plastics, glasses and cement, wood and paper product, petroleum product, textile product, electrical equipment, chemical and chemical product, automobile and auto- parts. All these sectors contribute to UK unparalleled economic growth. UK is now the ninth world leading manufacturing country with output totalling $244 billion in 2015. Manufacturing sector in UK accounted for 2% of world manufacturing output (House of Commons, 2018). The sector also accounts for 1% of UK gross

domestic product (GDP). All the various industries in the manufacturing sector have long-term relationship with international business through either exporting or importing or as suppliers of parts and components.

3. Sustainability performance

Extant literature has investigated the relationship between GSCM implementation and performance implications including environmental social economic and operational. There is still diverse opinion as far as literature is concerned with respect to this relationship. However, there is strong argument within literature supporting positive relationship between GSCM implementation and performance. For example, Lee et al. (2012) posit that inter-organisational linkages and collaboration could bring about enhancement in environmental performance. Chiou et al. (2011) argued that greening the suppliers and green innovation has a positive relationship on environmental performance and competitive advantage in Taiwan manufacturing firms. Esfahbodi et al (2016) argued that the adoption of SSCM has higher levels of environmental performance, but does not necessarily lead to improved cost performance in Chinese and Iranian manufacturing sectors. On the other hand, studies such as Bowen et al (2001) argued that SSCM practices do not bring forth short-term profitability and economic performance.

4.1 Research sample size and data collection

This study aims to examine the relationship between GSCM practices and sustainability performance. Further, this study examines the critical enablers that influence implementation of GSCM by UK manufacturing industries. Qualtrics dataset was used as a survey sources for this study. The use of qualtrics as an intermediary organisation was informed by previous studies that highlights the challenges uncounted in adopting representative sampling techniques where a general mistrust of outsiders results in low response rate to mail based survey (Zhenge et al., 2006; Abdulrahman & Subramanian 2012). The intermediaries introduced the researcher and the aim of the research to the respondents and assured them that their replies are for the purposes of academic excise and that their confidentiality would be kept. An online questionnaire survey is the research instrument used in this study and was solely target at manufacturing sector in UK. Initial invitations to participate in the survey were sent by email. The questionnaires were developed based on literature presented in the previous section (Rogers and Tibben-Lembke, 1999; Lau and Wang, 2009; Abdulrahman and Subramanian, 2012). This study identified key respondents such as first level managers, assistant managers, CEO and directors who are knowledgeable about the company's internal and external operations strategies. The survey was administered by online email sent to 250 manufacturing managers on 8th march, 2018. The initial email resulted in 93 usable responses. Follow up mails were sent five weeks after the first emails and no more completed questionnaires were returned. This brought the total usable questionnaire for this study to 93, which brought overall response rate to 37.2%. This study did not deal with non-response bias since all the usable response came at the same time without any late responses.

4.2 Sample Characteristics

This section provides an overview of the characteristics of the respondents and their organisations. This section is important because as the study's outcomes will be drawn based on these information. Industry type, size of the firm and the type of the respondents generally present the main charateristics of the sample in operations and supply chain management research (Forza, 2002; Esfahbodi, 2016).

Among the respondents, 14.4 % represented food and beverage industry, 14.4 % from metal, 13.4% from electrical and computer industries. 5.2% from motor vehicle and auto parts, 6.2% from clothing and textile, 6.2% from wood industry. 6.2% from chemical industries, 5.2% from paper making industries, 6.2 from rubber and plastics industries. 2.1 % from pharmaceutical industries, 3.1 from minerals and metallic industries, 9.3% from other related manufacturing industries. With respect to firm size characteristics, this study measured the firm size using the annual turnover obtained from the demographic questions. The study also relied on the EU criterial for measuring firm's size. This measurement classifies firms as large if the number of turnover is greater than 500 million pounds or

more, and small if the annual turnover is less than 100 million, medium if the annual turnover is more than 100 million but less than 500 million (Gimenez et al 2012; Esfahodi 2016). With this in mind and based on table 4 below 47.8% were classified as small (43) 23.3% were classified as medium (21) and 28.9% classified as large (26). Drawing on table 2, the questionnaires were mainly answered by senior managers who represented 64.5% (60). 33.3% represented first level managers (31) and 2.2% represent those who are neither managers nor supervisors (2) based on the information captured in table 2.

4.3 Respondent Profile

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	First level manager/supervisor	31	32.0	33.3	33.3
	Manager/Supervisor higher than first level (Senior lead ership included)	60	61.9	64.5	97.8
	Not a manager or supervisor	2	2.1	2.2	100.0
	Total	93	95.9	100.0	
Missing	System	4	4.1		
Total		97	100.0		

Table 2: The role of respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food and Beverage	14	14.4	15.6	15.6
	Clothing and Textile	6	6.2	6.7	22.2
	Wood and related product	6	6.2	6.7	28.9
	Paper and paper product	5	5.2	5.6	34.4
	Petroleum and Gas product	1	1.0	1.1	35.6
	Chemicals and chemical product	6	6.2	6.7	42.2
	pharmaceutical product	2	2.1	2.2	44.4
	Rubber and plastic product	6	6.2	6.7	51.1
	Mineral and non-metallic product	3	3.1	3.3	54.4
	Metal	14	14.4	15.6	70.0
	Electrical and computer product	13	13.4	14.4	84.4
	Motors vehicle and auto parts	5	5.2	5.6	90.0
	Others, Please specify	9	9.3	10.0	100.0
	Total	90	92.8	100.0	
Missing	System	7	7.2		
Total		97	100.0		

Table 3: Activities of Respondents Company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than or equal to 100	43	44.3	47.8	47.8
	101-500	21	21.6	23.3	71.1
	501-1000	9	9.3	10.0	81.1
	1001-5000	6	6.2	6.7	87.8
	Above 5001	11	11.3	12.2	100.0
	Total	90	92.8	100.0	
Missing	System	7	7.2		
Total		97	100.0		

Table 4: Annual turnover of respondents firms (millions in pounds)

5. Date analysis and result

In order to test the appropriateness of the data collected to check whether the data is normally distributed, the following steps were followed. First, the 90 collected data set powered by qualtrics software was transferred into an IBM statistical package called SPSS package version 23.0. The values of the research construct were then computed using their measurement items. These values were picked for descriptive statistics to demonstrate the characteristics of the data set. Further, in order to test the appropriateness and the normality of the data distribution, skewness and kurtosis test were undertaken (Field, 2009; Esfahbodi 2016). Two analyses were carried out to examine the impact of GSCM on sustainable performance and the role of critical enablers in GSCM implementation. Descriptive statistics, alpha coefficients were used to analyse the survey data and its consistency. The skewness and the kurtosis coefficients were used to determine the data normality.

Field (2009) posits that, for a data set to be classified as appropriate and achieve normality, the recommended coefficient should be within the range of -2.00 to two. Table 5 shows that the collected data for all the variables is normally distributed with the skewness and kurtosis coefficient falling within the recommended range. This goes to show that the data distribution. Drawing on the table 5 above it is very clear that the entire construct have high reliability value ranging from 0.860 to 0.962, well above the recommended level by (Churchill, 1997; Nunnally and Bernstein, 1994). The reliability value (Cronbach's Alpha values) of the entire construct exceeded the recommended value of 0.70 indicating high reliability (Hair et al 2011). The Cronbach's Alpha is the measure of internal consistency (how closely related the items are as a group). If the questions related to the same issue, participants will be expected to get similar scores on each question (Hair et al 2011). The overall reliability of the study was considered satisfactory. This further explains that internal consistency exists among the variables thereby supporting that the measurement items used in the study actually represented their correspondent variables (Hiar et al 2010).

Variables	**N**	**Mean**	**Std. Deviation**	**Cronbach's Alpha**	**Skewness**	**Kurtosis**
Eco Design	82	3.436	1.3394	0.953	-.546	-.528
Green Manufacturing	82	3.69	1.1790	0.953	-.697	-.287
Green Purchasing	82	3.415	1.3340	0.953	-.471	-.607
Reverse Logistics	82	3.66	1.2017	0.954	-.693	-.665
Environmental Performance	82	3.574	1.2868	0.961	-.731	-.436
Social Performance	82	3.432	1..2752	0.961	-.509	-.673
Economic Performance	82	3.311	1.2786	0.962	-.414	-.549
Gov. legislation	82	3.78	1.197	0.873	-.935	.066
Management commitment	82	3.80	.999	0.883	-.812	.612
Suppliers support	82	3.37	1.329	0.872	-.480	-.914
Customer support	82	3.67	1.197	0.869	-.659	-.301
ISO certification	82	3.84	1.202	0.875	-.912	.088
Information sharing	82	3.70	1.193	0.860	-.946	.259
Valid No	**82**					

Table 5: Descriptive statistics

5.1 Factor analysis

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.901	65.013	65.013	3.901	65.013	65.013
2	.630	10.505	75.518			
3	.577	9.617	85.135			
4	.334	5.564	90.699			
5	.323	5.385	96.084			
6	.235	3.916	100.000			

Note: Extraction Method: Principal Component Analysis
Kaiser-Meyer-Olkin Measure of Sampling Adequacy= 0.861
Bartlett's Test of Sphericity= 259.945; p< 0.0000.

Table 6: Factor analysis of Critical Enablers

Factor analysis was conducted to further confirm the groupings of the critical enablers from the survey data. The critical enablers comprises six measurement items. The Kaiser-Meyer-Olkin (KMO) measure confirmed the sampling adequacy required for principal component analysis (CPA). KMO is used to test the appropriateness of data for factor analysis (Field, 2009; Esfahbodi, 2016). Table 6 above shows KMO value as = 0.861 exceeding the recommended minimum value of 0.60 required for conducting factor analysis (Field, 2009). In addition, the sig. is .000, which indicates that the strength of the relationship between variables is strong and therefore the variables are suitable for factor analysis. Furthermore, the eigenvalue for the critical enablers measure was 3.901 exceeding the recommended value of 1.

5.2 Correlation

Correlation values indicate the strength of the association between any two metric variables with the sign (+ or -) indicating the nature of the relationship (Hair et al 2014) the values range from -1 to +1 with +1 indicating a perfect relationship, 0 indicating no relationship and -1 indicating a perfect negative relationship. The bivariate results using Pearson correlation coefficient is shown in table 7. The results below show significant relationship between critical enablers and GSCM (eco design, green manufacturing, green purchasing and reverse logistics) implementation. The correlation between critical enablers and GSCM implementation is shown in the table below showing the direction and nature of relationship. For GSCM to be implemented the tables below have shown that critical enablers measure by management commitment, supplier support, customers support, ISO certification, information sharing and government regulations when properly addressed could enhance and serve as power and energizer for successful implementation of GSCM.

GSCM Practices	Correlation coefficient	Sig.(2-tailed) P- values
Eco design	.671**	.000
Green production	.559**	.000
Green purchasing	.743**	.000
Reverse logistics	.617**	.000

**. Correlation is significant at the 0.01 level (2-tailed).

Table 7: Correlation coefficients of relationship between critical enablers and GSCM

The result of table 7 above shows that the relationship between critical enablers and four GSCM implementation is significant. From the table it can be seen that sig. (p values) for all the GSCM practices = 0.000. Since p< 0.05, it is concluded that critical enablers such as management commitment to sustainability, government regulations, ISO 14001 certification, information sharing, supplier support and customer pressure have a strong positive linear relationship with four GSCM implementation namely eco design, green production, green purchasing, and reverse logistics.

Conclusion

This paper gives empirical justification for a conceptual framework that identifies critical enablers and describes the relationship among GSCM implementation. The research objective of finding out whether critical enablers and GSCM implementation have relationship, the data above have provided justification for that. Based on empirical study of 82 respondents across manufacturing sector in UK, this study has justified that certain variables that enhance the capacity, capabilities and serve as a driving force for GSCM implementation must be present. So for green supply chain management to lead to sustainability performance, enablers such as ISO 14001 certification demanded by either suppliers or manufactures, sharing of quality information among departments and supply chain partners, management commitment and government regulations are key to ensure successful implementation of GSCM.

Reference

- Abdulrahman, M.D., Gunasekaran, A., Subramanian, N. (2014). ''Critical barriers in implementing reverse logistics in the Chinese manufacturing sectors. International Journal of Production Economy. Vol 147 pp.460-471
- Beamon, A. (1999), ''Designing the green supply chain'', Logistics Information Management, vol. 12 No4, pp 330-353.
- Balsmeier, P.W. Voisin, W. (1996). Supply chain management: a time-based strategy. Industrial Management. Vol 38 No 5, pp. 24-27.
- Bowen, F.E., Cousins, P.D., Lamming, R.C. and Faruk, A.C. (2001). Horses for courses. Greener Management International, 35 41-60.
- Bai, C., Sarkis, J., (2010). Greener supply development: Analytical evaluation using rough set theory. Journal of cleaner production Vol 17 No 2 pp.255-264.
- Carter, C and Ellram, L. (1999), ''Reverse Logistics: a review of the literature and framework for future investigation'', Journal of Business Logistics, Vol 19 No. 1, pp. 85-102.
- Carter, C.R. and Jennings, M.M. (2002), ''Social responsibility and supply chain relationships''. Transportation Research Part E: Logistics and Transportation Review. Vol. 38 No1, pp. 37-52.
- Chiou, T.Y., Chan, H.K., Lettice, F., Chung, S.H. (2011). ''The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan''. Transportation Research Part E. Vol. 47 pp. 822-836.
- Childhouse, P., Towell, D.R. (2003). '' Simplified material flow hold the key to supply chain integration. Omega Vol 1, pp. 17-27.
- De Brito, M., Carbone, V., lanquart, C. (2008). ''Towards a sustainable fashion retail supply chain in Europe: organisation and performance. International Journal of production Economics. Vol 114 No 2, pp. 534-553.
- Diabat, A., Kannan, D., Mathiyazhagan, K. (2014). '' Analysis of enablers for implementation of sustainable supply chain management – A textile Case. Journal of clearner production Vol 83 pp. 391-403.
- Gimenez, C., Vaart, T.V.D., Donk, D.P.V. (2012). '' Supply chain integration and performance the moderating effect of supply complexity. International Journal of operation and production management. Vol 32 No5, pp. 583-610
- Green Jr, K.W., Zelbst, P.J., Meacham, J., Bhadauria, V.S.(2012). '' Green supply chain management practices: impact on performance. Supply chain management. International journal. Vol 17 No 3, pp. 290-305.
- Jayaram, J., Avittathur, B. (2015). ''Green supply chains. A perspective from emerging economy. International Journal of production Economy. Vol 164, pp.234-244.
- Hair, Jr. J.F., Black, W.C., Babin, B.J., Anderson, R.E. (2014). Multivariate Data Analysis. Seven edition, Pearson New International Edition.
- Laksmimeera, B.L., Palanisamy, C. (2013). Aconceptual framework on green supply chain management practices. Industrial engineering letters Vol 3 No10.

PORT PERFORMANCE AND CRUDE OIL EXPORT LOGISTICS SYSTEM DISTRIBUTION IN NIGERIA

Ishaka shitu, John Dinwoodie and Saeyeon Roh
Department of International Shipping, Logistics and Operations, Plymouth Business School, UK

Introduction

This paper aims to explore strategies to improve port performance in crude oil export logistics system distribution in Nigeria. In addition, it aims to show the results and implications of the proposed strategies using Analytic hierarchy process (AHP) to determine their relative importance. The most pressing challenge is to ensure secure, efficient, effective, and sustainable supply chains of crude oil as a commodity. An important supply chains management issue involves port performance logistics in crude oil flows towards long-term benefit for all supply chain stakeholders in support of a healthy global economy. There is an increasing perception of high costs of doing business in Nigeria, and an inability to explore competitive advantage, hence causing delay for effective and efficient supply chain management (SCM) particularly in crude oil flows. Annual Ease of Doing Business Report (World Bank Report 2016), Nigeria ranks 169 among 189 countries with Mauritius ranking 32 as the best port in Africa. Report indicators showed that trading across the borders, which is a measure of a country's port effectiveness; present a more depressing ranking of 182 out of 185 countries.

Further, World Trade Organisation (WTO) found that delays and other costs of moving goods in developing economies including Nigeria were equivalent to a 219 *percent tariff*. This invariably affects crude oil export logistics systems. "One day lost because of some logistics error means millions of dollars lost… cost of logistics in countries like Nigeria could be as much as 30% cost of a project total" (McKinsey, 2010). An - integrated logistics framework of customer services is significant in this study. Nigeria has many competitors including the Middle East, the USA, and some African oil producing countries, which export crude oil to international market. Thus, this paper's contribution is about finding possible empirical measures of port performance in crude oil flows, which influence effective and efficient logistics, SCM, trade facilitation, and have an overall effect on socio- economic development of crude oil exploration and producing nations or companies in general. AHP is a popular multi criteria decision marking (MCDM) tool for formulating and analysing decision and its application to a decision problem involves four basic steps (Zahedi, 1986).

Review of relevant literature

Measures of port logistics efficiency in oil transport using AHP techniques

Pipelines are the most important and safest means of transporting bulk energy, as the economy of a country can be heavily dependent on smooth and uninterrupted operations of pipelines (Dey and Gupta, 200). Their considerable significance in ensuring smooth logistics operation of oil transport cannot be understated; oil pipeline projects are valuable investment decisions. Dey, (2004) explored AHP framework techniques to evaluate projects in the Indian oil pipeline industry to arrive at consensus decisions on project selection through the involvement of stakeholders. The sample size covered all project stakeholders' requirement and concerns. This project spanned owner, managers, consultants, suppliers, contractors, community, government ministry, and so on. The comprehensive sample is instructive to the present study. Moreover, this present study draws all stakeholders in the crude oil export supply chain in Nigeria. Thus, the output of the study is largely relevant to current study. In addition, in the present study, Nigeria needs continuous investment to upgrade pipelines either offshore or onshore, as empirical data showed that outdated, ageing pipelines needs replacing with a modern and risk averse, and technology driven pipelines to meet international best practices. In addition, the utilisation of AHP technique in this study can prioritise strategies to improve port performance in crude oil export logistics in Nigeria. The impact of efficient pipeline on logistics is immense as it reduces pipeline attacks and thus, makes them less susceptible to militant attacks, leaks and sabotage.

Dey, (2004, p.599) concluded that feasibility analyses of pipelines projects are presently conducted within a fragmented framework with many studies occurring prior to impact assessment, however, there are varied opinions and expectations of stakeholders input in the survey which led to desired decision of site selection. Thus, they found out that prioritising environmental and social factors for site selection problem would not only ensure a sustainable development, but also keep organisational productivity up, as it ensures interrupted operations with minimum failure throughout its life. The time and cost are critical physical performance indicators raised by (Dey, 2004, p.603) model, as the project under study completed successfully in 1999 without time or cost overruns. In contrast, these have impact on the logistics chains for instance Nigeria's historic poor environmental and social factors as both empirical and archival data revealed appears hindering efficient, effective cost logistics, as some of the pipelines need upgrading to modern standard. This model can be apply whenever pipelines projects are required in crude oil supply chains. There is increasingly need for a deep-water seaport in the development of a modern economy, for instance Baltic Sea is an arterial transport corridor between Eastern and Western Europe. Zavadskas et al., (2015, p.180) used AHP and Fuzzy ratio assessment methods to propose a model that could be implemented in the development of deep – water seaport in Klaipeda. They found out facility locations decision are a critical element in strategic planning for wide range of private and public firms. This could be replicated in the current study particularly in the development of offshore/ onshore fields to find most appropriate facility location to avoid supply disruption in the chains. One comparison alternative criteria they used, and that is very relevant to this study is accessibility to the marine terminals for calling vessels. Qualitative data and observation by the author reveal some smaller joint venture oil-producing firms have challenges with dredging and hinders safe and easy access to export terminals during loading operation. The proposed model can be used to improve accessibility to marine terminal and this has huge impact on operating cost, for instance maritime insecurity has huge impact on operating cost, finding appropriate location prior to design is critical. For instance, empirical data show the whole logistics systems in Nigeria definitely suffered from a degree of investment such as occasional frequent breakdown often subsea lines, which have to be taken out of the export systems, and that reduces loading rate of vessel, lead to variations in exporting rate hence disrupting supply chain distribution network. There are similarities and differences between this study and present one. Both are case studies and used AHP technique aimed at proposing strategies for a competitive and attractive port strategic management. The major difference is in the use of fuzzy additive ratio assessment (ARAS) method and secondary data while current study use mixed methods.

Cargo loading operation is one of the most critical shipboard operation on board oil/chemical tanker due to nature of the work, hence maintaining safety operation for effective logistics system during oil shipment is vital. Akuz and Celik (2016, p.424) studied a hybrid error probability determination approach that involves case of cargo loading operation in oil /chemical tanker ship. They deployed human error assessment and reduction technique (HEART) and AHP method to determine human error probability (HEP), due its importance in the marine industry (Williams 1988). Their proposed a model is useful in marine operation such as cargo loading and discharge, which is central to current study. In particular, measurement of cargo quantity such as fixed tank gauging systems measure ullage locally and readings are usually displayed remotely on monitor in cargo control room. Qualitative data revealed differences in ship-shore difference tend to be quite significant sometimes, although measures like OUT Turn on delivery is used to mitigate this, nevertheless, its cost implications to supply chains partners has huge impact on operating cost, revenue, market reliability and could lead to disagreement on quantity loaded. More importantly, human error/ factor in gauging requires human capital investment in training and retraining on industry latest manual of petroleum measurement standard (MPMS) for custody transfer particularly for manual measurement. Akuz and Celik (2016, p.430)'s proposed solution in the design of user-friendly software which appears useful to transform operational task scenario in database into meaningful information for prediction HEP. Thus, technology would play a critical role in reducing human error element for reliable accurate metering

system showing metred quantities for use as Bill lading data, thus, digitizing or standardising this will go a long way to definitely re- established confidence and accuracy of measurement.

Nature of the problem

The pressing challenge, which is overall research question; How can Nigeria improve its port performance and crude oil export logistics systems

Methodology

In March 2016, a qualitative study involving scoping interviews with nine experts in crude oil export supply chains was undertaken to understand the issues of concern. The results were analysed using informal ethnographic content analysis (ECA) as this allows categories to emerge (Bryman and Bell, 2015, p.300). Some of the categories that emerged are "training and retraining, improve security architecture, lack of modern technology, security threat to operation, difference in quantity of crude oil lifted, inadequate funding model, clarification of contract models, changes in date of lifting programme". In addition, "crude oil theft/ loss, deployment of new technology for pipeline protection, documentation, crude oil loss, multiple taxation, ineffective information sharing among stakeholders, maritime insecurity, and dispute over entitlement, and operational delay were identified". This resulted in inferences and subsequently hypotheses that guided semi -structured interview questions and two phases of interviews. Next, twenty semi- structured depth interviews were conducted followed by four focus groups and documentary analysis of shipping and news sources. Fourteen items for improvement strategies were formed from a template of issues gleaned from the empirical data. The author used Likert scales to measure respondent's attitude after which se*ven* items emerged; then used as instrument for experts to rank using AHP technique.

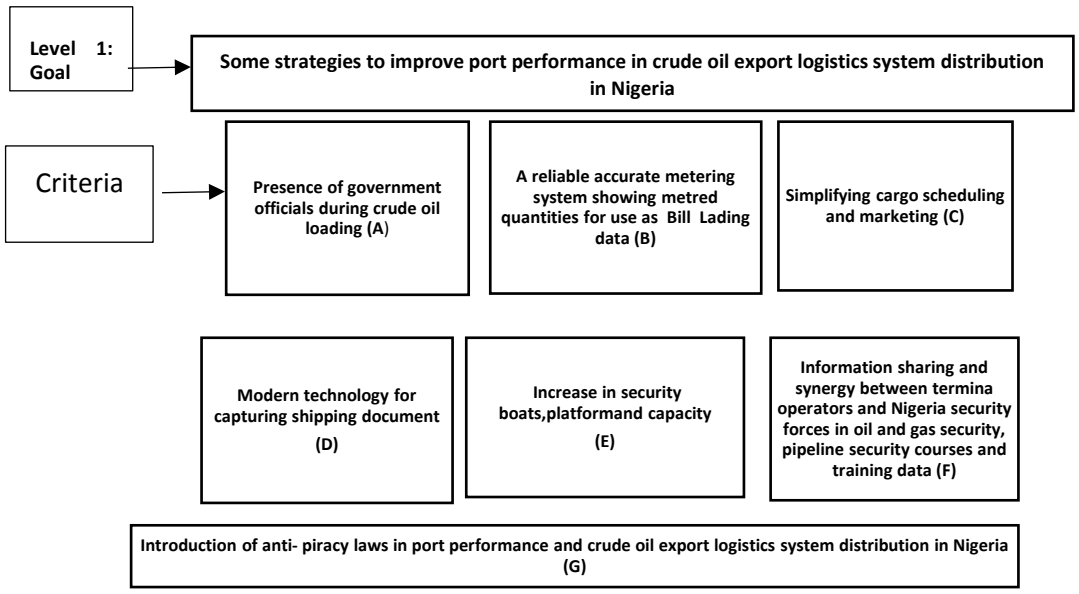
Research Method

Basic steps of AHP techniques

First, the author decomposed the decision-making problem into a hierarchy of seven criteria as seen in figure 1. A typical hierarchical structure is developed consisting two levels: Objective and a category. There are seven possible improvement strategies gleaned from empirical qualitative data*. Second, a pairwise comparison and establishing priorities among elements in the hierarchy. Third, synthesis judgements in order to obtain the weight for achieving goal, finally evaluation and checking of consistency of judgement. In this case, each element* were compared with the corresponding level. . The pairwise comparism were done on a nine-point scale (Saaty and Kearns 1985). The author chose the following words to represent the scale key: 1 = Equally important, 3= slightly more important, 5= strongly more important, 7= Demonstrably more important, 9= Absolutely more important. In addition, calibrated on the numerical scale: n (n-1)/2 comparisons. Where n is the number of elements with considerations that diagonal elements are equal to or one and the other elements will simply be the reciprocals of the earlier comparisons.

The author-performed calculations using excel spreadsheet to find the maximum Eigen value, consistency index (CI), consistency ratio (CR) and normalised values for each criteria. If the maximum Eigen value, CI, and CR are satisfactory, then decision taken based on the normalised values; else, the procedure was repeated until these values lie in a desired range. This method appears most appropriate to propose improvement strategies for this study. After building the AHP hierarchy, the next phase is measurement and data collection. Qualtrix software was used for the survey. See below a graphic summary of response rate in table 1. Some of the respondents were contacted via email invite on Qualtrix. Due to sensitivity of the research, some of the respondents were not willing to respond immediately; this could be due to busy schedule, vulnerability to piracy, company policy, inadequate knowledge and or lack of interest. However, the completion time for the survey is approximately 13 minutes. In addition, some of them complained about the questionnaire link expiration and the author was able to know during follow up call or reminder. Therefore, a new link

sent again in order to get sizeable number of respondents. See below Figure 1 showing AHP model for this study.



Source: (Author, 2018)

Figure 1: AHP Model for Port performance and crude oil export logistics system distribution in Nigeria

Distribution channel	Audience	Survey started	Response rate	Uncompleted	Completed	No response	Completion rate
Invite over email	79	18	14	5	17	11	67%
Anonymous link			1				
			18				
Total			**33**	**11**	**17**	**11**	**67%**

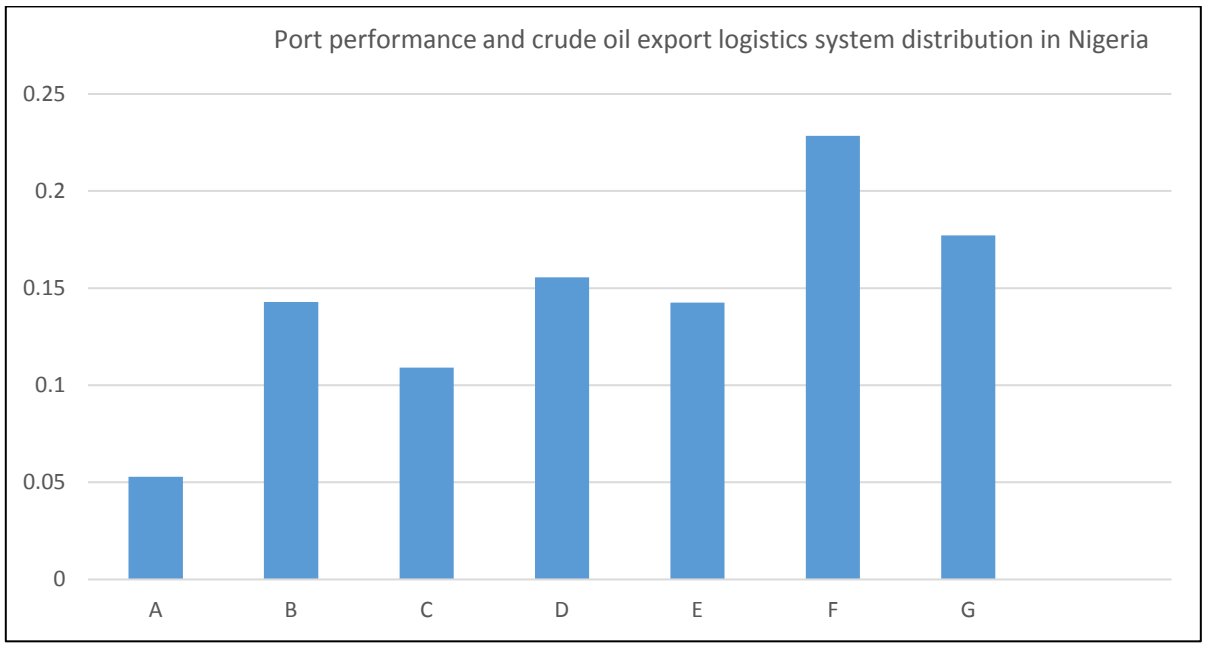
Table1: Distribution summary of AHP Survey

RESULTS /ANALYSIS

Criteria	A	B	C	D	E	F	G			Normalised weight	Percentage	Rank
A	0.133	0.052	0.026	0.036	0.030	0.076	0.017		0.369	0.0528	5.28	7
B	0.331	0.130	0.091	0.091	0.091	0.226	0.039		1.000	0.1428	14.28	4
C	0.321	0.092	0.064	0.052	0.075	0.122	0.038		0.764	0.1091	10.91	6
D	0.386	0.151	0.130	0.106	0.087	0.187	0.042		1.088	0.1555	15.55	3
E	0.434	0.139	0.083	0.118	0.097	0.109	0.019		0.998	0.1426	14.26	5
F	0.516	0.170	0.153	0.166	0.261	0.294	0.038		1.599	0.2285	22.85	1
G	0.352	0.149	0.072	0.120	0.167	0.337	0.043		1.241	0.1772	17.72	2
	2.473	0.883	0.619	0.689	0.807	1.351	0.238		7.059	1.008		

Note: Consistency index (CI) =, 0.025568, Consistency ratio (CR) = 0.01937

Table 2: Preference order of 17 group decision makers (DM) AHP Result



Source: (Author, 2018)

Fig 2: Graphical representation of 17 respondents Group DM showing performance comparisons of criteria

In this section, the result of analyses on the preference order of major strategies for a combined group Decision Making (DM) compose of 17 respondents and four sub groups span crude oil traders, cargo analyst, academics with expertise in oil supply chain, crude oil export regulators and terminal operators managers. However, only group DM and terminal operators' sub group were consistent. In essence the CR are less than 0.1, hence, consistency matrix is acceptable (Saaty, 1980). Further, can be useful and acceptable in the decision making; and selection process (Dagdeviren et al. 2009, p.8144).

In addition, other categories show fair idea of respondent intangible qualitative criteria alongside quantitative criteria (Badri, 1999, p.240). See above table 2 and 3 for result of both combined group and terminal operator's sub group DM responses respectively.

First, combined group DM showed that information sharing and synergy between terminal operators and Nigeria security forces in oil and gas security courses and training to be highest with 0.2285 (22.85%) score above all other strategies. In the same vein, one of the interview empirical evidence supported this finding as seen below. "However, at times, if there is any communication gap between Nigeria's state oil company and Nigerian Navy (NN), Navy do arrest our export tanker. For instance, if an officer will transmit a message to NN and then probably is on Friday and the person that supposed to send signal to Port Harcourt or Lagos or Warri was not available and then the vessel came during the weekend. If they do not have the vessel name on the list, they do arrest. Nevertheless, we do try to make sure they release vessels as at when due" (Crude oil export supply chain manager, February 2017). Inadequate information infrastructure result to information delay could result to demurrage, thus increasing cost of logistics, which impact all the stakeholders in the supply chains.

Second, introduction of anti- piracy law with (0.1772) 17.72% score, which is a backdrop of maritime insecurity. For instance, an informative quote from crude oil trader with immense experience on Nigeria's crude oil flow said"

*"*Nigeria has a bad reputation even doing vessel fixtures; vessel owners will charge you something known as "additional war risk" even to go Nigeria, this is something reserved for conflict zone areas known as conflict zone. Nigeria has picked up this reputation very unsafe place to load crude may be

unsafe; definitely a place to be courteous when loading crude which has been the main problem the country has faced which is understandable. Occasionally, vessels have been fired upon offshore/onshore by militants but it is not the norm it is an exception. Still, occasionally bunkering is an issue with complexity from certain authority as well, maritime authority either Navy, customs have been found to be complicit" (crude oil trading manager in one of the world leading trading company, 16/02/2017). Furthermore, attacks in the gulf of Guinea account for more than 40% of global total in first of 2018, says International Maritime Bureau (IMB). The impact is that supply chain actors expected to load cargoes particularly the ship owner want money, the cargo buyer and receiver would be disappointed because they have schedule something to happen and it does not happen due to unavailability this leads to reputational issues, and discount of Nigeria's crude price despite its quality, which is sweet crude with low.

Third, modern technology for capturing shipping document with accumulated weight of 0.1555 (15.55%). In essence, empirical qualitative study show excessive manual documentation during vessel clearances, information exchange among terminal operators; this is buttress in subjective view of senior official of an export terminal. "At times, you can hear some paper missing; if there is a way that a particular lifting can be trapped. May be; there is a system we can enter some information anywhere it goes, whether this paper got missing, we should not get worry of as nothing is going to happen, it will go a long way as things are changing". The fourth and fifth are a reliable accurate metering system and increase in security boats, platform and capacity with accumulated weight of 0.1428 and 0.1426 respectively, the former is slightly higher than the latter with 0.0002 that is infinitesimal, implying that are virtually the same in hierarchical structure. More importantly, standardising measurement is critical for efficient logistics and in particular, supply chain and this will reduced impact of ship shore difference largely. Thus, increase add value-to the value chain by increasing level of trust on agreement on quantity loaded during crude loading operation. Further, the sixth criteria is simplifying cargo scheduling and marketing with a score of 0.1091 (10.91%) and lastly, presence of government officials during crude oil loading operation. This appears the least important one as empirical evidence from qualitative interview showed disagreement within those professional engaged in crude oil supply chains. For instance, some of the interviewees have divergent opinion on numbers of government/ regulatory officials during crude oil loading operation; issues raised are duplication of roles, unnecessary inspection despite presence of agreement of crude oil sales contract among parties. Nevertheless, there was consensus on a few numbers instead of too many people, standard practice requires keeping number of visitors to a minimum and all must be accredited.

Criteria	A	B	C	D	E	F	G			Normalised weight	Accumulated weight	RANK
A	0.027	0.009	0.018	0.019	0.053	0.048	0.021		0.195	0.028	0.028	7
B	0.189	0.062	0.123	0.045	0.075	0.048	0.035		0.576	0.082	0.11	6
C	0.189	0.062	0.123	0.134	0.125	0.143	0.105		0.880	0.126	0.236	4
D	0.189	0.186	0.123	0.134	0.125	0.143	0.105		1.004	0.143	0.379	3
E	0.189	0.310	0.368	0.401	0.374	0.429	0.315		2.386	0.341	0.72	1
F	0.081	0.186	0.123	0.134	0.125	0.143	0.315		1.106	0.158	0.878	2
G	0.135	0.186	0.123	0.134	0.125	0.048	0.105		0.855	0.122	1.00	5
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000		7.000	1.000	1.00	

Note: ***CI= 0.098, Consistency ratio (CR) = 0.074***

Table 3: Preference order of Terminal Operators Group Decision Makers (DM)

For the terminal operator sub group an increase in security boats, platform and capacity is the main area of concern score = 0.341 because they see maritime insecurity as a pressing challenge in the crude oil export value chain. Hence increasing cost of logistics, from this perspective leads to increase in cost of chartering and likely demurrage, which reflects on the cost of tanker delays in port. Second,

Information sharing and synergy between terminal operators and Nigerian security forces in oil and gas security, pipeline security courses and training score 0.158 has a link with the first scenario, because effective information sharing is key to curbing maritime insecurity. Next were modern technology for capturing shipping documents 0.143, simplifying cargo scheduling and marketing 0.126 and introduction of anti- piracy law 0.122 and a reliable accurate metering system showing metred quantities for use as Bill of lading data 0.082. E- Documentation remains a challenge in international supply chains due to limited trust, regulations and cyber security threat (Mei and Dinwoodie, 2005, p.198). Thus, despite some increasing electronic transfer of some shipping documents, manual documents predominate. Presence of government officials 0.028 was rated lowest.

Discussion

Implications for theory

New areas worthy of consideration emerged in the logistics operation of crude oil flows including information sharing, a reliable accurate metering system showing metred quantities for use as Bill of Lading data and a need for anti – piracy law specific to Nigeria. Strategies for improvement are grounded in the experts' knowledge, which can be replicated. Academic literature emphasized that accurate information flow is central among supply chains links in a timely, coordinated fashion, which minimizes distortion; structured information management lies at the heart of SCM (Hull, 2002, p.8, Singh, 1996, p.28). Empirically the highest global weight complemented prior academic literature on information flows, in particular information sharing and synergy among the supply chain collaborators in Nigeria's crude oil flows. These were supported by interview data.

Implication for industry/practice:

An automation system for pipelines, inventory security systems and SCM concepts in logistics operation are central for efficient, effective SCM in crude oil flows and thus ensuring access to sustainable, affordable, and reliable sources of energy from Nigeria to the international oil market. In addition, other key items that needs improvement are legislation, training, effective electronic communication and information infrastructure. For Nigeria to have an edge over its competitors these empirical strategies are needed to optimise port performance and crude oil export logistics system distribution. *AHP assist in understanding the preference order of major criteria/attributes and proposing sustainable optimisation strategies.*

Policy implications:

In an era of increasing global oil demand despite increasing growth in an evolving transition scenario, there is an urgent need to shift from a traditional business model to a more modern model. The model must that accommodates challenges including climate change, collapse in oil prices, maritime insecurity/ geopolitical risk, investment in infrastructure (information infrastructure, digital technologies for efficient processes), and peak oil in an increasingly competitive market and a sustainable regulatory framework. Future research will be required to focus possibly focus group on monitoring and as well action research with terminal operator managers on strategies to curb maritime insecurity and safety of people.

References

- *Akyuz, E. & Celik, M. (2016) 'A hybrid human error probability determination approach: The case of cargo loading operation in oil/chemical tanker ship'. Journal of Loss Prevention in the Process Industries, 43 pp. 424-431.*
- *Badri, M. A. (1999) 'Combining the analytic hierarchy process and goal programming for global facility location-allocation problem'. International Journal of Production Economics, 62 (3), pp. 237-248.*
- *Bryman, A. and Bell, E. (2015). Business Research Methods. Fourth Edition. Oxford: Oxford*

- *Dağdeviren, M., Yavuz, S. & Kılınç, N. (2009) 'Weapon selection using the AHP and TOPSIS methods under fuzzy environment'. Expert Systems With Applications, 36 (4), pp. 8143-8151.*
- *Dey, P. K. (2004) 'Analytic hierarchy process helps evaluate project in Indian oil pipelines industry'. Int. J. Oper. Prod. Manage., 24 (5-6), pp. 588-604.*
- *Hull, B. (2002) 'A structure for supply-chain information flows and its application to the Alaskan crude oil supply chain'. Logistics Information Management, 15 (1), pp. 8-23.*
- *International Maritime Bureau, (2018). Pirate attacks worsen in Gulf of Guinea. [Online] Available at https://www.icc-ccs.org/index.php/1244-pirate-attacks-worsen-in-gulf-of-guinea [Accessed 11 May.18]*
- *Maletic, D., Maletic, M., Lvrencic, V., Al-Najjar, B. & Gomiscek, B. (2014) 'An application of analytic hierarchy process (AHP) and sensitivity analysis for maintenance policy selection'. Organizacija, 47 (3), pp. 177-188.*
- *Mei, Z. & Dinwoodie, J. (2005) 'Electronic shipping documentation in China's international supply chains'. Supply Chain Management: An International Journal, 10 (3), pp. 198-205.*
- *Saaty, T.L (1980). 'The Analytic Hierarchy Process, New York, NY: McGraw-Hill.*
- *Singh, J. (1996) 'The importance of information flow within the supply chain'. Logistics Information Management, 9 (4), pp. 28-30.*
- *The World Folio, (2013) 'Forward thinking logistics in Nigeria oil and gas sector. [online] Available http://www.theworldfolio.com/interviews/simone-volpi-managing-director-of-intels-nigeria-n2159/2159/ [Accessed 23 Jul.2016]*
- *World Bank, (2016) 'Doing Business 2016. Measuring regulatory quality and efficiency. [Online] Available https://openknowledge.worldbank.org/bitstream/handle/10986/23323/Doing0business0efficiency000Nigeria.pdf?sequence=1&isAllowed=y [accessed 19 Jul. 18].*
- *World Trade Organisation, (2015) World trade report 2015. D. Estimating the benefit of the Trade Facilitation Agreement [online] Available https://www.wto.org/english/res_e/booksp_e/wtr15-2d_e.pdf [accessed 20 Dec.18]*
- *Zahedi, F. (1986) 'GROUP CONSENSUS FUNCTION ESTIMATION WHEN PREFERENCES ARE UNCERTAIN'. Operations Research, 34 (6), pp. 883.*
- *Zavadskas, E. K., Turskis, Z. & Bagoius, V. (2015) 'Multi-criteria selection of a deep-water port in the Eastern Baltic Sea'. Applied Soft Computing Journal, 26 pp. 180-192*

EVALUATING SKILL REQUIREMENT FOR LOGISTICS OPERATION INDUSTRY BETWEEN LOGISTICS SERVICE PROVIDERS AND ACADEMICS

Chia-Hsun Chang[1] and Chi-Chang Lin[2]
[1]Liverpool John Moores University, UK
[2]Feng Chia University, Taiwan

Introduction

With the global fierce competitive business environment, international logistics capacity is becoming an inevitable countermeasure for international enterprises to meet the challenges of managing globe spanning supply chains successfully. International logistics emphasizes the establishment of core competitive advantage of international enterprises from the aspect of minimizing operating costs, inventory pressure and risk, as well as reducing production lead-time in the supply chain process. To achieve this goal, logistics operations require implementing and fulfilling accurately by skilled staff. Thus, to enhance their own logistics capacity, international enterprises need to strengthen the hardware and software facilities as well as the need to focus on staffs' skill training. Based on the knowledge-based theory, the elements of knowledge include information, technology, know how, and skill. The acquisition of knowledge can increase the value of the enterprise's production and gain a competitive advantage.

However, reports indicated that international enterprises are always facing the shortage of qualified staff for fulfilling a variety of logistics operational requirements (Arvis et al., 2016) and heavily burdened logistic expense (David, 2013). The international logistics service providers (LSPs) thus assist dealing with those logistics operations for the international enterprises. This phenomenon reveals that first line employees from LSPs are required to accept more practical skill training for coping with various situation in the global supply chain context.

The other emerged problem is that the skills required by the LSPs and the training given by the academics to first line logistics employees are different. Numerous studies have attempted to explore logistic operation related skill attributes (e.g., general business knowledge, managerial knowledge and logistics knowledge, etc.) and emphasized the importance on the selection of those attributes required by LSPs in logistics operation (Murphy and Poist, 1991, 2007; Gibson et al., 1998; Wu et al., 2013). The LSPs argue that skills such as foreign language, customer relationship and software application are most important, while those in academics contend that skills such as planning and communication ability should take as the first priority to be educated.

A discrepancy of perceived skills requirement of international logistics between these two roles may result in the inefficiency of using current human resources and the misuse of training resources. Under the consideration of such cognitive differences, the identification of necessary skills that logistic practitioners should equip is becoming a worth exploring issue.

There are several researches focused on the comparison of required skills between industry and academics. For example, Aasheim and Williams (2009) addressed information technology skills; Snoke and Underwood (2001) addressed information system skills. However, few of them addressed the difference of skill requirement between international LSPs and academics. In order to fill this research gap, this study empirically evaluates the crucial logistics skill requirements between LSPs' and logistics academics' perspectives.

The rest sections of this study are described as below. Section 2 reviews previous research on logistics skill requirements. The research methodology is then presented in Section 3, followed by discussion of the results in Section 4. Section 5 outlines the implications of the research findings and proposes recommendations for future research.

Literature review

Major international market trend, involving supply chain management, transportation, and information technology, are changing the way logistics is practiced and taught (Murphy and Poist, 2006, Thai et al., 2011; Thai, 2012). These trends are also changing the critical skill requirements needed by international LSPs. International logistics is the process of planning, implementing, and controlling the flow and storage of goods, services, and related information from a point of origin to a point of consumption located in a different country. It includes providing logistic support (major end items, material, and/or services) to, or receiving logistic support from other firms. A majority of research provided a list of skill requirement of international logistics required by international logistics service providers (Murphy and Poist, 1991, 2006, 2007; Gammelgaard and Larson, 2001, Poist et al., 2001; Kovács and Tatham, 2010; We et al., 2013).

Murphy and Poist (1991) proposed a framework entitled BLM model with 83 required skills in logistics industry (33 business skills, 18 logistics skills, and 32 management skills). They also defined business skill as the knowledge that logisticians must equip both directly and indirectly relates to business. Logistics skill refers to the skills that a logistician needs to be educated or equipped in various fields of logistics. Management skill means the managers need the skills relating to planning, organizing, and personal attributes to lead to companies survive in the complex business environment.

Although the BLM model has been used as a common tool to measure logisticians' required skills, it has been validated mostly in the American context (Thai et al., 2012). In addition, considering the target sample would include new coming employees, management skill is not involved in this study, as it should have a comprehensive experience on "real" management jobs, which is rare in new coming employees. Therefore, this study removes management skills and modifies business and logistics skills to those are more relevant to the aim of this study.

Business skills

Business skills include the basic skills used in any type of industry. Murphy and Poist (1991) proposed 33 business skills and categorized them into traditional skills and non-traditional skills. The top five skills include transportation and logistics, general business administration, business ethics, information system, and strategic management. Poist et al. (2001) examined the skill requirement from logistics managers' perspective. They proposed 13 general business related skills that new-hired logistics personnel should have and categorized them into three tiers based on their importance. The top 5 skills include communication skill, adaption ability, Multi-functional capabilities, Information system and computer skills, and foreign language. Gammelgaard and Larson (2001) analysed the difference of perception of supply chain management skills between logisticians and students who studied in the logistics related departments in the universities. They proposed nine business related skills, including business ethics, computer programming skills, database application, software knowledge, statistics analysis ability, planning management, industry background knowledge, technology knowledge and technique knowledge. Kovács and Tatham (2010) suggested that a logistician should require several general skills, including finance and accounting, information technology, change management, marketing, project management, strategic management, customer relationship management, supplier relationship management, and risk management. Wu et al. (2013) proposed 50 skills for global logistics managers in Taiwan. The results showed that the top five skills are related to general business skills, including international perspective, foreign language, communication, decision making, and risk management.

Logistics skills

For the logistics skills, it reflects the professional knowledge related to logistics area. Murphy and Poist (1991) found the top five logistics skills include traffic/transportation management, customer service, warehousing, inventory control, and material handling. Kovács and Tatham (2010) suggested a logistician should require some logistics skills, including legal, customs, import and export management, transportation management, inventory management, warehousing, purchasing and

procurement, forecasting, reverse logistics, port/airport management, and logistics information system. The results from Wu et al. (2013) showed that the logistics related skills are less important than general business skills, but also important according to their weights. The important logistics skills they found include logistics professional knowledge, customs regulations, purchasing capability, delivery management, raw material planning, and storage management.

Comparison by different groups

Murphy and Poist (2006) compared the difference of skill requirements between senior and junior logistics managers. The results indicated that both senior- and entry- level logisticians emphasize on the business skills of supply chain management, transportation and logistics, and business ethics. The results also indicated that the top three logistics skills for senior-level logisticians include customer service, inventory management, and transportation and traffic management, whereas entry-level logisticians emphasize more on transportation and traffic management, logistics information management, and warehousing management. Murphy and Poist (2007) compared the skill requirement between 1990s and 2007. The results show that the business skills were getting increasing important on speech communications, production management, and international business, whereas the logistics skills were increasingly important in international logistics, forecasting, and return goods handling. Razzaque and Sirat (2001) analyzed the logistics skills equipped by mid-level and high-level logistics managers between Singapore and Malaysia. The results indicated that Singapore managers emphasized skills such as transportation management, customer service, inventory management, warehousing, and demand, whereas Malaysia managers focused on those of customer service, inventory management, warehousing, and demand prediction. This indicates that the skill requirement might be different based on the background of the respondents.

Methodology

Sample

The sample of shipping agencies was selected from Directory of the National Association of Shipping Agencies. Meanwhile, population of forwarders were drawn from members of the International Ocean Freight and Air Freight Forwarders Association. Samples of international LSPs were selected from local warehousing, transportation and customs brokers association. In addition, samples of academic fields were selected from professors and lecturers those who were lecturing at logistics and transportation related fields in Taiwan's university and colleges.

In total, 1,447 questionnaires were posted to logistics related firms and academics. Based on the reply time period, the respondents were classified into two groups. The first group with 121 responses was collected in three weeks, and the second group with 69 responses was collected after three weeks. A total of 190 mailing were received yet the valid replies were 181 because of some missing data in the removed nine respondents. Among of these valid responses, 142 were from international LSPs and 39 were from logistics academics. The valid response rate was 12.6 %. The result presents that 1,021 questionnaires were sent to forwarders and received 87 replies (response rate: 8.3%), 46 replies from 259 shipping carriers (response rate: 17%), 8 replies from 51 third party LSPs (response rate: 15.7%), 5 replies from 10 airline carriers (response rate: 50%) and 44 replies from 106 scholars (response rate: 36.8%).

To detect any potential non-response bias, Armstrong and Overton (1977) recommend ensuring that the second wave of respondents' responses which are having similar characteristics to the first part of preventing from any non-respondents' case. The total 181 survey respondents were divided into two groups based on their response waves (first: n=121, 66.9% and second: n=69, 38.1%). t-tests were conducted on the two groups' responses and the results indicated that, at the 5% significance level, there were no significant differences in the two groups' responses to the various items. t-test results suggested that this study does not have non-response bias since late respondents' responses were similar to those of first wave respondents.

Research methods

The research analytical steps were conducted as follows. The first step was the selection of business and logistics skill attributes respectively for LSPs and logistics academics. In determining questionnaire items, it is crucial to ensure the validity of their content, since it is an important measure of a survey instrument's accuracy. Content validity refers to the extent to which an item measures what it is supposed to measure (Cooper and Emory, 1995). Content validity assessment typically involves an organized review of a survey's content to ensure it includes the necessary information. The content validity of the questionnaire used in this study was tested through a literature review and interviews with interviewees. The results indicate that 29 business and 20 logistics skill attributes were appropriate and therefore selected for the questionnaire.

In the second step, after collecting the replies, analysis of variance (ANOVA) was employed to test the perceived differences of logistics skill requirements between academics and four groups of international LSPs (forwarder, maritime carrier, 3rd party, and airline carrier). In the third step, factor analysis with principal components analysis was employed to summarize a large number of skill attributes into a smaller number of underlying dimensions called critical factors. VARIMAX rotation was used to transform a set of interrelated variables into a set of unrelated linear combinations of these variables. Only variables with a factor loading than 0.5 were selected. Having eigenvalues greater than one was used as the criterion to determine the number of factors in each data set. In addition, a reliability test based on Cronbach's α was used to test the internal consistency of questionnaire responses.

Result of empirical analysis

Characteristics of respondents

About the characteristics of respondents, the results showed that 35.2% of firm's survey participants were vice-presidents or above, nearly 42% were managers and assistant managers, 4.2% were directors, 4.2% were sales representatives, 9.9% were clerk, and 4.9 % were others. This study attempted to investigate the importance of perceived logistics skill in all aspects of logistics dimensions, therefore the views of managers as well as general employees (e.g. sales representatives or clerks) were all considered for evaluation. In terms of work experience, results indicated that a majority of respondents (37.3%) served more than 20 years in port, whereas 16.2% of respondents had been working between 16 to 20 years, 14.1% were between 11-15 years, 17.6% were between 6-10 years, and 14.8% with work experience were less than 5 years.

As regards for age of logistics firms, results revealed more than one third of logistics firms (38.8 %) had been established for more than 20 years, followed by 6-10 years (19.7%), 11-15 years (19.0%) and 16-20 years (17.6%). Only 4.9% of logistics firms operated their business less than five years. Furthermore, the results also showed that nearly half (42.9%) of logistics firms earn annual revenue more than 101 million NT$, followed 11-50 (19.7%), 5-10 (15.5%), less than 5 million (11.3%) and 51-100 (10.6%). Further, 41.5% of sampled logistics firms had employees less than 20, whereas 26.1% of firms had employees between 21-50 personnel. 14.8% hired employee more than 250 personnel followed 9.9 % (101-250) and 7.7% (51-100).

In terms of the respondents from academics, of all the logistics academics surveyed, 46.2% were assistant professors, 20.5% and 17.9% were professors and associate professors, respectively. Only 15.4% of respondents were lecturers. Most of respondents had PhD degree (84.6%) in this survey. In addition, more than 25% of logistics academic respondents had lectured and conducted research in the related filed for more than 10 years, over 35% were between 5 and 10 years, and over 30% of respondents (33.4%) had logistics related lecturing experience for less than 5 years. This indicated that more than 66% of respondents had conducted research and lectured in the logistics fields for more than five years and consequently had sufficient knowledge to answer the questionnaire accurately and reliably.

Results of Factor analysis

Factor analysis was used to reduce both the 29 business and the 20 logistics attributes to smaller sets of underlying factors in order to detect the presence of meaningful patterns among the original variables and to extract the main dimension factors. Only variables with a factor loading greater than 0.50 are selected (Hair et al., 2010). Two business skills (human resource management and organization psychology) and four logistics skills (electronic commerce, transportation economics, logistics law and regulation, and international logistics) were eliminated as they had two factor loading scores greater than 0.50 or very close to 0.50.

In Table 1, six identified key business skill factors accounted for approximately 65.397 per cent of the total variance. The 6 factors were labelled and categorized below:

Business skill attributes	F1	F2	F3	F4	F5	F6
Regression analysis	**0.867**					
Multivariate analysis	**0.839**					
Operation research	**0.819**					
Statistics	**0.750**					
Microeconomics	**0.703**					
Macroeconomics	**0.677**					
Customer relationship management		**0.814**				
Marketing management		**0.725**				
Consumer behaviour		**0.696**				
Strategic management		**0.579**				
International exchange			**0.748**			
International finance			**0.643**			
Insurance			**0.631**			
Business ethics			**0.529**			
Business regulation			**0.509**			
International trade			**0.500**			
Software application				**0.720**		
Management information system				**0.710**		
Computer program language				**0.604**		
Database application				**0.601**		
Excel application				**0.595**		
Accounting					**0.822**	
Financial management					**0.806**	
Business administration					**0.551**	
Business writing						**0.761**
English capability						**0.634**
Business negotiation						**0.596**
Eigenvalues	10.041	2.607	2.059	1.691	1.477	1.089
Percentage variance	34.626	8.991	7.098	5.832	5.094	3.756
Cronbach Alpha	0.9116	0.8187	0.8005	0.8113	0.7568	0.6310
Mean	3.265	3.917	3.688	3.876	3.771	4.242

Table 1: Factor analysis for business skill attributes

Table 2 revealed four logistics skill factors accounted for approximately 73.634% of the total variance. They were labelled and categorized below:

Logistics and SCM skill attributes	F1	F2	F3	F4
Distribution management	**0.850**			
Retailer management	**0.833**			
Order management	**0.788**			
Quality assurance management	**0.783**			
Delivery management	**0.769**			
Purchase management	**0.764**			
Inventory management	**0.761**			
Producing management	**0.672**			
Warehousing management	**0.655**			
Logistics system simulation		**0.841**		
Enterprise resource planning		**0.692**		
Logistics information system		**0.685**		
Transportation management			**0.820**	
Intermodal transportation			**0.814**	
Global logistics management				**0.775**
Supply chain management				**0.737**
Eigenvalues	10.342	2.203	1.162	1.020
Percentage variance	51.712	11.015	5.808	5.099
Cronbach Alpha	0.9399	0.8511	0.8613	0.7711
Mean	3.606	3.669	4.099	3.880

Table 2: Factor analysis for logistics skill attributes

A reliability test based on Cronbach's Alpha was used to test whether these dimensions were consistent and reliable. In Table 1, Cronbach Alpha values for the six business skill factors were all more than 0.6; while in Table 2, Cronbach Alpha values for the four logistics skill factors were all more than 0.75. The reliability values for business and logistics skill factors were considered adequate for a satisfactory level of reliability in the research (Nunnally, 1978; Iacobucci and Churchill, 2010).

Table 1 and 2 also revealed the importance of the critical factors of both business and logistics skills requirements based on the mean values. For business skills factor shown in Table 1, Factor 6 (communication skill) was considered as the most important factor, followed by Factor 2 (customer and strategy management skill), Factor 4 (computer skill), Factor 5 (finance skill), Factor 3 (international trade and regulation skill) and factor 1 (data analysis). In Table 2, the most important factor was Factor 3 (transportation skill), followed by Factor 4 (global logistics and supply chain management skill), Factor 2 (logistics information management skill) and Factor 1 (logistics operation skill).

Analysis of variance (ANOVA) results

Analysis of variance (ANOVA) was used to examine whether the skills factors differ among the scholars and the four groups of international logistics firms. As shown in Table 3, LSPs were divided into four roles, namely forwarder, maritime carrier, 3rd party, and airline carrier to compare the perceptual difference with those in logistics academics.

For business skill, the maritime carrier in the dimensions of communication (mean = 4.356) and computer (mean = 3.961) tended to gain the higher mean scores than those of other international logistics firms and logistics academics, whereas forwarder had higher mean score in the customer and strategy skill (mean = 3.997). In contrast, logistics academics had higher mean scores in business factors of finance (mean = 3.992), international trade and regulation (mean = 4.122) and, data analysis (mean = 3.565) than the other four international logistics firms.

For logistics skill, the 3rd party had the highest mean score in the factor of transportation (mean = 4.125), while maritime carrier gained the highest mean score in the dimension of logistics operation (mean = 3.783). Airline carrier had the higher mean score Global logistics and supply chain management skill (mean = 4.100). Furthermore, the results also indicated that logistics academics had higher mean score (mean = 3.896) than the other international logistics firms.

	Type of international logistics service providers				Logistics academics(5)		
	Forwarder (1)	Maritime carrier (2)	3rd party (3)	Airline carrier(4)			
	N = 85	N = 44	N = 8	N = 5	N= 39		
Skill Factor	Mean	Mean	Mean	Mean	Mean	P	LSD
Business skill							
Communication	4.200	**4.356**	4.125	4.133	4.021	0.009**	(1,5)(2,5)(3,5)(4,5)
Customer and strategy management	**3.997**	3.767	3.969	3.800	3.961	0.362	
Computer	3.877	**3.961**	3.575	3.590	3.898	0.000**	(2,5)(3,5)(4,5)
Finance	3.788	3.807	3.625	3.400	**3.992**	0.774	
International trade and regulation	3.716	3.682	3.417	3.700	**4.122**	0.000**	(1,5)(2,5)(3,5)(4,5)
Data analysis	3.181	3.395	3.313	3.475	**3.565**	0.387	
Logistics skill							
Transportation	4.112	4.091	**4.125**	3.900	4.023	0.000**	(1,5)(2,5)(3,5)
Global logistics and supply chain management	3.871	3.864	3.938	**4.100**	3.889	0.933	
Logistics information management	3.637	3.712	3.646	3.867	**3.896**	0.000**	(1,5)(2,5)(3,5)(4,5)
Logistics operation	3.530	**3.783**	3.778	3.044	3.667	0.000**	(2,5)(3,5)(4,5)

** Significance level p<0.01

Table 3: ANOVA of skills factors' differences among international logistics firms and academics

Results indicated that the evaluation statistically differed for the dimension of business skill in communication, computer, and international trade and regulation. While referring to the dimension of logistics skills, items including transportation, logistics information management, and logistics operation were found to significantly different between LSPs and academics. A post hoc with LSD method was then conducted to determine which groups are significantly different with other groups. In the business skill dimension, items such as "communication", "international trade and regulation" revealed a perceptual difference between logistics academic and four groups of LSPs. In the item of "computer", perceptual difference was also found between logistics academic and three groups of LSPs (i.e. maritime carrier, 3rd party, and airline carrier). With regards to logistics skill, "transportation" was perceived difference between logistics academics and three groups of LSPs (i.e. forwarder, maritime carrier, 3rd party). While regarding to "logistics information management", four groups of LSPs' perception were also found difference from logistics academics. Finally, maritime carrier, 3rd

party and airline carrier hold difference opinion to logistics academics in evaluating “logistics operation”.

Discussion and conclusion

This study empirically investigated the crucial attributes and factors of business and logistics skill requirements from perspective of international LSPs and logistics academics. Survey data collected from 181 respondents from logistics practical and academic fields for identifying crucial logistics operation skills.

Factor analysis was employed to identify six crucial business skills, namely, data analysis skill, customer and strategic management skill, international trade and regulation skill, computer skill, finance skill and communication skill. Four logistics skills were also identified, namely, logistics operation skill, logistics information management skill, transportation skill, and global logistics and supply chain management skill. The findings suggest that communication skill is perceived as the most important business skill, followed by customer and strategy management skill, computer skill, finance skill, international trade and regulation skill, and regression analysis skill; whereas transportation skill is perceived as the most important logistics skill, followed by global logistics and supply chain management skill, logistics information management skill and logistics operation skill.

The results of ANOVA indicated that both business skill and logistics skill dimensions were significantly different between international LSPs and logistics academics. The results indicated that the perceptions are significantly different in the dimension of business skill on communication, computer, international trade and regulation; while in the dimension of logistics skill on transportation, logistics information management, and logistics operation are perceived differently between international LSPs and logistics academics.

Some of academic and practical contributions were provided by this study. From the academic aspect, while a majority of previous studies on logistics skills assessment have been discussed, there is still a lack of examination of logistics skill assessment compared between international LSPs and logistics academics. This study not only investigated the perceived importance of logistics skills between international LSPs and logistics academics but also to highlight the important factors of logistics skills. From the managerial perspective, the research findings help international LSPs identify and provide logistics skills training for the staff engaging in their logistics operations. Further, this study identified six crucial business skill factors and four logistics skills, which provide useful information for international LSPs to identify important skill requirements for strengthening logistics competence of international firms. This study also provides a comprehensive understanding of skill requirement discrepancy between international LSPs and academics. The results show that there is still a large cognitional gap of required skills in logistics area between industrial managers and educators. In order to reduce the different cognition between LSPs and educators, this study suggests that it is necessary to conduct regularly cooperative education by both roles. Educators can thus adjust the courses to meet the requirement by the international LSPs; whereas LSPs can also reduce training courses cost and time for the new employees.

This study is limited to examining skills requirements specifically in international logistics firms. There exists wide scope for future researches to investigate this issue by different industries. Future research can conduct an effect-and-cause analysis and consider enablers (e.g. logistics capability) and dependent variables (e.g. logistics performance and organizational performance) of logistics skill. Moreover, this study identified crucial logistics skills from international LSPs and academic perspective; future research can consider the perceptions of stakeholders. The other worth noting consideration is that since this research mainly focused on international logistics supply providers based on Taiwan, future research can apply the assessment approach of this study to identify logistics skills in other countries.

References

- Aasheim, C. L., Li, L., & Williams, S. (2009). 'Knowledge and skill requirements for entry-level information technology workers: A comparison of industry and academia'. *Journal of Information Systems Education*, Vol. 20 No. 3, pp. 349-356.
- Armstrong, J.S. & Overton, T.S. (1977). 'Estimating nonresponse bias in mail surveys', *Journal of Marketing Research*, Vol.14, pp.396-402.
- Arvis, J.F, Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., Raj, A., & Naula, T. (2016), *Connecting to Compete 2016: Trade Logistics in the Global Economy: The Logistics Performance Index and Its Indicators*. Washington, D.C.: Communications Development Incorporated.
- Cooper, D.R. & Emory, C.W. (1995), *Business Research Methods*, Chicago: Richard D. Irwin.
- David, P. (2013), *International Logistics: The Management of International Trade Operations* (4th Ed.). OH: Cicero Books.
- Gammelgaard, B. & Larson, P.D. (2001), 'Logistics skills and competencies for supply chain management', *Journal of Business Logistics*, Vol.22 No.2, pp. 27-50.
- Gibson, B., Gibson, M. & RutnER, S. (1998), *Careers in Logistics, Council of logistics Management*, Oak Brook, IL.
- Hair, J. F., Black, W.C., Babin, B.J. & Anderson, R.E. (2010), *Multivariate Data Analysis*, 7th Ed., Prentice Hall.
- Iacobucci, D. & Churchill, G.A. (2010), *Marketing Research: Methodological Foundation* (10th Ed.). NY: Dryden Press.
- Kovács, G. & Tatham, P. (2010), 'What is special about a humanitarian logistician? A survey of logistic skills and performance'. *Supply Chain Forum: An International Journal*, Vol. 11, No. 3, pp. 32-41.
- Murphy, P.R. & Poist, R.F. (1991), 'A comparison of head-hunter and practitioner views regarding skill requirements of senior-level logistics professionals', *Logistics and Transportation Review*, Vol. 27 No.3, pp. 277-294.
- Murphy, P.R. & Poist, R.F. (2006), 'Skill requirements of contemporary senior- and entry- level logistics managers: A comparative analysis', *Transportation Journ*al, Vol.45 No.3, pp.46-60.
- Murphy, P.R. & Poist, R.F. (2007), 'Skill requirements of senior-level logisticians: a longitudinal assessment', *Supply Chain Management: An International Journal*, Vol.12 No.6, pp.423-431.
- Nunnally, J.C. (1978), *Psychometric Theory*. Second edition, New York: McGraw-Hill.
- Poist, R.F., Scheraga, C.A. & Semeijn, J. (2001), 'Preparation of logistics managers for the contemporary environment of the European Union'. *International Journal of Physical Distribution & Logistics Managem*ent, Vol.31 No.7/8, pp.487-504.
- Razzaque, M.A., & Sirat, M.S.B. (2001), 'Skill requirements: perception of the senior Asian logisticians', *International Journal of Physical Distribution & Logistics Management*, Vol. 31 No.5, pp374-395.
- Snoke, R. & Underwood, A. (2001). 'Generic attributes of IS graduates: A comparison of Australian industry and academic views'. *Journal of Global Information Management (JGIM)*, Vol. 9 No. 2, pp. 34-41.
- Thai, V.V. (2012), 'Competency requirements for professionals in logistics and supply chain management'. *International Journal of Logistics: Research and Applications*, Vol.15 No.2, pp.109-126.
- Thai, V.V., Cahoon, S., & Tran, H.T. (2011), 'Skill requirements for logistics professionals: findings and implications', *Asia Pacific Journal of Marketing and Logistics*, Vol. 23 No.4, pp.553-574.
- Wu, Y.C., Huang, S.K., Goh, M., & Hsieh Y.J. (2013), 'Global logistics management curriculum: perspective from practitioners in Taiwan', *Supply Chain Management: An International Journal*, Vol. 18 No. 4, pp. 376 – 388.

MODELLING AND OPTIMIZATION OF INDIGENOUS BOAT BUILDING OPERATIONS IN NIGERIA'S NIGER DELTA

Ibeawuchi C. Nze[1], Agaviezor K. Oke[1] and Geraldine N. Okeudo[2]
[1]Department of Maritime Management Technology, Federal University of Technology, Owerri, Nigeria
[2]Department of Transport Management Technology, Federal University of Technology, Owerri, Nigeria

1. Introduction

The building process of Boats is becoming increasingly complex as more subsystems of approaches are being considered and the various components of production processes are taken into consideration to improving not only local but small and medium scale production of Boats at an improved production mix. This may reduce costs associated with the production processes. This paper tends to address the problem of wastages in material allocation of the raw material resources in the production process in the maritime manufacturing sector of marine Boats and related maritime tools. The Boat Building Company situated along DSC Expressway, Warri Delta State, Nigeria was used as a case study due to inconsistencies in profit margins of the boat building Company and to address staff agitation for improved wages.

Several optimization models, including linear programming, have been applied to the product mix selection problem. Since its development in 1947, linear programming (LP) theory and related solution techniques have been widely extended and used as an optimization tool in a variety of problem areas including the production planning and product mix selection areas. Albright and Winston (2009), posits that many other optimization decisions can be well solved by modern linear programming modeling procedures via appropriate problem formulation and equation fittings.

Savsar (2011) explains that decision-making in product mix selection could be difficult due to large number of possibilities involved. Resource limitation could make decision difficult to meet customer demand and hence reduce the opportunity to earn profits. In the light of the above, this study attempts the application of linear programming Techniques to the manufacturing of Marine Boats using indigenous available resources in order to maximize the profit within the aforementioned constraints. The Specific Objectives include:

i. To model indigenous boat building capacity of yards in the Niger delta, Nigeria
ii. To determine the optimal mix of materials and labour in boat building
iii. To determine the maximum profit level with optimal mix of materials and labour in the yard.
iv. To determine the effect of wage increase of company workers and its effect on profit margin.

The following questions will guide the analysis and the results of this research.

i. What model would optimize indigenous boat building capacity of yards in the Niger delta, Nigeria?
ii. What is the optimal mix of resources and labour for various boat models?
iii. To what extent would material mix for the production of each boat attain optimal profit?
iv. What is the effect of wage increase on the objective function?

2. Materials and methods

2.1 Sources of Data

Data required for this study were collected from primary and secondary sources. The primary source of data was through oral interviews administered to some management staff of Tuwasco Marine and Boat

Building Company. Secondary source of data was a survey of existing documents and published materials .The data set used for this work was collected as extract from the records of Tuwasco Marine and Boat Building Company Limited, DSC Expressway Warri, Nigeria on the production of the three boat types. These include the Nineteen Capacity Passenger Utility Speed boat (NCPB), Twenty three Capacity Passenger Utility Speed boat (TCPB) and Twenty three Capacity Carrier boats (TCCB) respectively.

2.2 Method of Data Analysis and Modeling

In order to provide empirical answers to the research questions, the Linear programming technique is applied by the use of Excel Solver for windows software for the analysis. The marketing approach of the company is to ensure a relative reduction in the selling price per unit purchase of each boat to users, government agencies and companies on demand. This design is to encourage wholesale (large purchases of boats for the Maritime transportation of goods and passengers).

2.2.1 Variable Definitions

The generalized variables form for linear programming problem is stated as:

Maximize $= a_{11} x_1 + a_{12} x_2 + a_{13} x_3 \leq r_1$ .....(1)

Subject to

$a_{12} x_1 + a_{12} x_2 + a_{13} x_3 \leq r_1$ .....(2)

$a_{21} x_1 + a_{22} x_2 + a_{23} x_3 \leq r_2$ .....(3)

$a_{31} x_1 + a_{32} x_2 + a_{33} x_3 \leq r_3$ .....(4)

$a_{41} x_1 + a_{42} x_2 + a_{43} x_3 \leq r_4$ .....(5)

$a_{51} x_1 + a_{52} x_2 + a_{53} x_3 \leq r_5$ .....(6)

$a_{61} x_1 + a_{62} x_2 + a_{63} x_3 \leq r_6$ .....(7)

Where c_j, and r_j are given constraints the variables x_1, x_2, x_3 are called decision variables. The problem is to find the values of the decision of the (x_1, x_2, x_3) which maximize the objective decision variables or which maximizes the objective function in order to produce the optional solution. This procedure is called the simplex Algorithm where:

~~Z~~ = total profit contribution of the various products of the company for the period.

C_1 = profit contribution coefficient i.e the numeric values that express the per unit contribution to the profit equation.

$X_1 \ldots X_n$ = the set of unknown we are seeking to determine i.e the various products (boats) produced by company

A = technological coefficients i.e the numeric value that expresses the per unit usage of the right hand size

$r_1 \ldots r_n$ = the resources value that we seek to fully utilize in the production.

T = the maximum labour time available for the production period in the yard

$t_{1\ldots} t_n$ the labour time required to produce one unit of the various products of Tuwasco Marine Services.

2.2.2 Decision Variables

X_1 = the quantity of Nineteen Capacity Passenger Boat (NCPB) to be Produced

X_2 = the quantity of Twenty three Capacity Passenger Boat (TCPB) to be Produced

X_3 = the quantity of Twenty three Capacity Carrier Boat (TCCB) to be Produced

The Profit Contribution coefficient given as the numerical values that express the per unit contribution to the profit equation are stated as:

P_1 = the average net contribution by one unit of Nineteen Capacity Passenger Boat (NCPB).

P_2 = the average net contribution by one unit of Twenty three Capacity Passenger Boat (TCPB).

P_3 = the average net contribution by one unit of Twenty three Capacity Carrier Boat (TCCB).

2.2.3 Model Formulation

In the model, technological coefficients represent the numerical values that expresses per unit usage of the various raw materials in the production of the various products.

C_{11} = Cost of laminating and fitting materials in producing one unit of Nineteen Capacity Passenger Boat (NCPB).

C_{21} = Cost of woven materials in producing one unit of Twenty three Capacity Passenger Boat (TCPB).

C_{31} = Cost of laminating materials and fitting in producing one unit of Twenty three Capacity Carrier Boat (TCCB).

Labour time here represents the time needed to produce one unit of the various products of boat construction as follows:

T_1 = the labour time in hours required to produce one unit of Nineteen Capacity Passenger Boat (NCPB).

T_2 = the labour time in hours needed to produce one unit of Twenty three Capacity Passenger Boat (TCPB).

T_3 = the labour time required to produce a unit of Twenty three Capacity Carrier Boat (TCCB).

T = Maximum labour time available for the production.

These represent the resource values that we seek to be fully utilized. For instance,

B_1 = the amount of money available within the production period for the purchase of laminating and fitting

B_2 = the amount of money available for the purchase of woven

B_3 = the amount of money available for the purchase of resin

B_4 = the amount of money available for the purchase of catalyst

B_5 = the amount of money available for the purchase of Pigment

Profit contribution		₦140,200	₦256,000	₦315,000	
Boat Model		**19PU**	**23PU**	**23C**	**Available**
1.	Fabricating	40	60	80	300
2.	Woven	25	50	60	200
3.	Resin	110	220	330	1000
4.	Catalysts	5	10	15	200
5.	Accelerator	2	3	5	30
6.	Pigment	3	3	4	40
7.	Clear gel	20	22	40	200
8.	Labour constraint	20,000	30,000	40,000	300,000
9.	Time constraint	48	96	168	210

Source: Tuwasco marine and boat building company's store records

Table 1: Summary of variables relationship

Boats	Production cost	Selling price per boat	Profit
19PU	309, 800	450,000	140,200
23Pu	493,200	750,000	256,800
23C	685,000	1,000,000	315,000

Source: Authors' computation based on field work

Table 2: Unit Profit Contribution by Various Boats

The linear programming model for the boat building is formulated thus:

Maximize $140{,}200x_1+256{,}000x_2+315{,}800x_3$

Subject to: raw material and labour constraints

Fabricating materials $400\times_1 + 600\times_2 + 50\times_3 \leq 300$ ..... (8)

Woven Material $25\times_1 + 50\times_2 + 60\times_3 \leq 200$ ..... (9)

Resin $110\times_1+220\times_2+330\times_3 \leq 1000$ ..... (10)

Catalyst $5\times_1+10\times_2+ 15\times_3 \leq 200$ ..... (11)

Pigment $3\times_1+3\times_2+4\times_3 \leq 40$ ..... (12)

Accelerator $2x_1+3x_2+5x_3 \leq 30$ ..... (13)

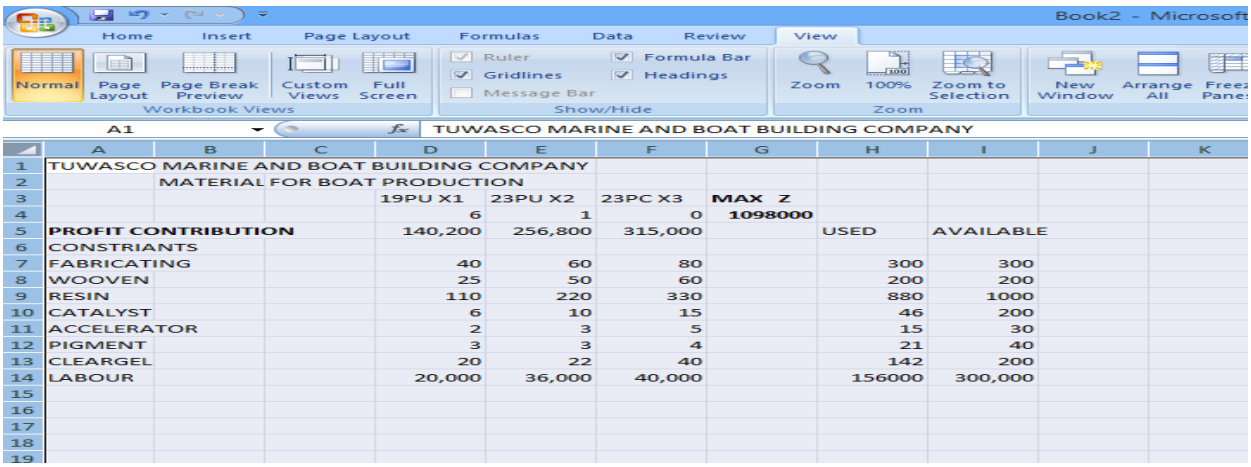
Clear gel $20\times_1 +22\times_2+40\times_3 \leq 200$ ..... (14)

Labour $20{,}000\times_1+ 36{,}000\times_2+ 40{,}000\times_3 \leq 300{,}000$ ..... (15)

$X_1, X_2, X_3 \geq 0$ ..... (16)

3. Analysis of results

The Optimal Solution to the formulated Linear Programming Model is shown in figure 1.



	A	B	C	D	E	F	G	H	I	J	K
1	TUWASCO MARINE AND BOAT BUILDING COMPANY										
2		MATERIAL FOR BOAT PRODUCTION									
3				19PU X1	23PU X2	23PC X3	MAX Z				
4				6	1	0	1098000				
5	PROFIT CONTRIBUTION			140,200	256,800	315,000		USED	AVAILABLE		
6	CONSTRIANTS										
7	FABRICATING			40	60	80		300	300		
8	WOOVEN			25	50	60		200	200		
9	RESIN			110	220	330		880	1000		
10	CATALYST			6	10	15		46	200		
11	ACCELERATOR			2	3	5		15	30		
12	PIGMENT			3	3	4		21	40		
13	CLEARGEL			20	22	40		142	200		
14	LABOUR			20,000	36,000	40,000		156000	300,000		
15											
16											
17											
18											
19											

Source: Excel solver output

Fig. 1: Optimal solution of the LP problem

The model produced an optimal solution satisfying all the optimality conditions for the Boat Building company.Results reveal that 6 units of the Nineteen Capacity Persenger Boat (NCPB) should be produced,1unit of the Twenty three Capacity Passenger Boat (TCPB)should be produced and no unit of the Twenty three Capacity Carrier Boat (TCCB) should be produced with a total objective function of N1,098,000.

On the other hand, fabricating/ laminating constraints and the wooven constriants have a slack of Zero (binding constraints) in that they both satisfy the optimality conditions.The implication is the possibility of acquiring more of the Fabricating/laminating materials and the wooven materials for an improved objective function. Other constraints like the Resin, accelerator,catalyst,pigments,labour and cleargel did not satisfy the optimality of the LP and such are regrded as loose or non binding constraints. These are constriants in the LP whose changes do not affect the optimal solution. Non binding constraints have a shadow price of zero.

3.1 Sensitivity Analysis

The labour cost of was doubled in the Tuwasco Marine and Boat building Model. Specifically, the labour cost for producing the Nineteen Capacity Passenger Boat (NCPB) was increased from N20,000. 00 for two staff to N40,000.00and from N36,000.00 to N72,000.00 for the Twenty three Capacity Passenger utility boat (TCPB), and from N40,000.00 to N80,000.00 for the building of the Twenty three Carrier Boat (TCCB) due to agitation for increased wages. The result shows a corresponding effect on the objective function of the Company. The implication is that even at increased labour cost to the company arising from wages, there was no significant effect/change on the objective function of the boat building model. This addresses staff agitation for improved and increased wages.

One of the key component material needed for the production of boat- resin- was reduced by half, for the Nineteen Capacity Passenger boat that is from 110 units to 55units and for the Twenty three Capacity Passenger utility boat, it was reduced from 220 units to 110 units. Then for the 23 Capacity Carrier boat it was reduced from 330units to 165units, and optimality was attained satisfying all the constraints with the following outcome.

The total optimized profit increased from N1,098,000.00 to N1,199,454.55 with boat producing capacity of 3 for the Nineteen Capacity Passenger Boat and 3 for the Twenty three Capacity passenger Boat and none for the Twenty three Capacity Passenger Boat as well. The fabricating and laminating constraints and resin constraints became binding constraints. This implies a surplus material mix on resin, thus reducing wastages as other constraints were not binding.

4. Discussion

Results of this paper are discussed here based on research questions as follows:

Is the profit level of Tuwasco marine and boat building company maximized?

Solution of the LP offered by the software as shown in the figure 1, gives optimal profit level of the company to be ₦1,098,000.00 as against its former profit level of ₦721,000.00. This results in a profit improvement of ₦377,000.00 meaning that, for optimal profit operations, Tuwasco marine and boat building company should keep profit level of ₦1,098,000.00 based on the available resources.

To what extent would the material mix for production of each boat optimally utilized to reduce wastages and increase productivity?

The optimal boats for Tuwasco marine and boat building company computed using the model developed is given as: NCPB x_1 = 6boats , TCPB x_2 = 1boat, TCCBx_3 = 0 with an improved objective function of N1,098,000. This implies that the company should concentrate its resources to the production of six (6) NCPB and one (1) 2TCPB model and no resources should be placed on the TCCB except on special demand.

To what extend can the material resources used for the production of boats be altered to attain optimality so as to avoid wastage?

For each constraint the shadow prices reveal exactly how much the objective function will change with a change in the right hand side of the corresponding constraint equation. For example, in the fabricating constraint equation, the optimality range is between 320 and 240 respectively while the objective function would be exactly 1180 (i.e. given a change in the right hand side from 300).Similarly, for woven materials costs, provided the right hand side of the constraints remain between 227.2727 and 187.50 respectively the objective function will remain optimal. This is in line with the findings of Asiegbu and Nze (2013).

For variables, the reduced cost column gives us, for each variable which is currently zero x_1 and x_2 an estimate of how much the objective function will change if the variable is to be non zero. It is worthy to note that the value in the reduced cost column for a variable is often called “the opportunity cost” for the variable. Hence the variable of x_3 for TCCB of the objective function needs to change by 2600.00009 resulting to an increase since we are maximizing before the variable becomes non zero. In other words, the profit per unit on the TCCB would need to increase by 2600.00009 before it would be profitable to produce any unit of boat x_3. This supports the work of Sobieszczanski-Sobieski (1990).

Furthermore, by varying the coefficient of TCCB (x_3) in the objective function, the allowable changes reveals that the coefficient of x_3 in the objective function lies between 315,000 + 2600.000009 and 315,000 – 1E + 30 while that of x_2 lies between 256,800 + 23600 = 280,400 and 256,800 – 3250.000012 = 262,549.9999. Hence the values of the variables of the linear programming solution will remain unchanged. Similar conclusions could be drawn from the NCPB x_1 unit with an allowable increase of

31,000 and allowable decrease of 3250.00001 thus 140,200 – 31,000 and 140,200 – 3250.00001= ₦109,200 and 136,949.9999 respectively.
To what extent can the boat building company increase her staff salaries without having much effect on the objective function?

It was clearly shown that when the cost of labour was increased by 100percent as wages the solver gave an unchanged objective function of N1,098,000 showing there is no significant relationship between increased cost of labour and the boat building company. This equally supports the works of Sobieszczanski-Sobieski (1990) and Savsar (2011).

5. Conclusion

The major findings of this study reviewed the application of linear programming techniques in the building of marine boats in Tuwasco Marine and Boat Building Company, Warri in the allocation of scarce resources. The Excel solver gave a more practical and efficient approach to optimization of the model towards achieving higher profits and revealed which boat production the company should concentrate on. Also the objective function of Tuwasco Marine and Boat Building Company exceeded its former profit production capacity Z>N 712,000. The model rather optimized at N1,080,000, an appreciable profit increment of N386,000 representing a 54.3% increase in the profit represented as the objective function in the model.

The formulated model for the boat building Company showed that there was a significant effect on wastages avoidance and optimality. Resin in particular was halved in quantity and model still optimized at a higher objective function profit of N1,199,454.00 with the production of 3 NCPB and 3 TCPB and none for the TCCB.

That a possible increase in staff salaries wages has no significant negative effect on the objective function for the company From the above premise, it could be inferred that, though un-utilized capacities abound, but for optimality the overall objective of profit maximization of the organization is achievable. However, it was of greater interest to note also that, organizations should not only crave for maximization, but optimality. The implication of this is that, profit should be maximized at the lowest cost possible. This is evident in the analysis of this research work using the Excel Solver for Optimization, where optimum quantities were not only arrived at, but also with the possible cost reduction per unit/Boat. The surplus/slack units were also very interesting in this research since it creates opportunity for organizations to see the need for non-idleness of resources.

To this end, Boat manufacturing Companies, having idea of the expected idle resources a priori, it can plan for optimum materials to be ordered for. The Slack or Surplus column in a solver solution report reveals how close it is to satisfying a constraint as equality. This quantity, of less-than-or-equal-to (≤) constraints, is generally referred to as slack. Hence when it is greater-than-or-equal-to (≥) the constraints, are known as surplus. Therefore, for a constraint to be exactly satisfied as equality, the slack or surplus value will be zero. If a constraint is violated, as in an infeasible solution, the slack or surplus value will be negative. Above all, the adjourning communities would benefit from the multiplier effects arising from the operations of the boat yards.

References

- Albright, S. C. & Winston, W. L. (2009), 'Management Science Modeling' *3rd ed. South-Western Cengage Learning.*
- Asiegbu, B. C. & Nze, I.C. (2013). 'Optimization of Port Operations in Nigeria: A Scenario for Emerging River Ports', *IISTRD West African Journal of Industrial & Academic Research*, Vol. 6, No. 1, pp. 84- 91.
- Savsar, M. (2011), 'Analysis and Modeling of Maintenance Operations in the Context of an Oil filling Plant', *Journal of Manufacturing Technology Management ,* Vol. 22 Issue 5 pp. 679-697.
- Sobieszczanski-Sobieski, J. (1990), 'Sensitivity analysis and multidisciplinary optimization for aircraft design: recent advances and results', *Journal of Aircraft Vol.* 27 Issue 12 pp. 993- 1001.

INVESTIGATING ICT DIFFUSION DYNAMICS AMONG SMEs THIRD-PARTY LOGISTICS PROVIDERS IN NIGERIA: AN EXPLORATORY MIXED-METHOD STUDY

Anthony Ezenwa[1, 2], Anthony Whiteing[1], Daniel Johnson[1] and Akunna Oledinma[3]
[1]University of Leeds, UK
[2]Federal University of Technology Owerri, Nigeria
[3]University of Warwick, UK

Introduction

Information and communication technology (ICT) has potential consequences for the management of supply chain and logistics operations, and the links between ICT and transformation of supply chain and logistics processes have become a subject of concern globally (Chen et al., 2007, Parasuraman and Grewal., 2000, Awoyemi and Mustakim, 2017). Hence the academic literature frequently reflects on the impact of ICT solutions on supply chain performance (Gunasekaran et al., 2015a, Prajogo and Olhager, 2012., Bharadwaj, 2000). Cheng-Min (2006) suggests that the use of ICT tools strengthens coordination of the flow of physical goods and services. Also, application of ICT solutions can reduce the role of distribution channels and intermediaries such as wholesalers (Martínez Sánchez and Pérez, 2005). However, there is little information regarding the mechanisms that influence ICT diffusion among 3PL SMEs (Gunasekaran and Ngai, 2003, Evangelista, 2011), especially in developing countries such as Nigeria (Tob-Ogu et al., 2017). This current study responds to this gap by examining how locally evolved conditions factor into ICT diffusion challenges among 3PL SMEs in Lagos State, Nigeria. Our goal is precisely to explore how contextual factors interact with the utilization of the available ICT tools among the 3PL SMEs in the study site, as such businesses are mainly responsible for logistics activities in the region (Tob-Ogu et al., 2017). We addressed the following research question to achieve the objective of the study: How do context-specific factors influence ICT diffusion among the logistics operators in Lagos State, Nigeria and what are the effects of the causal interrelationships among the affected factors?

The study was carried out in two phases. Phase one explored the problems through scoping field meetings with the relevant stakeholders, while Phase two centred around a questionnaire survey of the 3PL SMEs in the study site which we used to substantiate the findings from the phase one study. Here, 3PL refers to 'the activities carried out by logistics providers on behalf of the shippers, consisting of at least transportation and other activities such as warehousing, and inventory management activities' (Berglund et al., 1999, p.51). Lagos state was selected for the study based on its socio- economic importance in Nigeria and Sub-Saharan Africa. The rest of this paper article is structured as follows; brief literature review and theoretical framework; the research methodology and results; the discussion and finally the conclusion of the study.

Literature review and theoretical framework

Our knowledge of ICT adoption among the 3PL SMEs has benefited from a number of research papers in recent years, including evidence from Kilpala et al. (2005) that 3PL SMEs are reluctant to adopt relevant ICT tools in the Barents Region. Kwok and Haibo (2012) affirm that 3PL SMEs in China tend to utilize less expensive ICT at a tactical level, mainly to cut cost and reduce errors. Gunasekaran and Ngai (2003) suggest that 3PL SMEs in Hong Kong are flexible and innovative towards ICT adoption but constrained by financial and human resources. Similarly, Pokharel (2005) showed that 3PL SMEs in Singapore adopt primary ICT tools such as computers, internet connections and electronic data interchange (EDI), with large companies having more motivation to adopt ICT than their small logistics operator counterparts. Also, 3PL SMEs in Italy are mainly motivated to adopt relevant ICT tools due to service customization. Evangelista et al. (2013) found 3PL SMEs in Italy invest a relatively small proportion of their income on ICT tools. Evidence from Tob-Ogu et al. (2017) reveals that small and medium freight operators in Nigeria are more likely to adapt ICT tools other than those intended by the original equipment manufacturers (OEM) to overcome operational challenges. This review confirms the findings of previous studies are not always consistent and hence there is a need to examine the causal relationships among the relevant factors.

The theoretical framework underlying the work reported in this paper is based on the Hart et al. (2015) assertion that an integration of the Technology Acceptance Model (TAM) (Davis, 1993), the Technology-Environment-Organization (T-O-E) model (Tornatzky and Fleischer, 1990) and the Theory of Planned Behaviour (TPB) (Fishbein and Ajzen, 1975) would enhance our ability to predict of e- commerce adoption among SMEs. This is partly because it is argued that SMEs can exhibit the characteristics of both individuals and firms, due to the possible overbearing influence of their owner- managers on overall operations. Specifically, TAM depicts ICT adoption at an individual level, predicated on the perceived usefulness and ease of use of systems. TPB reflects the influence of the external variables on adoption behaviours, while T-O-E connotes ICT adoption at the firm level. Correspondingly, we envisage that examining the interrelationship of TAM, TOE, and TPB may well offer improved insight into the influences of the locally evolved issues on ICT acquisition and decision quality of firms of 3PL SME firms in Nigeria.

Methodology

Data collection: we conducted the data collection in two stages as follows. In Phase one, around 120 participants were involved in a scoping field study. Public administrators constituted about half of the attendees (52.5%), followed by logistics operators and researchers each constituting a quarter of the attendance (25.5%, 25.0%). Once the research objectives and themes had been explained, participants were grouped into fifteen mini groups, each comprising about eight persons. Participants were encouraged to talk openly about issues affecting ICT diffusion among 3PL SMEs in Nigeria, and their coping strategies. The participants reached a consensus statement at the second gathering which reflected the various dimensions in which locally-evolved conditions influence ICT diffusion among the 3PL SMEs. This consensus then formed the basis for creation of a questionnaire survey to gather information from operators. Phase two started with the research supervisors, collaborators, and other stakeholders amending the wordings of the questionnaire phrasing to ensure ease of understanding which would assist in survey response. We then piloted the survey instrument with the sample of fifty 3PL SMEs. The survey was then administered to a sample of Nigerian 3PL SMEs. After data screening, this process realized 295 usable survey responses. The respondents include the owner-managers (5.4%), Assistant General Managers (10.8%), Operation Managers (10.8%), other management staff (68.5%), and other undisclosed staff (2.4%).

Methods of data analyses: We used the interpretive method of qualitative analysis for the phase one study while covariant-based Structural Equation Modelling (SEM) with AMOS graphics software was used in the phase two study for the analysis of the questionnaire data. Precisely, the SEM analysis involves the following: (i) interaction effects with 'stat tool package.Xls.' (ii) Mediation effects using the Baron and Kenny (1986) approach/ bootstrapping and (iii) moderation effects using the invariant tests procedure for the designated variables. Accordingly, the interaction analysis was determined by strengthening (+) or dampening (-) effects of the respective interacting variables. Also, partial mediation occurred if the regression weights (β) reduce after the introduction of the mediator variables. Full mediation occurred when the significant causal relationships between the proposed variables turned insignificant after the introduction of mediator variables. On the other hand, there were no mediation effects if the concerned variables to be mediated were not significantly causally related. Further, the moderation analysis was interpreted according to the high or low effects of the moderator variables (regression weight scores) on the proposed causal relationships. Z score was used to denote if there were significant differences among the sampled respondents.

Causal model and hypotheses development: The research variables include the predictor variables; consumer readiness (CR), the scope of business operations (SBO) and facilitating conditions (FC). The mediator variables entailed perceived usefulness (PU) and perceived ease of use (PEOU) of ICT, while the moderator variables relate to ICT experience and education status respectively. Additionally, the controlled variables were gender, age, and frequency of ICT use (see Figure 1). Consequently, twenty hypotheses were developed for the study, thus:

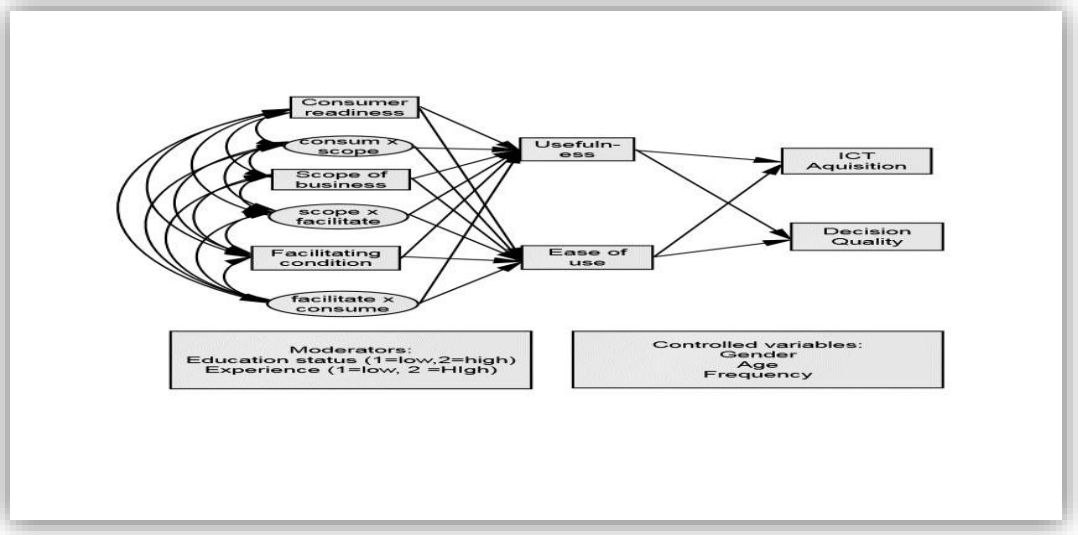


Figure 1: The causal model (Adapted, Lowry & Gaskin, 2014)

Predictor variables: According to Zhu et al. (2002), there is a causal relationship between CR and internet penetration. Ayo (2008) links limited CR to adopt ICT in Nigeria to reduced online businesses, rigours of the system, and lack of security of online transactions in the area. Sawhney and Prandelli (2000) suggest that consumer CR can attain improvement through the development of a common language or technological network which can enhance learning capability, trust, and motivation. Hitt (1999) argues that SBO is causally related to ICT acquisition and decision quality especially concerning the diversification of services. (EC). Zhu et al. (2002) suggest that ICT adoption is causally influenced by the SBOs on three grounds: (i) Computerization of business activities lessens internal coordination expenditure, harmonizes administrative complexities, and enhances information processing. (ii) Business establishments with substantial SBO are attracted to e-commerce (EC) as it reduces searching costs for buyers and raw material sellers (Bakos, 1991) and also improves inventory control (Chopra and Meindl, 2001). (iii) Large firms tend to gain more from the alliance of the EC and regular business activities as the combination of the two enables firms to compete favourably. The next predictor variable, FC includes those external factors that must be met to avert firms from facing extinction as highly functional establishments display enterprising creativity, novelty, and collaborations which allow them to remain competitive (Triandis, 1980, Thompson et al., 1994). Mische (2001) and Piater (1984) propose that FC include government regulations, antitrust measures, and policy actions. In the light of these, we developed the following six hypotheses to test the interactive effects of the predictor variables on the mediator variables as follows: H1/ H2: FC strengthens the causal relationships between CR and PU/PEOU of IC. H3/ H4: SBO strengthens the causal relationships between CR and PU/PEOU of ICT. H5/ H6: FC strengthens the causal relationships between the SBO and PU/PEOU of ICT respectively**.**

Mediator variables: According to TAM, PU and PEOU mediate the impact of system design features on usage (Davis, 1993)**.** It suggests that system characteristics influence adoption behaviour via motivational variables such as PU and PEOU. According to Lu et al. (2003), PU explains potential users' intuitive expectations that utilizing a particular ICT tool enhances performance. ICT tools with less mental effort attract more users than otherwise (Opia, 2008). Further, Clarke (2000) through a survey of 800 professionals, identified ease of use among five other factors as a major influencing factor for the use of wireless handheld devices. Accordingly, we proposed the following twelve hypotheses to test the mediating effects of the PU and PEOU on the relationship between the predictor variables and response variables as follows: H7/ H8: PU/PEOU of ICT mediate the causal relationships between CR and ICT acquisition**.** H9/ H10: PU/PEOU ICT mediate the causal relationships between the SBO and ICT acquisition. H11/ H12: PU/PEOU of ICT mediate the causal relationships between the FC and ICT acquisition. H13/ H14: PU and PEOU of ICT mediate the causal relationships between CR and decision quality. H15/ H6:

PU/PEOU of ICT mediate the causal relationship between SBO and decision quality. H17/18: PU/PEOU of ICT mediate the causal relationship between the FC and decision quality respectively.

Moderator variables: Hambrick and Mason (1984) propose that the peculiarity of every organization reflects the characteristics of their decision makers. Hence e-commerce adoption among the SMEs depends on the individual difference factors (IDF) of the owner-managers which comprise education, age, gender, and experience (Hart et al., 2015). According to Zmud (1979), experience ranks top among other IDF in technology adoption research and more precisely, internet users' experiences influence the actual use of a specific system (Agarwal and Prasad, 1999, Chau, 1996). Similarly, education status affects individuals' abilities to innovate, comprehend, and accept change (Hambrick and Mason, 1984). Therefore, we hypothesized that ICT experience and education status significantly moderate the causal relationships among the proposed causal relationships, thus: H19: ICT experience moderates the causal relationship between the SBO and PU of ICT. H20: Education status moderates the causal between CR and ICT adoption.

Construct validity: The construct validity for the Structural Equation Modelling (SEM) was confirmed via exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) as follows: EFA was performed to extract the appropriate items for the SEM analysis. The result of the EFA analysis reveals that the pattern matrix loading was adequate. The factor correlation matrix was also suitable as there was no significant correlation between the observed variables. The rotation method was Promax with Kaiser Normalization, and the iteration converged in 7 iterations. The KMO (0.94) and Bartley (7092.45) tests were significant respectively. The cumulative variant test was also significant (0.65) as was the non-redundant residual test (0. 20). Further, the goodness of fit ($\rho<0.001$) and adequacy of the EFA analysis was confirmed adequate as the Cronbach Alpha values were above 0.80 for all the variables.

The result of the CFA shows that the model was fit for the Structural Equation Modelling - the RMSAE and PCLOSE scores were 0.037 and 1.00; CFI and CMNIDF were also within limits (0.97, 1.41.2); the observed variables were not significantly different between groups. Hence we did not further refine the model. Also, the average variance extracted (AVE), composite reliability (CR) of the observed variables, and the curve estimation tests are significantly linear ($\rho<0.001$). The F-values were within proper limits, and there were no multi-collinearity issues among the variables as the VIF values are within usable ranges (<3.00). However, the common bias test revealed that one of the items in the decision quality variable was abnormal and this was resolved by placing a constraint on it. Finally, we confirmed the SEM, as the CMIN/DF (1.196), CF (0.978), PCLOSE (0.298), and RMSEA (0.057) were within reasonable limits respectively.

Results

Hypotheses	Results	Remarks
FC strengthens the relationship between CR and PU/PEOU	- /-	H1/ H2, not supported
SBO strengthens the significant relationship between CR and PU/PEOU	-/-	H3/ H4, not supported
FC strengthens the relationship between SBO and PU/PEOU	-/+	H5/ H6, not supported an supported

*- / + signs denotes dampening and strengthening effects of the predictor variables

Table 1: Two-way interaction effects of the predictor variables

Hypotheses	Direct without mediation	Direct With mediation	ndirect effects	Results	Remarks
PU and PEOU mediate the relationship between CR and ICT acquisition	β=0.357; 0.350,	β=0.128; 0.148,	ρ<0.05	Partial mediation	H7/ H8, partially supported
PU and PEOU mediate the relationship between SBO and ICT acquisition	ρ<0.05	P = 0.158; 0.157	ρ<0.05	Full mediation	H7/ H8, fully supported
PU and PEOU mediate the relationship between FC and ICT acquisition	ρ = 0.063; 0.067	ρ =0.358; 0.356	=0.110; 0.140	No mediation	H9/ H10, not supported
PU and PEOU mediated the cl relationship between CR and decision quality	ρ<0.01	=0.745; 0.764	ρ<0.05	Full mediation	H11/ H12, fully supported
PU and PEOU mediated the relationship between SBO and decision quality	ρ =0.439; 0.410	ρ =0.116; 0.115	=0.160; 0.212	No mediation	H13/H14, not supported
PU and PEOU mediated the relationship between FC and decision quality	ρ =0.063; 0.164	ρ =0.059; 0.254	=0.130; 0.321	No mediation	H15/ H16, not supported

* R2 = (CR = 0.57; SB0 =41; FC = 51)

Table 2: Mediation effects of the PU and PEOU of ICT

Hypotheses	Effects: low; high (β)	z-score	p. value	Remarks
ICT experience moderates the relationship between SBO and PU of ICT	0.178; 0.387	1.706	<0.05	(H19= supported)
Education status moderates the relationship between CR and ICT acquisition	0.012; 0.143	2.383	<0.050	(H20=supported)

Table 3: Multi-group moderation effects of the ICT experience and education status

Study one: We found in the phase one study that the ICT use by 3PL SMEs in Lagos State, Nigeria is largely limited to the use of primary ICT tools such as mobile phones and emails for their operations, due to lack of enabling environment in the region. The lack of enabling environment related to inadequate road networks, lack of steady electricity, and technological platforms. Besides, the informants linked the situation to political corruption which they said has persisted over many years.

Study two: The results of the stage two study are represented in the Tables 1, 2, and 3 as follows: (i) Two-way interaction results indicated that FC and SBO dampened the causal relationships between CR and PU/PEOU of ICT. FC also dampened the causal relationship between SBO and PU of ICT.

Alternatively, FC strengthened the significant causal between SBO and PEOU of ICT. (ii) Mediation analysis revealed that PU and PEOU of ICT mediated the causal relationship between CR and ICT acquisition. On the other hand, there were no significant causal relationships between FC and ICT acquisition and decision quality. Likewise, there was no significant causal relationship between SBO and decision quality. Hence, there were no significant mediation effects of PU and PEOU of ICT among those relationships. (iii) Multi-group moderation analysis showed that ICT experience and education status significantly moderated the causal relationship between SBO and PU of ICT, and CR and ICT acquisition. Additionally, there were significant differences in ICT experience and education status among the owner-mangers of the firms as revealed by the Z scores.

Discussion and conclusion

Drawing evidence from our findings in the stage two study, we have demonstrated that inability of the firms to acquire relevant advanced ICT tools does not lie only with the non-significant causal relationships between FC/SBO and ICT acquisition/decision quality but also with their dampening effects on the causal relationships between CR and PU/PEOU. These revelations may help to address the conflicting reports concerning ICT diffusion challenges among 3PL SMEs and also validates the phase one study. For example, the dampening effects of the FC and SBO may relate to the impact of the lack of enabling environment in the study region. Notwithstanding, the results indicated that CR was not significantly affected by the unfavourable business environment which demonstrates the resilience of the operators. This is in line with the previous studies that 3PL SMEs are innovative and flexible (Gunasekaran and Ngai, 2003, Tob-Ogu et al., 2017). Alternatively, the dampening effects of the FC on the causal relationship between SBO and PU of ICT may account for the reluctance of 3PL SMEs to adopt advanced ICT (Kilpala et al., 2005, Pokharel, 2005, Cephus, 2016). It could also be likened to the inability of the firms to maximize the potential causal relationship between SBO and e- commerce such as diversification of services (Hitt, 1999). Again, the result confirms the vulnerability of the 3PL SMEs in Nigeria regarding ICT adoption as the majority of them have resorted to the inappropriate adaptation of ICT primary ICT tools to remain competitive (Tob-Ogu et al., 2017). The findings align with Fishbein and Ajzen (1975) proposition that external variables influence adoption behaviours according to the prevailing circumstances. Additionally, the significant moderating effects of ICT experience and education status on the causal relationships between the SBO and PU of ICT, and CR and ICT acquisition confirmed the resilience of logistics operators which may be connected to their ICT adaptation capabilities (Tob-Ogu et al., 2017). Overall, lack of adequate FC was the primary inhibitor, followed by the limited SBO. Alternatively, CR was the enabling factor.

The implications of the study suggest that engaging with context-specific issues can help unpack the problems affecting ICT diffusion among 3PL SMEs. Around these findings, we discovered why the 3PL SMEs in the study site are not willing to acquire relevant advanced ICT to enhance their operations. Hence the study may represent a useful point of entry by relevant stakeholders to assess the circumstances surrounding ICT diffusion challenges among the 3PL SMEs in the study site and similar environments. More precisely, the information from the study may be useful for developing intervention schemes and sustainable long-term strategies to mitigate the problems. Also, ICT vendors and OEM may tap information from the study to assess innovative ways to cover the digital gap. Besides, relevant entrepreneurs may also find the information from the research useful for their investment decisions.

In conclusion, our findings suggest that it is misguided to focus on individual factors to address ICT diffusion challenges among the 3PL SMEs, especially in the developing logistics environments where effects of the locally evolved conditions are complex and conflicting. Therefore, it is critical to focus on all relevant factors such as environmental, organizational and technological factors. The limitations of the study include the limited sample size and population in the phase two study. We recommend that further studies should focus on assessing the customers' perspective of the ICT diffusion challenges in the study site to create a potential avenue to address the problems holistically.

References

- AGARWAL, S. & PRASAD, J. 1999. Are individual differences germane to the acceptance of new information technologies. *Decision Sciences,* 30**,** 361-391.
- AWOYEMI, O. & MUSTAKIM, M. 2017. Factors Influencing the Information and Communication Technology (ICT) of Third Party Logistics in Malaysia. *Int. J Sup. Chain. Mgt,* 6 202-208.
- AYO, C. 2008. E-commerce in Nigeria: What the future holds. *Journal of Internet Banking and Commerce,* 13**,** Retrieved from http://www.arraydev.com/commerce/jibc
- BAKOS, Y. 1991. A strategic analysis of electronic marketplaces. *MIS Quarterly,* 15**,** 295-310.
- BARON, R. M. & KENNY, D. A. 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology Quarterly,* 51**,** 1173-1182.
- BERGLUND, M., VAN LAARHOVEN, P., SHARMAN, G. & WANDEL, S. 1999. Third Party Logistics: is there a new future? *International Journal of Logistics Management,* 10**,** 59-70.
- BHARADWAJ, A. S. 2000. A resource-based perspective on information technology capability and firm performance: an empirical investigation. *MIS quarterly* 169-196.
- CEPHUS, K. 2016. *Factors influencing Information and CommunicationTechnology (ICT) acceptance and use in small and medium enterprises (SMEs) in Kenya.* Doctor of philosophy Explorartory study - quantitative research methodology, Capella University.
- CHAU, P. 1996. An empirical assessment of a modified technology acceptance model. *Journal of Man-agement Information Systems,* 13**,** 185-204.
- CHEN, M., ZHANG, D. & ZHOU, L. 2007. Empowering collaborative commerce with web services enabled business process management systems. *Decision Support Systems,* 43**,** 530-46.
- CHENG-MIN, F., AND YUAN CHIEN-YUN. 2006. The impact of information and communication technologies on logistics management. *International Journal of Management and Enterprise Development***,** 909.
- CHOPRA, S. & MEINDL, P. 2001. *E-business and the supply chain,* New Jersey: Prentice Hall., Upper Saddle River.
- CLARKE, C. 2000. Coming attraction. *Wireless Review,* 17**,** 12-16.
- DAVIS, F. 1993. User acceptance of information technology: System characteristics, user perceptions and behaviour impacts. *International Journal of Man-Machine Studies,* 38**,** 475- 487.
- EVANGELISTA, P. 2011. *ICT diffusion in SMEs. An investigaton into the Italian transport and logistics service industry*.
- EVANGELISTA, P., MCKINNON, A. & SWEENEY, E. 2013. Technology adoption in small and medium sized logistics providers, Indusrial Management & Data Systems. *Business Administration, Management, and Operations Commons and the Industrial Engineering Commons,* 113**,** 967-989.
- FISHBEIN, M. & AJZEN, I. 1975. Belief, attitude, intention and behaviouir: An introduction to theory and research. *In:* M., A., ADDISON (ed.), Wesley.
- GUNASEKARAN, A., IRANI, Z., CHOY, K.-L., FILIPPI, L. & PAPADOPOULOS, T. 2015a. Performance measures and metrics in outsourcing decisions: a review for research and applications. *Int. J. Prod. Econ.,* 161**,** 153-166.
- GUNASEKARAN, A. & NGAI, E. W. T. 2003. The successful management of a small logistics company. *International Journal of Physical Distribution & Logistics Management,* 33**,** 825-842.
- HAMBRICK, D. & MASON, P. 1984. Upper echelons: The organization as a reflection of its top managers. *Academy of Management Review,* 9**,** 193-205.
- HART, O., OJIABO, U. & BARTHOLOMEW 2015. Integrating TAM and TOE Framework and Expanding their Characteristics Construcrs for E-Commerce Adoption by SMEs. *Proceedings of Informing & IT Education Conference (InSITE).*

- HITT, L. 1999. Information technology and firm boundaries: Evidence from panel data. *Information Sys-tems Research,* 10**,** 143-149.
- KILPALA, H., SOLVANG, W. D., WIDMARK, J., BAGAEVA, A. & TUOHINTO, P. 2005. Analysis of ICT use in the Barent region: research findings from logistics service providers and forest industry. *Sustainable Transport in the Barent Region (STBR)*.
- KWOK, H. L. & HAIBO, H. 2012. A Survey-Based Study on ICT Adoption in the Third-Party Logistics Industry. *International Journal of Information Systems and Supply Chain Management* 5.
- LU, J., YU, C., LIU, C. & YAO, J. 2003. Technology acceptance model for wireless internet. *Internet Re-search: Electronic Networking Applications and Policy,* 13**,** 206-222.
- MARTÍNEZ SÁNCHEZ, A. & PÉREZ, M. 2005. Supply chain flexibility and firm performance: a conceptual model and empirical study in the automotive industry. *International Journal of Operations & Production Management* 25**,** 681-700.
- MISCHE, M. 2001. *Strategic renewal: Becoming a high-performance organization,* Upper Saddle River, New Jersey: Prentice-Hall.
- OPIA, O. 2008. An exploratory study of the moderating effects of trust on e-commerce adoption behaviour of Nigerian small enterprises. *African Journal of Entrepreneurship,*1.
- PARASURAMAN, A. & GREWAL, D. 2000. The impact of technology on the quality-value-loyalty chain: a research agenda. *Journal of the academy of marketing science (2000) 168-174.***,** 168- 174.
- LOWRY, P.B. & GASKIN, J. 2014. Partial Least Squares (PLS) Structural Equation Modelling (SEM) for Building and Testing Behavioural Causal Theory: When to Choose It and How to Use It. *IEEE TPC* 57**,** 123-146.
- PIATER, A. 1984. *Barriers to Innovation,* London, Frances Printer.
- POKHAREL, S. 2005. Perception on information and communication technology perspective in logistics - A study or transportation warehouse sector in Singapore. *The Journal of Enterprise Information Management,* 18**,** 136-149.
- PRAJOGO, D. & OLHAGER, J. 2012. Supply chain integration and performance: the effects of long-term relationships, information technology and sharing, and logistics integration. 135, 514–522. *Int. J. Prod. Econ.,* 135**,** 514-522.
- SAWHNEY, M. & PRANDELLI, E. 2000. Communities of creation: Managing distributed innovation in turbulent markets. *California Management Review,* 42**,** 26-54.
- THOMPSON, R., HIGGINS, C. & HOWELL, M. 1994. Influence of experience on personal computer utilization: Testing a conceptual model. . *Journal of Management Information Systems,* 1**,** 167-187.
- TOB-OGU, A., KUMAR, N. & CULLEN, J. 2017. ICT adoption in road freight in Nigeria - A case study of the petroleum downstream sector. *Technological forecasting & social change*. 131, 240-252.
- TORNATZKY, L. & FLEISCHER, M. 1990. *The process of technology innovation,* Lexington, M.A: Lexington Books.
- TRIANDIS, H. 1980. Values, attitudes, and interpersonal behavior. *Nebraska symposium on motivation: Beliefs, attitudes, and values,* In H. E. Howe, Jr. & M. M. Page (Eds.), 195-259.
- ZHU, K., KRAEMER, K. & XU, S. A cross-country study of e-business adoption using the technologyorganization-environment framework. Proceedings of the International Conference on Information Systems, 2002 Barcelona, Spain.
- ZMUD, R. W. 1979. An emperical investigation of the dimesionality of the concept of information. *Dicision Science,* 9**,** 187-195.

EVALUATION OF LIQUEFIED NATURAL GAS BUNKERING PORT SELECTION

A-Rom Kim[1, 2], Young-Joon Seo[2] and Dong-Wook Kwak[3]
[1]Institute of Economics & Business Administration, Kyungpook National University, Daegu, South Korea
[2]School of Economics & Trade, Kyungpook National University, Daegu, South Korea
[3]School of Strategy and Leadership, Coventry Business School, Coventry University, Coventry, UK

1. Introduction

Globally, the environmental crisis caused by global warming has created the serious problem of increasing greenhouse gases, sulfur oxides, nitrogen oxides, and particulate matter. As a result, demand for responses to climate change and environmental protection is increasing (Zhu et al., 2017). This demand has strengthened environmental regulations on air pollutant emissions from ships managed by international organizations, such as Tier III of the International Maritime Organization (IMO) (Gritsenko, 2017). Liquefied natural gas (LNG) is a potential solution to meeting these stronger regulations. Regarding greenhouse gas emissions from ships, LNG is cleaner burning than heavy diesel oil (HDO) and marine gas oil (MGO) because of its negligible sulfur content (Lloyd's Register, 2012).
Because demand for LPVs is expected to increase, assessing the factors of LNG bunkering port selection in LNG bunkering industries is worthwhile. Furthermore, a dearth of academic research exists in the field of LNG bunkering (Lloyd's Register, 2012; 2014; DNV, 2012), thus presenting a plausible reason for venturing deeper into the relatively uncharted field of LNG bunkering research. This study employs a second-stage approach in empirical analysis and selects criteria for a shipping company's choice of a LNG bunkering port using literature reviews and interviews. The approach then adopts a fuzzy-AHP methodology to reveal the priority of LNG bunkering port selection criteria in LNG bunkering decision making.

2. Literature review

2.1 Port selection

The port selection problem is directly connected to port competitiveness. According to Malchow and Kanafani (2004), because competition among ports has intensified, various intermodal facilities are being improved to minimize the time that shipments are at the port. In addition, port infrastructure and superstructure are being augmented, such as expanding storage space and dredging channel depths to allow shipping companies to operate large vessels. Port selection, which focuses on customer (user) decisions, is part of customer behavior research and includes carriers/shipping companies, shippers, and freight forwarders (Brooks et al., 2011; Tongzon, 2009). Thus, ports should provide sound facilities and services for users.

A considerable body of literature exists from various stakeholders, including shippers, shipping companies, and freight forwarders, on port attractiveness, competitiveness, efficiency, and selection using a number of methodologies. In these studies, factors that affect port selection are identified and categorized using different classification methods. Previous research on port choice models focused on the port choices made by shippers. Other studies identified and described various factors of shippers' port selection using different methodologies (Tongzon, 2009; Hesse and Rodrigue, 2004). Recent research has studied the choice of a port from the perspective of liners and carriers. Lirn et al. (2003) suggested a set of trans-shipment port selection criteria from the viewpoint of the container carrier.

2.2 LNG bunkering port

Currently, U.S. shipping company TOTE Maritime operates 3,100 TEU-class LNG-powered containerships. Notably, major liners, such as UASC and CMA-CGM, also recently ordered large LNG-powered containerships. Therefore, ports may have to invest in LNG bunkering facilities to accommodate larger LNG-powered containerships. Currently, only a few ports have LNG bunkering facilities (e.g., Incheon, Long Beach, and Antwerp). Therefore, if a port invests in LNG bunkering

facilities today, it may have an advantage in attracting LPVs, which will allow it to leverage the competition from other rival ports. As a representative example, the Danish government suggested LNG as an alternative fuel for ships and environmental improvement of state-owned vessels that use new lightweight materials and alternative fuels (Danish Government, 2012). DNV (2012) noted that 4–7 million tons of LNG p.a. are required by 2020, which corresponds to 0.2–0.3% of global LNG production by 2010 because 1,000 more vessels will be fueled by LNG and sailing within regions, primarily in ECAs. They recommended that LNG bunkering be evaluated for validity, such as regarding safety, the environment, regulations, logistics, technology, operations, finance, and the business perspective.

However, the literature on LNG bunkering ports is still in its initial phase. Some existing studies explored the role of the port authority (PA) with respect to the LNG bunkering port (Wang and Notteboom, 2015), LNG bunkering port development (TRI-ZEN, 2016), and a feasibility evaluation of LNG bunkering (DNV, 2012).

3. Methodology

3.1 Fuzzy-AHP

This research aims to identify the selection factors among various LNG bunkering ports using integrated AHP techniques under a fuzzy environment. Fuzzy-AHP is used to determine the preference weights of the evaluation using triangular fuzzy numbers (TFNs) based on the various characteristics of LNG bunkering ports (Kaya and Kahraman, 2011). This research uses TFNs for the evaluation. The steps in the fuzzy-AHP are presented as follows.

Step 1: Define scale of relative importance used in the pairwise comparison matrix

In this step, TFNs are utilized for pairwise comparisons and to find fuzzy weights because they are intuitively easy for decision makers to use and calculate. Additionally, modelling TFNs has proven to be effective in formulating decision problems for available information that is subjective and imprecise. The computational process for fuzzy-AHP is detailed as follows. A TFN can be defined by a triplet (a1, a2, a3), and the membership function $\mu_{\tilde{A}}(x)$ is defined by:

$$\mu_{\tilde{A}}(x) = \begin{cases} (x-l)/(m-l), & l \le x \le m \\ (u-x)/(u-m), & m \le x \le u \\ 0, & otherwise \end{cases} \qquad Eq.\ (1)$$

This research uses nine basic linguistic terms with respect to a fuzzy nine-level scale. Each membership function (scale of a fuzzy number) is defined by three parameters of the symmetric TFN—the left point, the middle point, and the right point—of the range over which the function is defined.

Step 2: Construct the fuzzy comparison matrix

In this step, pairwise comparison matrices among all criteria in the dimensions of the hierarchy system are constructed. Linguistic terms are assigned to the pairwise comparisons by asking which is the more important of each of the two dimensions, as in the following matrix $\tilde{A}$.

$$\tilde{A} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & 1 \end{bmatrix} = \begin{bmatrix} 1 & 1/\tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ 1/\tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/\tilde{a}_{n1} & 1/\tilde{a}_{n2} & \cdots & 1 \end{bmatrix} \qquad Eq.\ (2)$$

where,

$$\tilde{a}_{ij} = \begin{cases} \tilde{9}^{-1}, \tilde{8}^{-1}, \tilde{7}^{-1}, \tilde{6}^{-1}, \tilde{5}^{-1}, \tilde{4}^{-1}, \tilde{3}^{-1}, \tilde{2}^{-1}, \tilde{1}^{-1}, \tilde{1}, \tilde{2}, \tilde{3}, \tilde{4}, \tilde{5}, \tilde{6}, \tilde{7}, \tilde{8}, \tilde{9} & 1, i \ne j \\ 1 & i = j \end{cases}$$

Step 3: Define the fuzzy geometric mean and fuzzy weight
In this step, the geometric mean technique is used to define the fuzzy geometric mean and fuzzy weights of each by Hsu and Huang (2014):

$$r_i = (a_{ij}^1 \times a_{ij}^2 \times \cdots \times a_{ij}^{10})^{1/n} \qquad n = 1, 2, \cdots, n \qquad Eq.\ (3)$$

$$w_i = r_i \times (r_1 + r_2 + r_3 + \cdots + r_n)^{-1} \qquad Eq.\ (4)$$

where a_{ij} is a fuzzy comparison value of dimension *i* to criterion *j*. Thus, r_i is a geometric mean of fuzzy comparison value of criterion *i* to each criterion and w_i is the fuzzy weight of the *i*th criterion and can be indicated by a TFN.

Step 4: Determine the best non-fuzzy performance (BNP) value
In this step, the BNP value for each weight (l, m, u) is determined and given by Sun (2010).

$$BNP\ value = \frac{[(u-l)+(m-l)]}{3} + l \qquad Eq.\ (5)$$

Step 5: Rank the criteria
The criteria are ranked using the BNP values. The criterion with a larger BNP value is considered to have a stronger effect when compared with other criteria.

3.2 Data collection
Previous research related to the aforementioned studies was circulated among experts to obtain better insights into the problem. In this study, through interviews and the literature review, 20 detailed sub-criteria under five main criteria (cost, geography, port reputation, port service, and safety/security) were identified. The overall objective of the decision process determined for LNG bunkering port selection is on the first level of a hierarchy. The main criteria are on the second level, and the sub-criteria are on the third level of the hierarchy (see Table 1). The questionnaire for the analysis was distributed to each shipping company by referencing the world ports climate initiative (WPCI) website and the list of world LPVs (LNG World Shipping, 2016). From October 13 to November 30 2017, 134 questionnaires were distributed to the population and 24 were returned, for an approximate response rate of 18%. Depending on the consistency of the answers, 20 questionnaires were finally adopted. Twenty respondents from shipping companies consisting of CEOs, general managers, and operations managers with professional experience answered the questionnaire. According to Abduh and Omar (2012), one of the benefits of using AHP is that it does not require many respondents for the analysis, and it can be applied with just one respondent. In reality, AHP has been applied in research with small sample sizes to determine the hierarchical analysis based on experts' opinions (Peterson et al., 1994; Kamal et al., 2001; Shen et al., 2015). The detailed criteria are as follows.

Main criteria	*Sub-criteria*	*Description*
Cost (M_1)	Incentive/discount (C_1)	Discounts and incentives on eco-friendly vessels from environmental regulations of international organizations
	LNG price (C_2)	Low LNG price
	Port service charge (C_3)	Low port service charge
	Ship turnaround time (C_4)	Short ship turnaround time attributable to saving operating costs
Geography (M_2)	Geographical location (G_1)	Proximity to ECAs or main navigation routes
	Port accessibility (G_2)	Closeness to shipping companies' service routes

	Port traffic (G_3)	Number of calls at port
	Port weather conditions (G_4)	Sound weather conditions for LNG bunkering
Port reputation (M_3)	Experienced human resources (PR_1)	Education and training requirement for workers of the bunker vessel and experienced workers at the port
	Port disputes (PR_2)	Low level of port disputes
	Public opinion/word of mouth (PR_3)	Retain/develop positive public perception of the port
	Technical conditions related to LNG bunkering (PR_4)	Required facilities and technology for LNG bunkering (e.g., TTS: Truck-to-ship, STS: Ship-to-ship, TPS: Terminal-to-ship)
Port service (M_4)	Efficiency of LNG bunkering process (PS_1)	Short bunkering time attributable to the efficiency of the LNG bunkering process
	Infrastructure /superstructure (PS_2)	Infrastructure and facilities provision for LNG bunkering
	Port congestion (PS_3)	Low port congestion
	Relationship among stakeholders (PS_4)	Sound relationship among LNG ports, LNG suppliers, and port users
Safety /security (M5)	LNG bunkering safety (SS_1)	LNG bunkering safety (e.g., ESD; Emergency Shut-down Systems, Safeguard Systems)
	Port security (SS_2)	Number of accident, accidents prevented, and guards
	LNG bunkering regulations (SS_3)	Compliance with regulations and standards for LNG bunkering, such as regulations of SIGTTO (Society of International Gas Tankers and Terminal Operators), OCIMF (Oil Companies International Marine Forum), IMO (International Maritime Organization), ISO (International Organization for Standardization), CEN (European Committee for Standardization), and NFPA (National Fire Protection Association)
	LNG supply regulations (SS_4)	Compliance with regulations and standards for LNG supply, such as ISO.TS 18683:2015 Guidelines for Systems and Installations for Supply of LNG as Fuel to Ships, LNG Bunker Checklists developed by IAPH's (International Association of Ports and Harbors) WPCI (World Ports Climate Initiative)

Table 1: The criteria and their descriptions

4. Empirical analysis

In this section, fuzzy-AHP is performed to determine the priority when shipping companies choose a LNG bunkering port. Selecting a LNG bunkering port is important for the following three reasons.

(1) Demand for LPVs has increased as a result of environmental regulations of international organizations. However, scant research exists on the analysis of LNG bunkering ports.

(2) Related LNG bunkering industries are still in an early phase and technologies are new. These industries will most likely develop and offer even more sustainable alternatives for the future.

(3) Advanced ports (Singapore, Rotterdam) are already preparing for LNG bunkering. The government or PA preparing the LNG bunkering port will be able to implement policies for more competitive LNG ports by understanding the priorities of shipping companies when selecting LNG bunkering ports.

Respondents were asked to construct pairwise comparisons of the five major criteria and 20 sub-criteria by employing linguistic variables. Using the arithmetic mean, the pairwise comparison matrices of the criteria and sub-criteria are established. The consistency ratio values of all matrices are less than 0.1, indicating that these matrices are sufficiently consistent. Then, linguistic expressions were transformed into FTNs and a fuzzy evaluation matrix was established (see Table 1). The next step is to obtain a fuzzy weighted evaluation matrix. Using the criteria weight calculated, the weighted evaluation matrix is established by Eq. (3) and Eq. (4). The results of the analysis are shown in Tables 2 and 3.

Major criterion	Consistency	Major criterion weight	Major criterion BNP	Ranking
Cost (M_1)	0.091	(0.142, 0.157, 0.177)	0.159	4
Geography (M_2)		(0.257, 0.283, 0.309)	0.283	1
Port reputation (M_3)		(0.111, 0.121, 0.133)	0.122	5
Port service (M_4)		(0.165, 0.185, 0.207)	0.186	3
Safety/security (M_5)		(0.230, 0.254, 0.280)	0.255	2

Table 2: Ranking of main criteria for LNG bunkering selection

Sub-criterion	Consistency	Sub-criterion weight	BNP	Ranking	Total ranking
C_1	0.066	(0.257, 0.302, 0.345)	0.301	1	5
C_2		(0.191, 0.216, 0.248)	0.218	4	14
C_3		(0.229, 0.266, 0.310)	0.268	2	8
C_4		(0.195, 0.216, 0.245)	0.219	3	13
G_1	0.088	(0.351, 0.380, 0.411)	0.381	1	1
G_2		(0.201, 0.227, 0.252)	0.226	3	11
G_3		(0.200, 0.228, 0.253)	0.226	2	10
G_4		(0.153, 0.169, 0.189)	0.170	4	18
PR_1	0.094	(0.309, 0.346, 0.380)	0.345	1	3
PR_2		(0.181, 0.201, 0.221)	0.201	3	17
PR_3		(0.149, 0.164, 0.181)	0.165	4	19
PR_4		(0.263, 0.289, 0.327)	0.293	2	6
PS_1	0.096	(0.259, 0.289, 0.323)	0.290	2	7
PS_2		(0.203, 0.225, 0.257)	0.228	3	9
PS_3		(0.149, 0.161, 0.179)	0.163	4	20
PS_4		(0.294, 0.325, 0.347)	0.322	1	4
SS_1	0.090	(0.319, 0.356, 0.393)	0.356	1	2
SS_2		(0.193, 0.221, 0.254)	0.223	4	12
SS_3		(0.191, 0.213, 0.239)	0.215	3	15
SS_4		(0.185, 0.210, 0.240)	0.212	2	16

Table 3: Ranking of sub-criteria and total ranking for LNG bunkering selection

5. Discussion and concluding remarks

Studies on LNG bunkering port selection that incorporate applications from the perspective of shipping companies are lacking. This paper offers invaluable policy implications for governments and PAs that plan to build and operate LNG bunkering ports in the near future. The results of the analysis enable them to: (1) more clearly understand the needs of shipping companies regarding LNG bunkering ports, (2) determine how to provide efficient LNG bunkering services, and (3) make prompt adjustments to meet their development strategies. The results also enable LNG bunkering port managers to: (1) grasp the present strengths and weaknesses of their ports and (2) help them establish future strategies to improve the competitiveness of their ports. This paper represents a first step in exploring LNG bunkering port selection.

The final ranking of the criteria is determined according to the BNP values. The results indicate that, among the 20 sub-criteria of LNG bunkering port selection by shipping companies, geographical location (G1) ranked first as the most competitive factor, followed by LNG bunkering safety (SS_1), experienced human resources (PR_1), and relationship among stakeholders (PR_4). In reality, shipping companies normally obtain LNG bunkering services at the North Sea and the Baltic Sea given the ECAs. In addition, in these regions, LPVs are actively being operated and LNG bunkering ports are the most distributed. These examples might indicate that the adoption of an ECA is highly related to the development of LNG bunkering ports. Moreover, for shipping companies to make optimal decisions on the choice of LNG bunkering ports may be helpful. After the analysis, the strategic recommendations may be provided to the government or PA that is preparing the LNG bunkering port. The results indicate that most shipping companies decide on a LNG bunkering port with a stronger emphasis on safety/security or port services rather than port reputation. Therefore, when developing a LNG bunkering port, the government and the PA should improve its safety and security under limited port capacity to enhance its LNG bunker supply efficiency and shorten its waiting time. Meanwhile, the findings indicate that the efficiency of the LNG bunkering process (PS_1) was the fifth most important factor. Therefore, port operators should improve the efficiency of port operations and, at the same time, secure sound LNG bunker suppliers in the port. Such partnerships will lead more shipping companies to obtain LNG bunker services at this port by reducing ship turnaround time (Barnes-Dabban et al., 2017).

The following policies are recommended from a consideration of both the initial more theoretical evaluation and the empirical evidence.

- Incentive/discount policy: The incentive and discount policy is a significant problem arising from the introduction of LPVs. The government and the PA should use various forms of financial support to promote LNG bunkering in its port, such as by developing a differential port tariff for LPVs, such as the Green Award at the port of Rotterdam and the Environmental Ship Index (ESI) of WPCI.
- Communication policy: The government and the PA should take a conative coordinating role with respect to sustaining honorable communication within the port community regarding the its LNG bunkering port, such as by (a) improving public opinion to promote the use of LNG bunkering ports and (b) projecting a publicity campaign or by forming conferences, seminars, or workshops (Kuznetsov et al., 2015).
- Collaborative policy: The government or the PA preparing a LNG bunkering port should institute collaboration opportunities with stakeholders of the port (e.g., industrial players such as LNG bunkering ports, LNG suppliers, and port users). Collaboration can focus on the development of the LNG port (e.g., location selection), the safety assessment of the LNG port environment, and the development of bunkering standards and guidelines. Collaboration is believed to improve interactive knowledge and its sharing, which can reduce market uncertainty (Wang and Notteboom, 2015).

The following items highlight the study's limitations: (1) because no major LNG bunkering ports exist, shipping companies have limited selection; (2) for the same reason, this study cannot propose alternative LNG bunkering ports; and (3) shipping companies' decisions may be non-objective and may neglect actual vessel and port conditions. Therefore, important additional studies can follow this paper. Future research directions are as follows: (1) shipping companies that lack LPVs should be added to the analysis; (2) after large LNG bunkering ports are constructed, alternatives should be analyzed; and (3) a two-phase methodology combining fuzzy-AHP-TOPSIS and a sensitivity analysis can be incorporated to confirm the robustness of the analysis. Nevertheless, the authors strongly believe that the study has provided an ideal platform for further research on this increasingly important subject.

References

- Abduh M., Omar M.A. (2012) 'Islamic-bank selection criteria in Malaysia: An AHP approach', *Business Intelligence Journal*, Vol. 5, No. 2, pp. 281–281.
- Acosta M., Coronado D. & Cerban M.D.M. (2011), 'Bunkering competition and competitiveness at the ports of the Gibraltar Strait', *Journal of Transport Geography*, Vol. 19, pp. 911–916.
- Bajpai S. & Gupta J.P. (2007), 'Securing oil and gas infrastructure', *Journal of Petroleum Science and Engineering*, Vol. 55, No. 1–2, pp. 174–186.
- Barnes-Dabban H., van Tatenhove J.P.M. & van Koppen K.C.S.A. (2017) 'Termeer K.J.A.M., Institutionalizing environmental reform with sense-making: West and Central Africa ports and the "green port" phenomenon', *Marine Policy*, Vol. 86, pp. 111–120.
- Brooks M.R., Schellinck T. & Pallis A.A. (2011), 'A systematic approach for evaluating port effectiveness', *Maritime Policy & Management*, Vol. 38, No. 3, pp. 315–334.
- Chang Y.T., Lee S.Y. & Tongzon J.L. (2008), 'Port selection factors by shipping lines: Different perspectives between trunk liners and feeder service providers', *Marine Policy*, Vol. 32, No. 6, pp. 877–885.
- Danish Government (2012), *Denmark at Work: Plan for Growth in the Blue Denmark*.
- DNV (2012), *LNG bunkering demand and bunkering infrastructure*.
- Gritsenko D. (2017), 'Regulating GHG emissions from shipping: Local, global, or polycentric approach?', *Marine Policy*, Vol. 84, pp. 130–133.
- Hesse M. & Rodrigue J.P. (2004) 'The transport geography of logistics and freight distribution', Journal of Transport Geography, Vol. 12, No. 3, pp. 171–184.
- Hsu, W.-K. & Huang, S.-H. (2014) 'Evaluating the service requirements of Taiwanese international port distribution centres using IPA model based on fuzzy AHP', *International Journal of Shipping and Transport Logistics*, Vol. 6, No. 6, pp. 632-651.
- Kamal M., Al-Subhi & Al-Harbi (2001) 'Application of the AHP in project management', *International Journal of Project Management*, Vol. 19, No. 1, pp. 19–27.
- Kaya T. & Kahraman C. (2011) 'An integrated fuzzy AHP–ELECTRE methodology for environmental impact assessment', *Expert Systems with Applications*, Vol. 38, No. 7, pp. 8553–8562.
- Kotrikla A.M., Lilas T. & Nikitakos N. (2017), 'Abatement of air pollution at an Aegean island port utilizing shore side electricity and renewable energy', *Marine Policy*, Vol. 75, pp. 238–248.
- Kuznetsov A., Dinwoodie J., Gibbs D., Sansom M. & Knowles H. (2015) 'Towards a sustainability management system for smaller ports', *Marine Policy*, Vol. 54, pp. 59–68.
- Lirn T.C., Thanopoulou H.A. & Beresford A.K.C. (2003), 'Transhipment port selection and decision-making behaviour: Analysing the Taiwanese case', Int*ernational Journal of Logistics Research and Applications*, Vol. 6, No. 4, pp. 229–244.
- LNG World Shipping (2016), *Revealed – the global LNG-fuelled fleet*.
- Lloyd's Register (2012), *Lloyd's Register LNG Bunkering Infrastructure Study*.
- Lloyd's Register (2014), *LNG Bunkering Infrastructure Survey 2014*.
- Malchow M. & Kanafani A. (2004) 'A disaggregate analysis of port selection', *Transportation Research Part E*, Vol. 40, No. 4, pp. 317–337.

- Notteboom T.E. & Vernimmen B. (2009), 'The effect of high fuel costs on liner service configuration in container shipping', *Journal of Transport Geography*, Vol. 17, pp. 325–337.
- Peterson D.L., Silsbee D.G. & Schmoldt D.L. (1994) 'A case study of resources management planning with multiple objectives and projects', *Environmental Management*, Vol. 18, No. 5, pp. 729–742.
- Shen, L., Mathiyazhagan, K., Kannan, D. & Ying, W. (2015) 'Study on analysing the criteria's for selection of shipping carriers in Chinese shipping market using analytical hierarchy process', *International Journal of Shipping and Transport Logistics*, Vol. 7, No. 6, pp. 742-757.
- Sun S.-C. (2010) 'A performance evaluation model by integrating fuzzy AHP and fuzzy TOPSIS methods', *Expert Systems with Applications*, Vol. 37, pp. 7745–7754.
- Tetraplan (2014), *LNG in shipping – Perspectives for regional ports*.
- Tongzon J.L. (2009), 'Port choice and freight forwarders', *Transportation Research Part E*, Vol. 45, pp. 186–195.
- TRI-ZEN (2016), *LNG Market Perspective*.
- Wang S. & Notteboom T. (2015), 'The role of port authorities in the development of LNG bunkering facilities in North European ports', *WMU Journal of Maritime Affairs*, Vol. 14, pp. 61–92.
- Wang Y., Yeo G.-T. & Ng A.K.Y. (2014), 'Choosing optimal bunkering ports for liner shipping companies: A hybrid Fuzzy-Delphi-TOPSIS approach', *Transport Policy*, Vol. 35, pp. 358–365.
- Zhu M., Li K.X., & Lam J.S.L. (2017), 'Incentive policy for reduction of emission from ships: A case study of China', *Marine Policy*, Vol. 86, pp. 253–258.

IDENTIFYING REVERSE EXCHANGE PRACTICES: A COMPARATIVE STUDY OF LAUNDRY LOGISTICS IN PUBLIC HOSPITALS (THAILAND)

Thianthip Bandoophanit[1] and Liz Breen[2]
[1]Khon Kaen Business School, Thailand
[2]University of Bradford School of Pharmacy and Medical Sciences, UK

Healthcare laundry management

Linen is a general term for clothing items, including blankets, bed sheets, blue sheets, patients' clothes, gowns and towels (Gajuryal, 2014). The management of used hospital linen differs from other large institutions because they are contaminated with blood excreta or secretions and others have been used for infected patients (Barrie, 1994). Various studies found that poor-cleaning linen can pose as a vehicle for the transfer of pathogens to patients or hospital workers; which can contribute to the spread of nosocomial infections (e.g. Fijan and Turk, 2012). The transmission of diseases can prolong the patient's stay in the hospital or even, in extreme cases, paralyze the carrying out of surgical operations (García Fernández et al., 2001). Therefore, effective healthcare linen management is very important for all healthcare settings. Laundry management aims at providing sufficient clean linen to all users, with the qualified standards of cleanliness and timeliness (NHS, 2015), and complying with particular Guidelines of National Health Service Infection Control (IC). Linen management is either responsible by the Laundry Department (inhouse) or outsourced to external providers. This can sometimes lead to the perception of depleted quality standards incresasing the potential of infection and contamination (Toffolutti et al. (2017). On reviewing extant literature on linen/textile management in healthcare we can see that the most salient discussions have focused on (i) controlling the spread of infections/antimicrobial textiles (e.g. Anand et al., 2010, Cheng et al., 2015), (ii) the observations of microencapsulation of herbal extracts for microbial resistance in textiles (Thilagavathi and Bala, 2007, Hui et al., 2013) and (iii) the development of smart healthcare textile and hygiene products (Stoppa and Chiolerio, 2014). Improvements laundry operations honed in on the following areas (i) investing in new machinery, (ii) cost optimization, (iii) adopting new cleaning strategies, and (iv) using in-house facilities vs outsourcing this service.

Reverse Exchange Theory: For healthcare reusable products

Reverse Exchange (RE) is an immature area of logistics study, but is grounded in more traditional theories particularly Reverse Logistics (RL). The RL concept focuses the movement of products or materials in the opposite direction for the purpose of creating or recapturing value, or for proper disposal (Rogers and Tibben-Lembke, 2001). Unlike RL, RE relies on product exchanges (those which are used as part of a service process for a given period of time, so 'on loan to someone for a specific purpose' but will have to be exchanged within a given period of time or when they are no longer needed) (Bandoophanit et al., 2017). The concept and application of RE has been examined in a number of different sectors and operational foci: medical device exchanges (Xie et al., 2016); service supply chains (Kumar et al., 2016); and customer motivation (Yuan et al., 2016, Bandoophanit et al., 2017). In the service industries, RE takes an insight into the exchange of single-used products between specific stakeholders e.g. customer, distributor and manufacturer. Therefore the exchange has a clear movement and low repetition of exchange (Kumar et al., 2016). This is very similar to several healthcare products such as single-used medical devices – infusion pumps (Xie et al., 2016). However this has never been applied to products such as bed linen that requires the daily exchanges to maintain service continuity.

Within the hospital operation there are several multiple-use products such as linen, metal medical devices, food containers that have to be exchanged multiple times within their life cycle and if they are not available services can be delayed or halted. These exchanges are generally occurring through their lifetime, returning to non-specific customers, and mostly within the hospital (Hootajuta and

Poonnakitikasem, 2010, Smith et al., 2011). Unlike other service industries, the expectation of healthcare customers is much greater concerning hygiene and safety; which increases the importance to explore and apply the use of RE in this area. As reported by Bandoophanit et al. (2017) there is a dearth of research studies and publications which focus on laundry operations as a closed-loop service. The authors state that *"To all intents and purposes this system, purpose, design and execution sits firmly within a number of supply chain camps, relating to Supply Chain Management (SCM), Reverse Logistics (RL), Closed-Loop Logistics (CLL) and Reverse Exchanges (RE)"* (Bandoophanit et al., 2017, p. 2). As shown in other studies (e.g. Xie et al., 2016) the concept of RE is being more widely explored and adopted but there are currently no known RE laundry management studies available.

Laundry logistics in Thailand's healthcare settings

By law, Thailand Ministry of Public Health (MOPH) is responsible in governing and controlling all public hospitals including the compliance of new legislation, the amounts of budget allocated, labour employed and organizational structure (NHSO, 2013, Ministry of Public Health, 2018). The infection control regulation (2013) aims to prevent or stop the spread of infections in healthcare settings. This includes the guidelines for laundry such as (i) staff must wear proper protections, (ii) used linen must be sorted and bagged before carrying to the laundry, and (iii) infected linen must be washed in high-temperature water etc. As reported by Bandoophanit et al (2017) when applying RE to a laundry management service, the focus is on a group of products which include bed linen, towels and gowns/pyjamas for patient/ward use. These items are used by the patient for a given duration and then returned to be cleaned at the laundry and reallocated. R/E in this industry is more person/patient centric and innately responds to patient demand for the service and bed capacity. These items are all single use so the turnover is very high and can be more than once a day. From an operational and economic perspective the focus in laundry operations is both 1) the availability of the product - how can it be recovered, cleaned and returned for further use in a controlled and timely fashion but also 2) the durability of the product - how can we maintain/extend the product's lifecycle to get maximum utilisation and value from it. Previous studies found the causes of linen shortages uncovered included having lower stock volume than standards (less than 4-6 sets), ineffective cleaning activities/management, poor linen exchange system, inappropriate duty, segregation broken machines, insufficient personnel, weak procurement practices and over-stocking on hospital wards (e.g. Bandoophanit et al., 2017)

A limited number of studies have applied reverse exchange concept to deeply explore and compare the laundry management of several hospitals for better understanding a wide range of operational efficiency/inefficiency, root causes and effective solutions. In order to examine and propose recommendations for improvement within the reverse exchange of laundry logistics systems, these elements and others will be explored in this study.

Research methodology

Key methods used to investigate RE practices as applied to laundry logistics in these hospitals were interviews, observations and documentations for data collection (Johl and Renganathan, 2010). The study adopted a 'purposeful sampling strategy' method, selecting three case hospitals to collate information-rich cases related to the phenomenon of interest (Palinkas et al., 2015). Due to having limited time and budget, the selection criterion used to select the sites were: 1) being the best practices in laundry management; 2) accessibility of data and 3) short transportation to case hospital. Therefore, three case hospital were contacted called "B" (2,000 beds), "C" (867 beds) and "D" (826 beds) located in different province. The hospital visits were undertaken during February and March 2018. These areas were observed: laundry management processes (particularly the linen exchanges), and standards; personnel perception and understanding of these processes; statistical data, failure identification, root cause analysis and problem resolution data associated with this operation. A large volume of collected data was reviewed and managed by "content analysis". This was then further analyses using **'The 4-M Checklist'**. This tool allowed the researcher to analyses contributing factors

(man, machine, methods, and materials) which led to the development of performance indicators (Bringslimark, 2006). Therefore, after observing linen management processes (**M-M**ethod), key research indicators can be developed including (i) sufficiency of linen (par/set) (**M-M**aterials), (ii) a volume of machines (**M-M**achines), (iii) a number of personnel (**M-M**an), (iv) speed (hour/day) (**M-M**ethods) and quality of service (**M-M**ethods). Through this process, when comparing degrees of achieving the objectives across cases, the similarities and differences can be noticed (Miles and Huberman, 1994, pp., p.190).

Research findings

1) Hospital Background

In order to fully understand the concept of reverse exchanges in Thai Hospitals observational analaysis was undertaken in the case study sites. There were three case hospitals (see Table 1) referred to in this study as Hospitals "B", "C" and "D".

Background	Hospital "B"	Hospital "C"	Hospital "D"
1.1 Bed-size	2,000 beds	867 beds	826 beds
1.2 Type	University Hospital	Central Hospital	Central Hospital
1.3 HA level	HA3, now moving to CQI	HA3	HA3, now moving to CQI
1.4 Volume of used linen	9,000 – 10,000 kg/day	7,500 – 8,000 kg/day	4,500 – 5,000 kg/day
1.5 Laundry Management	In-house	In-house 2,500 kg (infected linen), and Outsourced 5,500 kg (general linen)	In-house
1.6 User	78 Large Departments (key users: ICU followed by Surgery wards and operation theatres)	40-50 Departments (key users: ICU)	73 Departments (key users: Medicine ward, and Surgery ward)
1.7 Volume of staff	1 Head and 67 workers	1 Head and 42 workers	1 Head and 42 workers

Source: Hospital "B", "C" and "D".

Table 1: Overview of Hospitals within the study.

2) Summary of Findings

Using data collected from the various data collection tools, the following profile was constructed of hospital site laundry logistics based on the Value Chain theory (see Table 2). Some similarities and differences were clearly presented. Their similarities include cleaning time per cycle (4-5 hours), following standards of linen management processes, and management of old/torn linen. The differences identified were particularly stock levels ("B"-3 sets, "C"- not sure, and "D" – about 1 set), budget spent on linen ("B" 15-18 million Baht in 2016 but no budget spent during 2017, "C" 21-22 million Baht per year, and "D" 1 million Baht in 2017).

Reviewed criterion	Hospital "B"	Hospital "C"	Hospital "D"
2.1 Purchase of linen	Head: annually for 15-18 million baht Staff: "B" did not purchase* last year	Sub Head: the purchase is 21-22 million baht per year.	Head: annually for 1 million baht
2.2 Set of linen ***(Linen Shortage)***	-Patient cloth = 4 sets - Low usage linen = 2 sets *So average = 3 sets	- Do not ensure about this because linen was lost very often	- Now has only 1 or less-than-1 set. Last two years usually has 3-4 sets
2.3 Linen lifetime	General linen- 3 years Operation linen – 2 years	N/A	1 year or less
2.4 Time per cleaning cycle	4-5 hours up to a day	Inhouse = 4-5 hours Outsource = 6 hours/more	4-5 hours
2.5 Control of torn linen	-Type the year of purchasing on linen -Torn linen is fixed/repaired	-Torn linen is fixed/repaired	-Type the year of purchasing on linen -Torn linen is fixed/repaired
2.6 Washer/ Dryer	50% of the washers were not functioning for more than 6 months	Broken issue was caused by programme error for some machines	2 from 5 washers are not functioning due to a programme error for more than 3 months
2.7 Linen segregation	Untie bed knot, various medical objects and human waste are sent to washer.	Small objects are rarely found with linen.	A bag of surgical waste (e.g. wastage blood), forceps, scissors, needle syringe, blades and bed pans are found every day amongst linen bundles.

Source: Hospital "B", "C" and "D".
*currency conversion 1 USD = 33 Baht, and 1 GBP = 43 Baht.

Table 2: Observation Results on Linen Management.

Data Analyses and Discussions

The observations and analyses of data from Table 1 and Table 2 provided evidence of factors which negatively impact on the availability of linens in Thai hospitals. These are analysed further below using Value Chain and 4M frameworks supported by RE theory.

1. **Man - Personnel:** Personnel at "B" had the largest laundry operation with 9,000 – 10,000 kg of linen per day and 67 staff. Each staff member had to manage 134.33 – 149.26 kg of linen. The US guidelines state that a one staff member should manage 60-75 kg of linen, or 15 personnel for 200-300 bed (including managers) (Gajuryal, 2014). According to this, "B" should have more than 150 staff for 10 tons of linen; therefore, more than 80 staff (1.5 time) should be recruited to support the high-workload activities. The heavy-workload activities of luandry are washing-drying linen, and folding linen; which found having insufficient staff. Besides, staff of these activities have to work from 07.00 to 22.00 daily and has only 2-4 day-off per month. Interestingly, the Head of Laundry decided to recruit 7 additional staff to transport linen twice a day (7.30 – 9.00 and 15.00 – 16.30). This activity was mainly supported by a nurse aid or maid from wards who have more free-time than laundry staff. "D" also requires more staff of at least 40 persons. Clearly, only "C" has provided appropriate workload for their staff (59.52 kg of linen per day). When asked why some hospitals have insufficient staff, "C" said that, *"It is mostly decided by the Director about how the budget is allocated. If they realize the importance of laundry, they can allocate more budget like our hospital."* Most interviewees felt that they had very

high workload and reported this issue several times and asked for more staff. Previous studies indicate that clear guidance provided by the Ministry of Public Health (MOPH) should be given to all public hospitals and all hospital departments to support Healthy Workplace Framework (Department of Health, 2018). A more serious monitoring and action taken on budget allocation, and the real workload versuss job description, as part of HA should be considered and provided (Barrie, 1994, NHS, 2015).

2. **Budget and Linen**: From Table 2, "C" appears to have appropriate working levels of linen stock. However it was reported that the wards of "C" have poorer control on linen usage, which staff, patients and relatives can pick more linen than needed which contributed to regular linen shortages. "B" and "D" reported that they have suffered greater linen shortages. Observations on several wards of "B" found that they had a larger safety stock than they need; with some wards refusing to reduce their stock levels. In comparision "D", had only 1 or less sets of linen, which is much lower than the standard expectation. It means that linen used each day must be collected, cleaned and delivered back to be used for the night cycle. Since there is no linen safety stock maids on wards provide better control of using and disposing/sorting wastage linen from wards, as well as transporting linen to and from laundry by themselves. The extensive pressure from users dictated that the laundry services of "D" had the fastest cleaning time - 4-5 hours per cycle. From our study, it can be concluded that an common cause of linen shortages was a limited purchasing budget. The average budgets for purchasing linen annually were (i) "C" - 21-22 million Baht per year, (ii) "B" - 15-18 million Baht, and (iii) "D" – 1 million Baht (after having new Director). Other factors compounding linen shortages was the transfer of budget dedicated to linen procurement/replenishment to a hospital extension ("D"); new machinery ("B"); loss of stock due to patients leaving the hospital or dying ("B", "C" and "D"); weak outsourcing contract and performance ("C"); lack of support from senior management ("D"). The results indicated that the management and control of laundry logistics and the efficient turnover, exchange of stock relies heavily on many parties within the hospital operation. This concurs with the view that the administration and the laundry personnel have responsibility to provide better control/monitoring, and take action/make a decision when managing contracts e.g. outsourcing (Arisi-Nwugballa, 2016, Toffolutti et al., 2017). Leadership awareness is the key driver for successful adoption of new strategy to support the implementation of reverse exchange practices (Thiell et al., 2011, Xie et al., 2016).

3. **Machine and Management**: Other causes of linen shortage are due to (i) malfunctioning machines and (ii) poor waste segregation. 4 out of 8 washing machines at "B" Hospital were broken since the motors were blocked by small medical tools such as forceps, scissors, needle syringe and blades. The waiting time for these to be fixed and operational was more than 6 months. Similarly, "D" has 5 large-sized washers, and 2 were broken because of a program error with a similar lengthy repair time. Reparing machines can take longer time than expected because (i) it needs to purchase new parts, (ii) vendor's technicians are busy (sometime takes more than 6 months), (iii) hospital has too old machines to be fixed, and (iv) 4 new machines (3-4 years life) have poor quality that requires more frequent fixing. The Thai government dictates that certain processes need to be followed when requesting such products to be repaired. This lenghty process itself causes delays. The management of linen and the ineffective segregation practice has led to staff experiencing needle stick and sharp injures, as well as having to consent to blood tests to check for infections which can be time consuming so workers may be denied this opportunity (Sharma et al., 2010). According to waste management guidelines of the World Health Organisation (1999, 2011), these tools should be sorted at sources such as clinics and wards to be further sterilised, or disposed off, and not cause such risks in the laundry operations. Also, linen should be sorted from sources mainly into (i) infected linen and (ii) general linen, because they use different cleaning procedures, failure to do so carries risk but also extends the time taken for the laundry cycle.

Conclusion

The aim of the linen management is **'to provide regular and timely supply of clean linen to the satisfaction of patients and staff',** as mentioned earlier. This study principally applied RE theory, in combination with Value Chain and 4 M theories, in exploring the laundry department of large-sized

hospital sites. Too frequent exchanges (R/E) are generally found, mostly in Hospital "D"; delivering excessive hot cleaning per linen set. This highly deteriorates the fabric, reduces linen life time and increases the purchase volume in the following year. To minimize the exchange was undertaken and firstly found hardly achieved, since there is insufficient volume of linen (1-3 sets). It occurs although each site had the highest HA accreditation that specifies having 4-6 sets. Several causes were identified including (i) slow procurement processes and transparency, (ii) the imbalance between increasing volume of patients and the amount of budget allocated for linen, personnel and machinery (iii) equipment failure caused by ineffective product sorting and loading and (iv) procurement freezes. Even if having various limitations, to provide clean linen on time, maids on wards are key persons to control of using and disposing/sorting wastage linen from wards, as well as transporting linen to and from laundry by themselves. Evidently, human factors particularly by the perspective of the Director on budget allocation and the importance of laundry services, is the key driving forces providing insufficiencies of budget, linen, personnel and machine. These findings can influence government healthcare policy design, hospital procurement strategies, job design and management of hospital laundry operations in Thailand.

References

- Anand, S. C., Kennedy, J. F., Miraftab, M. and Rajendran, S. (2010) *Medical and healthcare textiles.* Elsevier.
- Arisi-Nwugballa, E. A. (2016) 'Does Outsourcing Improve Quality of Service in Public Healthcare Institutions in South-East Nigeria?', *International Journal of Academic Research in Accounting, Finance and Management Sciences,* 6(2), pp. 196-203.
- Bandoophanit, T. (2015) *Identifying Green Logistics Best Practice Leading to the Efficient Management of Resources and Waste in Thailand's Public Hospitals* PhD, University of Bradford.
- Bandoophanit, T. h., Breen, L., Naipinit, A., Pila-Ngarm , P., Permwanichagun, P. and Saenchaiyathon, K. 'Investigating the laundry logistics system of small-sized public hospital: Can the efficiency of operations be improved under the constraints of Thailand's administrative culture?', *Logistics Research Network Conference*, Southampton Solent University. CILT(UK).
- Barrie, D. (1994) 'How hospital linen and laundry services are provided', *Journal of Hospital Infection,* 27(3), pp. 219-235.
- Bringslimark, V. (2006) 'Operator error: Is it really the root cause of performance problems?', *Biopharm international,* 19(12), pp. 38.
- Cheng, V. C. C., Chen, J. H. K., Wong, S. C. Y., Leung, S. S. M., So, S. Y. C., Lung, D. C., Lee, W.-M., Trendell-Smith, N. J., Chan, W.-M. and Ng, D. (2015) 'Hospital outbreak of pulmonary and cutaneous zygomycosis due to contaminated linen items from substandard laundry', *Clinical Infectious Diseases,* 62(6), pp. 714-721.
- Department of Health (2018) *Healthy Workplace Framework* Available at: http://advisor.anamai.moph.go.th/main.php?filename=factory1.
- Fijan, S. and Turk, S. Š. (2012) 'Hospital Textiles, Are They a Possible Vehicle for Healthcare-Associated Infections?', *International Journal of Environmental Research and Public Health,* 9(9).
- Gajuryal, S., H. (2014) *Linen & laundry service*. Available at: http://www.slideshare.net/sharrygajuryalnepal/linen-laundry-service-38089774 (Accessed: 06/06/2015.
- García Fernández, V., González Torre, P. L. and Adenso Díaz, B. (2001) 'Quality optimization in the hospital laundry service: an application case', *International Journal of Health Care Quality Assurance,* 14(5), pp. 193-199.
- Hootajuta, W. and Poonnakitikasem, P. (2010) 'Logistics and Supply Chain Management in Hospital Industry', *Engineering Today,* 85.
- Hui, P. C.-L., Wang, W.-Y., Kan, C.-W., Ng, F. S.-F., Wat, E., Zhang, V. X., Chan, C.-L., Bik-San Lau, C. and Leung, P.-C. (2013) 'Microencapsulation of traditional Chinese herbs—PentaHerbs

extracts and potential application in healthcare textiles', *Colloids and Surfaces B: Biointerfaces,* 111, pp. 156-161.
- Johl, S. K. and Renganathan, S. (2010) 'Strategies for gaining access in doing fieldwork: Reflection of two researchers', *The Electronic Journal of Business Research Methods,* 8(1), pp. 42-50.
- Kumar, M. A. A. B. J. A. G.-R. V., Parry, G. C., Brax, S. A., Maull, R. S. and Ng, I. C. L. (2016) 'Operationalising IoT for reverse supply: the development of use-visibility measures', *Supply Chain Management: An International Journal,* 21(2), pp. 228-244.
- Miles, M. B. and Huberman, A. M. (1994) *Qualitative data analysis: an expanded sourcebook.* Thousand Oaks; London: Sage Publications.
- Ministry of Public Health (2018) *The aim of t he Ministry of Public Health* Nonthaburi.
- NHS, Hospital, W.U.T. (2015) *Linen and Laundry Policy.* United Kingdom.
- NHSO (2013) *Annual Report of National Health Security Office Year 2013*. Available at: http://www.nhso.go.th/FrontEnd/page-about_result.aspx (Accessed: 17/06/2015
- Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N. and Hoagwood, K. (2015) 'Purposeful sampling for qualitative data collection and analysis in mixed method implementation research', *Administration and Policy in Mental Health and Mental Health Services Research,* 42(5), pp. 533-544.
- Rogers, D. S. and Tibben-Lembke, R. (2001) 'An examination of reverse logistics practices', *Journal of Business Logistics,* 22(2), pp. 129-148.
- Sharma, R., Rasania, S. K., Verma, A. and Singh, S. (2010) 'Study of prevalence and response to needle stick injuries among health care workers in a tertiary care hospital in Delhi, India', *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine,* 35(1), pp. 74.
- Smith, B. K., Nachtmann, H. and Pohl, E. A. (2011) 'Quality Measurement in the Healthcare Supply Chain', *The Quality Management Journal,* 18(4), pp. 50-60.
- Srikar, K., Sharma, S. and Ghosh, S. (2015) 'Quality assurance hospital linen and laundry services', *International Journal of Science and Research,* 6(3), pp. 593-596.
- Stoppa, M. and Chiolerio, A. (2014) 'Wearable electronics and smart textiles: a critical review', *Sensors,* 14(7), pp. 11957-11992.
- Thiell, M., Zuluaga, J. P. S., Montañez, J. P. M. and van Hoof, B. (2011) 'Green Logistics: Global Practices and their Implementation in Emerging Markets', in *Green Finance and Sustainability: Environmentally-Aware Business Models and Technologies* [Online]. Version. Available at: http://www.irma-international.org/viewtitle/53258/.
- Thilagavathi, G. and Bala, S. K. (2007) 'Microencapsulation of herbal extracts for microbial resistance in healthcare textiles'.
- Toffolutti, V., Reeves, A., McKee, M. and Stuckler, D. (2017) 'Outsourcing cleaning services increases MRSA incidence: Evidence from 126 english acute trusts', *Social Science & Medicine,* 174, pp. 64-69.
- WHO (1999) *Safe management of wastes from healthcare activities*. Geneva. Available at: http://apps.who.int/iris/bitstream/10665/42175/1/9241545259.pdf (Accessed: 16/08/2015.
- WHO (2011) *Waste from health-care activities*. Available at: http://www.who.int/mediacentre/factsheets/fs253/en/ (Accessed: 04/05/2015.
- Xie, Y., Breen, L., Cherrett, T., Zheng, D. and Allen, C. J. (2016) 'An exploratory study of reverse exchange systems used for medical devices in the UK National Health Service (NHS)', *Supply Chain Management: An International Journal,* 21(2), pp. 194-215.
- Yuan, R., Liu, M. J., Chong, A. Y.-L. and Tan, K. H. (2016) 'An empirical analysis of consumer motivation towards reverse exchange', *Supply Chain Management: An International Journal,* 21(2), pp. 180-193.

IDENTIFYING GREEN LOGISTICS BEST PRACTICES: A CASE STUDY OF THAILAND'S PUBLIC HOSPITALS

Thianthip Bandoophanit[1], Liz Breen[2] and Kevin Barber[3]
[1]Khon Kaen Business School, Thailand
[2]University of Bradford School of Pharmacy and Medical Sciences, UK
[3]University of Bradford School of Management, UK

Introduction

According to the Global Green and Healthy Hospital Agenda: *"Hospitals generate significant environmental health impacts both upstream and downstream from service delivery, through the natural resources and products they consume, as well as through the waste they generate."* (Healthcare without Harm, 2011). The health sector's global climate footprint is very substantial. The National Health Service (NHS) in England emits 25% of CO_2 each year of total public sector emissions (WHO and HCWH 2009: 5). Interestingly, logistics activities produces more than half of total emissions, particularly procurement (61%) and travel (13%) (NHS 2013). Therefore, to promote greater sustainability and environmental health by considering a close-loop supply chain – green logistics (GL) should be the responsibility of all hospital functions/departments. But how this is actually achieved operationally is unknown at present.

In Thailand, improving hospital operations (both logistics and environment) is often hindered by these factors especially the government systems/policies, insufficient support, financial crises, as well as poor behavior (PCD 2010; Singkarin 2012; PCD 2013; Rattanaumpawan 2015). Poor behavior in this study refers to two key issues; one is the overuse of resources while another is the mismanagement of waste (e.g. mixing, leakage and poor burning system). Preliminary studies in related areas have also revealed that 'GREEN and CLEAN', the key environmental policy that supports resources and waste control for Thailand's public hospitals, limits sustainable development. Such barriers as mentioned above need to be addressed and overcome. This requires a need for restructure the approach to and execution of resources and waste management at both national and hospital levels to meet this national agenda (focusing on both human and physical elements that impact directly on this). This study investigated the movement and lifecycle of resources and waste within Thai hospital sites and identified the GL practices that effectively control/minimize the use of hospital inputs.

Healthcare resource and waste management

Hospitals use a wide range of resources including items such as linen, energy, food and cleaning products in addition to complex medical equipment and medicines. Various studies have identified significant wastes in the deployment of all these resources (e.g. HCWH 2011; Lapsuwansakul and Kunkum 2012). In general, the amount of resources that hospitals consume is driven by the number of inpatients and outpatients, equipment used, facility size, number and types of service, facility age and maintenance requirements (ESC 2003: 12). The avoidance of overusing resources by minimizing materials entering the hospital rather than focusing on waste control has been highly recommended (HCWH and WHO 2011). Therefore, the total environmental impacts can be minimized when integrating green into all units in the supply chain – called Green Supply Chain Management (GSCM) (Chin et al. 2015). It starts from the decision of selecting green materials (green procurement) for the production, to establish environmentally-friendly production and distribution of products, through to minimization of consumption and waste disposal (Ninlawan et al. 2010). Hospital waste was defined by the WHO (2011) as a byproduct of healthcare that includes sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical devices and radioactive materials. 80% of hospital waste is general waste (GW), while the remaining 20% is considered hazardous material that may be infectious, toxic or radioactive. Careful waste segregation and separate collection can reduce the waste volume

that requires specialized treatment (WHO 2011). In doing so it also reflects upon management culture, policy and regulation and stakeholder influence on this supply chain.

Thailand's healthcare resource and waste Mmanagement

This section firstly provides the overview of (i) how do hospitals manage their resources, from purchase planning through to waste disposal?, followed by (ii) the national agenda and policy to successfully manage hospital resources and waste. Investigating the operations and streams of healthcare resources and waste within Thai hospital sites was conducted by Bandoophanit et al. (2014a) and can be summarised as follows:

> Apart from patient, resources and waste are another key flows moving inside hospitals. The inventory flow involves purchase planning, submitting requisitions, Director's approval, placing purchase orders (PO), receiving purchased inventories, storing, distributing, and discarding waste. Different categories of resources are controlled by the particular department/office. After resources are used, they become various types of waste including general waste (GW), infectious waste (IW), hazardous waste (HW), recyclable waste (RW), and wastewater. Each waste has own specific management methods.

Moving to national level, in the ethos of pursuing and embedding Sustainability the Thai government advocate compliance with the country's Sufficiency Economy Philosophy (SEP).

> *"At the heart of Sufficiency Economy Philosophy (SEP) is the idea of acting with knowledge and with virtue. This means not being wasteful or consuming too extravagantly, and planning ahead for future risks and shocks. This type of prudent, moderate resource management and forward thinking can help Thailand across the board – on the individual level, among private sector actors and in terms of national policy – when it comes to climate action."* (2016: 40):

The SEP concept has been principally applied across Thailand since 1997 (NESDB 2017). The Ministry of Public Health (MOPH) introduced a key environmental policy for all healthcare settings, 'GREEN and CLEAN' later in 2011 (DOH 2012). It is grounded by elements especially the SEP concept (see Bandoophanit et al. (2014b)). Key practices include increasing use of renewable energy (e.g. wind and biogas), green areas, local food materials etc. In addition, some healthcare standards were revised and updated such as the policy to reduce the cost of medicine and medical supply by 10% (Ministry of Public Health 2013). Since the progress of environmental performance is linked with hospital accreditation (HA) and budget allocation (NHSO 2011), the number of public hospital who have opted to join this campaign has steadily increased. According to the report of GREEN and CLEAN, a number of hospitals presented positive outcomes particularly the minimization of total carbon emissions. In contrast, various studies presented poor control of resource management as well as habits of excessive use contrasting with a poor finance are largely found (e.g. Wanichsun 2012). Several hospitals faced problems such as insufficient green products/suppliers, qualified persons/organizations (e.g. logistics managers and waste handlers), knowledge and awareness as stated by Singkarin et al (2012). GSCM concept is rarely adopted in its true sense. When discussing waste control in Thailand's hospitals, Manowan (2009) claimed the factors resulting in poor waste management are the type of hospital and insufficient knowledge. Other studies point to insufficiencies of monitoring by the Director, budget and insufficient protections (Panyaping and Okwumabua 2006; Niyompanitpatana and Bonollo 2012; Tangpaitoon 2012; PCD 2013).

Because of these issues as highlighted by previous studies, a more focused approach to effective hospital waste management is necessary. Therefore there is a need for research to identify key areas of development for GL in Thai hospitals, to identify best practice in those areas and to include best practice to promote and implement GL best practice.

Methodology

This research aims to identify the Green Logistics (GL) practices that effectively manage resources and waste. To achieve the aim above, four sub-questions were formulated and delivered to:

1. What are the most important GL study areas in Thai public hospitals?
2. How should we measure the GL performance of resources and waste management?
3. What are the critical success factors that support green practice delivery in Thai public hospitals?
4. What are the barriers to addressing environmental programmes in Thai public hospitals?

Although to effectively addressing green in healthcare activities should consider all units in the supply chain as stated by various authors (e.g. Xie and Breen 2012), narrowing the focus of this research to focus on hospital internal logistics, from purchasing resources to waste disposal is more appropriate since Thai healthcare supply chain linkages are very weak. In a complex organization like healthcare facilities, to use mixed methods in collecting data from the field can effectively explore the GL adoption (e.g. Voss et al. 2002; Ubeda et al. 2011). Various tools including documentation, interviewing, observation and checklist (including floor plan) were recommended for exploring and understanding the operations of healthcare resources and waste selected (Bisson et al. 1993). Six case hospitals agreed to participate in this study (called "A", "B", "C", "D", "E" and "F"), due to having different types/sizes (30 beds – more than 500 beds), locations and a range of environmental performance issues. All names of case hospitals, research participants, and their locations (provinces) remain anonymous. Visiting hospital sites were undertaken during January to July 2014 to obtain data. Purposive respondent sampling was undertaken to ensure that data was collected from staff with experience of key resources and waste. 'Content analysis' method was selected to scrutinise the data collected and best practices were identified using 'cross case analysis' method.

Findings

1. What are the most important GL study areas in Thai public hospitals?

In order to answer this question the data collected was sorted using the following key areas (as informed by the GL literature): (i) resources (e.g. medical supplies, food materials, linen), (ii) waste (e.g. general/reusable waste –GW/RW, infectious waste-IW, sharps, hazardous waste-HW, (iii) hospital departments, (iv) all rankings and (v) human factors. These were developed from several studies (HCWH 2011; Punpeng 2011; Singkarin 2012; WHO 2012; Bandoophanit et al. 2014a).

2. How should we measure the GL performance of resources and waste management?

The concept of best practice refers a technique or method or process delivers a more effective outcome than any others (Frontex RDU 2012: 19). According to McKinnon (2010), good GL practices as applied in this study must be able to (i) reduce the amount of resource used/waste generated/other environmental impacts, and/or (ii) increase cost reduction/improved revenue, and/or (iii) offer well-beings, and/or (iv) provide fast logistical movement. More detail on this is presented in the literature.

3. What are the critical success factors that support green practice delivery in Thai public hospitals?

The hospitals within this study had varying factors which influenced the scale and pace of the introduction of new initiatives such as the hospital location, size, readiness for change and budget, and this affected the uptake of GL practices. As per the findings these were reported as examples of key practices for promoting an environmentally-friendly hospital (see Table 1). For instance, **Medical devices**: The hospital should select using more 'multiple-use' medical devices especially glass and metal devices, rather than increasingly using single-use ones. Another example, **Effective Microorganism (EM)**: It can disinfect metal medical devices and floors of operating theatres and should therefore be used more widely in hospitals. It can replace importing chemical sterilisation liquid, which 60-bed hospital can save greater than 400,000 Baht.

Item	Proposed new GL practice	Impact
1. Medical device management	Select using more 'multiple-use' medical devices especially glass and metal devices, rather than increasingly using single-use ones.	Reduction in cost, assurance of quality (inhouse), less waste, less products to landfill (non-recyclable)
2. Organic Foods	Grow own organic products/ or purchase organic products locally, in order to increase the proportion of organic foods in the hospital menus	Support health promotion, use local product and support local economic (SEP), and reduce cost (save up to 25%)
3. Effective Microorganism (EM)	Use waste from vegetables, fruits, raw meat and cooked foods for EM production. High-quality of EM liquid – as a sterilisation liquid	Use all food waste/ resource effectively, reduce use/import of chemical liquid, improve wastewater management
4. Biogas	Large-sized hospitals should have biogas plant, while small-sized hospitals should use Blanket biogas plant	Reduce energy use (at least 25-50% of LPG), and all hospital food waste; and get EM liquid and solid fertilizer from biogas production
5. Electricity	Implement hardware-systemware-peopleware concept, create energy-saving team to monitor their responsible areas, and promote good air ventilation rather than using the air conditioner	Reduce electricity usage and cost, improve infection and disease control

Source: By Authors.

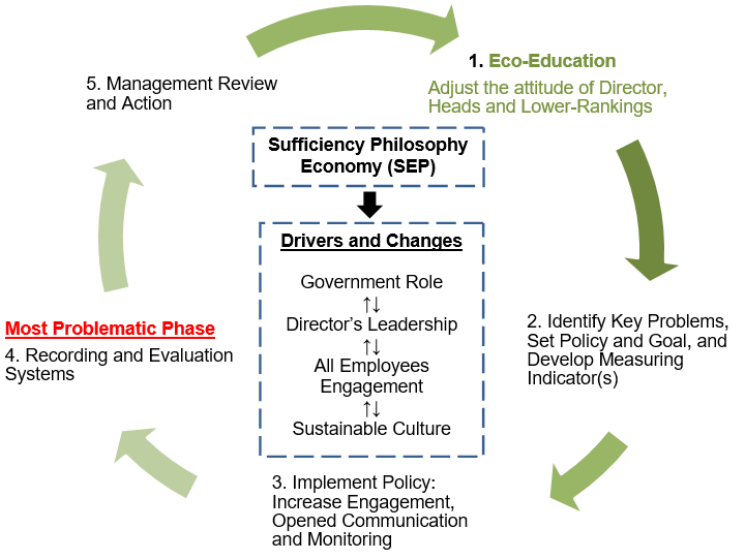
Table 1: Best GL Physical Practice Recommended and Applicability.

4. What are the barriers to addressing environmental programmes in Thai public hospitals?

The barriers identified when undertaking this cross case analysis included hospital budgets, time taken to adopt and use robust environmental practices, hospital size, and human resources.. For instance, the city hospital with limited space was unable to grow large quantities of organic food materials. A lack of environmentally responsible/accredited suppliers for e.g. medical devices and food materials, were stated by all case hospitals. The insufficient knowledge, budget, technology and awareness of this practice undermined the successful adoption of such a practice. Government regulations at times also provided further obstacles for example at the governmental level, several existing regulations/policies/systems present a negative impact on GL practice and they should be reviewed and updated. For instance, the government policy regarding medical devices stated that hospitals should: 'increase the use of single-use medical devices'. However if applied this practice would increase the volume of waste especially plastic medical devices that require specific incineration. A better and more green proposition would be that hospitals should increase the use of multiple-use medical devices and improve the sterilisation process and quality assessment (QA) associated with recycled medical devices.

Discussion

GL adoption is a human-based system, so its implementation would be seriously compromised without full commitment from the entire organization (Martinsen and Huge-brodin 2014; McKinnon et al. 2015). Within the Thai healthcare system and more specifically hospitals, SEP must be the principal vehicle of GL adoption (see Figure 1).



Source: Modified from US EPA (2013).

Figure 1: The recommended cycle for effectively addressing GL.

As such the involvement of all staff in the SEP strategy deployment and the delivery of GL practices is imperative to its success and longevity. The Director holds a particular pivotal role in support GL adoption and awareness of its purpose and success in Thai hospitals. At a governmental level, solving problems based on the hospital feedback should be considered. Moreover, policy development should be cooperated with a public hospital network, and ensuring the effectiveness of new system/guideline before its deployment into policy. Therefore there is a need for research to identify key areas of development for GL in Thai hospitals, to identify best practice in those areas and to include best practice to promote and implement GL best practice.

Limitations

A small respondent sample (6 case hospitals) can result in low generalizability. The researcher attempted to negate this by her extensive interview database with staffs of case hospitals, by using one-to-one interviews with all grades of hospital staff. There was limited access to some hospital documents, which can affect the accuracy of identifying best practices.

Conclusions

The study aims to identify GL practices to better control the volume of resources used and waste generated. This was achieved via a review of key logistical processes and lifecycle of resources and waste within Thai hospitals. Many green practices were revealed including reusing medical devices, producing EM sterilization liquid and embedding biogas plant. On their own they cannot successfully reduce environmental impacts, but they can contribute to increased cost savings and support the improvement of logistical operations. In addition, key findings were that green initiatives need to be supported by: sufficient environmental education; two-way communication; effective evaluation and recording systems; and Director-level support. Thus, effectively introducing and managing GL within these settings requires the coordination of all staff (clinical and other), and the consideration of all environmental impacts from product purchasing through to waste disposal. Importantly, GL adoption in the Thai context should be grounded in the Sufficiency Economy Philosophy concept (e.g. moderation, wisdom, and happiness), as well as contemporary hospital logistics theory and practice. On a final note for Thai hospitals to operate in a sustained sustainable manner, the current Hospital Accreditation and related government regulations and standards should be reviewed to determine their compatibility with and support for such sustainable development.

References

- Bandoophanit, T., Breen, L. and Barber, K. (2014a) Mapping the logistics flows of Thai public hospitals: Can resource use and waste generation be better controlled? In *Post-graduate research conference* 2014. University of Bradford, UK.
- Bandoophanit, T., Breen, L. and Barber, K. (2014b) Undertaking a holistic examination of Green Logistics theory and practice. Learning from the past and moving forward. 2014.
- Bisson, C. L., McRae, G. and Shanner, H. G. (1993) *An Ounce Of Prevention: Waste Reduction Strategies For Healthcare Facilities.* Chicago, Illinois: American Society for Healthcare Environmental Services of the American Hospital Association.
- Chin, T. A., Tat, H. H. and Sulaiman, Z. (2015) Green Supply Chain Management, Environmental Collaboration and Sustainability Performance. *Procedia CIRP* 26, 695-699.
- DOH (2012) *GREEN and CLEAN Hospitals.* http://carbonfootprint.anamai.moph.go.th/ Accessed 05/06/2013.
- ESC (2003) *Greener Hospitals: Improving environmental performance.* Germany: http://www.bms.com/Documents/sustainability/downloads/greenh.pdf
- Frontex RDU (2012) *Best Practice Operational Guidelines for Automated Border Control (ABC) Systems.* European Agency for the Management of Operational Cooperation, Research and Development Unit,. *https://bit.ly/2KYBXhz* Accessed 9/05/2013.
- HCWH (2011) *Global Green and Healthy Hospitals: A Comprehensive Environmental Health, Agenda for Hospitals and Health, and Systems Around the World*.
- HCWH and WHO (2011) *Global Green and Healthy Hospitals: A Comprehensive Environmental Health, Agenda for Hospitals and Health, and Systems Around the World*.
- Lapsuwansakul, K. and Kunkum, D. (2012) *Accounting Cost and Economics Cost, Thammasat University Hospital.* Thammasat University Hospital Research Project for Performance Development. *https://bit.ly/2rJGDzj*
- Manowan, V. (2009) *Awareness and management of hospital waste in developing countries: A case study in Thailand*. The George Washington University.
- Martinsen, U. and Huge-brodin, M. (2014) Environmental practices as offerings and requirements on the logistics market. *Logistics Research* 7 (1), 1-22.
- McKinnon, A., Browne, M., Whiteing, A. and Piecyk, M. (2015) *Green logistics: Improving the environmental sustainability of logistics.* Kogan Page Publishers.
- McKinnon, A. C. (2010) *Green logistics : improving the environmental sustainability of logistics.* London: Kogan Page.
- Ministry of Foreign Affairs Thailand. (2016) *A Practical Approach toward Sustainable Development: Thailand's Sufficiency Economy Philosophy. https://bit.ly/2rDG0bd*
- Ministry of Public Health. (2013) *The framework of inspection and supervision:* 10% *Cost reduction policy.* http://203.157.186.16/gauge/index.php
- NESDB. (2017) ***National Economic and Social Development*** Office of the National Economic and Social Development Board. Bangkok: http://www.nesdb.go.th/more_news.php?cid=230&filename=index Accessed 04/07/2017.
- NHS (2013) *NHS, Public Health and Social Care Carbon Footprint* 2012. http://www.sduhealth.org.uk/documents/carbon_footprint_summary_nhs_update_2013.pdf Accessed 16/08/2015
- NHSO (2011) *The outcomes of promoting service development, the budget allocation according to quality criterion.* Accessed 17/06/2015.
- Ninlawan, C., Seksan, P., Tossapol, K. and Pilada, W. (2010) The implementation of green supply chain management practices in electronics industry. 2010. Vol. 3.
- Niyompanitpatana, T. and Bonollo, E. (2012) A Design Study of Sustainable Infectious Waste Management Systems for Small Healthcare Providers in North-Eastern Thailand. *OIDA International Journal of Sustainable Development* 4 (4), 65-76.

- Panyaping, K. and Okwumabua, B. (2006) Medical Waste Management Practices in Thailand. *Life Science Journal* 3 (2), 88-93.
- PCD (2010) *An Overview of Hazardous Waste Management & Prevention in Thailand. https://bit.ly/2IBzlbl* Accessed 04/06/2015.
- PCD (2013) *Report of infectious waste situation in Thailand year* 2013. Bangkok: *https://bit.ly/2rIm71S* Accessed 17/05/2015.
- Punpeng, T. (2011) *GREEN and CLEAN Hospitals Project.* Department of Health. Thailand:
- Rattanaumpawan, P. (2015) Perception, attitude and knowledge of antimicrobial resistance, appropriate antimicrobial use, and infection control among the sixth year medical students in three medical schools. *IDWeek,*. San Diego, CA, USA, 2015. The Infectious Diseases Society of America (IDSA).
- Singkarin, D. (2012) *The development of the 2nd National Logistics and Supply Chain Research Strategies (*2012-2016) (ร่างยุทธศาสตร์วิจัยโลจิสติกส์แห่งชาติ (พ.ศ.2555-2557)). Bangkok: RDG5450013. *http://elibrary.trf.or.th/project_content.asp?PJID=RDG5450013*
- Tangpaitoon, S. (2012) *The management of electronic waste in Thailand. http://www.thailandindustry.com/guru/view.php?id=16560&section=9* Accessed 21/05/2015.
- Ubeda, S., Arcelus, F. J. and Faulin, J. (2011) Green logistics at Eroski: A case study. *International Journal of Production Economics* 131 (1), 44.
- US EPA (2013) *Environmental Management Systems (EMS) and ISO* 14001. *http://www.epa.gov/EMS/* Accessed 30/03/2015.
- Voss, C., Tsikriktsis, N. and Frohlich, M. (2002) Case research in operations management. *International Journal of Operations & Production Management* 22 (2), 195-219.
- Wanichsun, G. (2012) *Review of beneficial use of resources. http://www.urnurse.net/ur-review-example.html* Accessed 29/05/2015.
- WHO (2012) *Overview of Wastes from Health Care Activities. http://webcache.googleusercontent.com/search?q=cache:SEO0BsW-eCAJ:www.unep.org/ietc/Portals/136/Events/HealthcareWasteWorkshop-July2012/1-Wilburn.ppt+&cd=3&hl=en&ct=clnk&gl=uk* Accessed 07/03/2015.
- WHO and HCWH (2009) *Healthy hospitals, healthy planet, healthy people: Addressing climate change in healthcare settings.* World Health Organization. *http://www.who.int/globalchange/publications/healthcare_settings/en/*
- Xie, Y. and Breen, L. (2012) Greening community pharmaceutical supply chain in UK: a cross boundary approach. *Supply Chain Management* 17 (1), 40-53.

THRESHOLD CONCEPTS – THEIR IDENTIFICATION AND USE IN OPERATIONS

Charles Thornton
Plymouth Business School, University of Plymouth, UK

Introduction

Threshold concepts (TCs) have been identified as a crucial aspect of student learning which when mastered can open up new and previously inaccessible ways of thinking. Moreover they have been very well received by the academic community (e.g. McLean, 2009). While a wide range of disciplines including history, economics and maths (eg Meyer and Land, 2003: and Cronin, 2016) have been examined the author could find no work on operations. Furthermore, most extant empirical work is resource intensive (eg Barradell and Peseta, 2012) and as TCs can vary from student to student (Shanahan, Foster and Meyer, 2016) this inhibits regular research. Consequently, this paper seeks to address these issues by carrying out work to identify TCs in operations using pre existing module data.

The literature review will examine the literature and set out areas for further work; research methods will examine current methods and propose a time efficient method to collect data to address the gaps identified, finally the results will be presented and discussed and a conclusion will highlight the significance of the work and prose future work.

Literature review

Since Land and Meyer's seminal paper (2003) TCs have attracted a significant amount of attention and while there are conceptual and methodical issues which will be addressed later it is worth noting the level of adoption within HE. TCs offer significant opportunities in terms of reviewing the learning of students both through the curriculum, with a focus on key areas, how material is delivered, and how students learn (see Barradell and Peseta, 2014; and Mclean, 2009). Moreover, there have been high levels of interested in academics in TCs suggesting a strong take up in the concept, not only in initial interest but also on sustained interest global in wide range of disciplines (McLean, 2009).

Lund and Meyer' seminal work (2003) identified threshold concepts as having five characteristics. *Transformative* being 'akin to a portal, opening up a new and previously inaccessible way of thinking about something . . . it represents a transformed way of understanding, or interpreting, or viewing . . . without which the learner cannot progress' where learner starts to think like a professional. (Meyer and Land, 2003; p.53). *Troublesome* were learning might be counter-intuitive, alien, tacit, ritualised, inert, conceptually difficult, super complex or a require a major change in ways of thinking (Perkins 2006, Land, Cousin, Meyer & Davies 2005, Land, Meyer & Baillie, 2010). *Irreversible* – difficult to unlearn, and *integrative* – combine several aspects. Finally, *bounded*, the delineation of a conceptual space with a specific purpose (Smith, 2006) which may have a different meaning from everyday usage. Further evolution has resulted from an attempt to differentiate TCs from educational concepts including core or key concepts, which has led to three additional characteristics being suggested (e.g. Baillie, Bowden and Meyer, 2013). *Liminality* ie partial understanding (Land, Meyer and Baille, 2010) perhaps part way between a child and an adult (Cousin, 2006), *reconstitution* ie reconfiguring learning by discarding earlier concepts and *discourse* with discipline specific language (Baillie, Bowden, & Meyer, 2013; Meyer & Land, 2005; Nicola-Richmond, Pépin, Larkin and Taylor; 2018).

However, there has been confusion as to whether all characteristics have to be met, in an effort to clarify, it has been argued that TCs should be liminal and transformative and are likely to have many of the other characteristics (e.g., Lund and Meyer, 2005 and Rowbottom, 2007) though confusingly the exact number is not specified. As an alternative, it has been suggested that troublesomeness is the most important TC (Barradell, 2012). However if taken by itself any learning which is troubling could then become a TC (Barradell, 2012), additionally it could become a filter with other criteria used to

confirm (see Rodger and Turpin (2011). In short, identification has with conceptual challenges that remain unresolved for researchers (Barradell and Peseta, 2014), the characteristics can be considered subjective (O'Donnell, 2010; and Rowbottom, 2007), which leads into issues around the empirical research (Rowbottom, 2007).

Given such issues the empirical researcher is left with two alternatives, firstly, either not carry out or hold back research in the hope that such difficulties will be resolved. Or secondly, acknowledge that there are conceptual issues and argue that although not a perfect situation this should not stop research in such an important pedagogic issue and carry out research with the main of contributing knowledge though acknowledging the conceptual weakness. Not unsurprisingly the author has adopted the second view, hence this paper.

TCs can vary by discipline, Meyer and Land's (2003) initial work was in economics where they identified opportunity cost a threshold concept, in maths they used Artigue's (2001) suggestion of limits, similarly precedence in law and for history the issue of subjectivity (Cronin, 2014) have been identified. In short differences in the practice and thinking of disciplines and their teaching makes it unlikely that 'one size fits all' (Barradell, 2012). Consequently, work needs to be carried out by discipline (McLean, 2009).

Furthermore, TCs can also vary from student to student (O'Donnell, 2010: Rowbottom, 2007), for example, Shanahan et al. (2006) found that disciplines studied previously and type of previous education had a greater impact on outcomes than university class or tutorial attendance. At this stage, it is worth noting that there have been significant changes in UK secondary education since 2010, which have affected the assessment and structure of the key qualifications, taken at both 16 and 18/19. Consequently, TCs can vary not only by discipline but also by student cohort.

Moreover while there is work in many business disciplines e.g. marketing, e.g. (von der Heidt, 2014) and accountancy (Gronow, and Morrison, 2017) the author could find non examining operations either in it is widely accepted academic function in general business degrees or as part of a narrower specialism e.g. operations and supply chain management.

Research methods

While there are a limited number of empirical papers (Walker, 2013) a wide variety of methods have been adopted to measure TCs. These include interviews, case studies, reflection, framing exercises (see Quinlan et al., 2013; Lucas and Mladenovic, 2007; Barradell and Peseta, 2014; Davies and Mangan 2008) and questionnaires, surveys, short answer problems and review of old examination papers (Davies and Mangan, 2005) and the involvement of other stakeholders such as professional bodies (Barradell, 2012).

Pertinently and making data collection more complex lecturers do not always agree amongst themselves as to threshold concepts in their discipline and only a small number of TCs identified had all of Meyer and Land's original five characteristics (Lucas and Mladenovic, 2007) let alone the three additional ones. Moreover, research involving students which focuses on the area of learning they find difficult may take them in areas they find emotional (Lucas and Mladenovic, 2009)

To conclude a wide variety of methods including multiple methods have been used which can include students, academic and other stakeholders eg professional bodies. While this is laudable in terms of the methods used and resources deployed if TCs can vary depending on the student intake I submit that there is also a role for resource lite approach which could be carried out relatively quickly on annual basis. Furthermore, as there is no widely identified professional body which confers a licence to practice in operations it was relatively easy to eliminate any professional body. As TCs focus on the student perspective, and as lecturers can disagree on them (Lucas and Mladenovic, 2009) it was

decided to follow (Quinlan et al., 2013) and that students should be the sole source of data. Given the aim of limiting resources it was decided to use data which was already going to be collected with a slight adjustment.

Consequently, student feedback forms were used. It was decided not to use TC characteristics on the grounds that they can be confusing and the more time spent on this the fewer the number of students were likely to complete the questionnaire. Instead form were modified and students were asked what they had found the most difficult and why with the aim of using this to identify areas of difficulty and from this TCs.

The second piece of data came from reflections on an individual portfolio piece of work which covered two main but interlinked topics – quality through a consideration of the applicability of Statistical Process Control (SPC) to service and a case study applying quality and Slack, Brandon-Jones and Johnston's (2016) four other POs. Students were asked to identify their most difficult aspect of each piece of work, why it was difficult and how they tacked this difficulty, again the what gave the aspect of operations, the why might indicate whether it was at TC or not and how it was tackled was more for module development than strictly tied to TCs. On the reflective work, the aim was to gain information on the areas which were troublesome from the first question with details on why from the second (to assist in assessing whether they met the characteristics of TCs). The final question was more for module assessment purposes but included in the data collected and analysed as it may give some indication as to the teaching and learning on the module may be developed.

The module chosen for this study was one the author leads and is the sole teachers, it is a final year module of 75 students in operations management. Students are enrolled on the module from a variety of educational backgrounds including direct entry student from the UK FE providers with Foundation Degrees, overseas students and students who have completed a placement year alongside students from the UK in their third year of uninterrupted study.

The data was analysed using thematic analysis where data is coded data for themes and facilitates presenting order in an orderly and logical manner (e.g. Saunders, Lewis, Thornhill; 2016: and Easterby-Smith, Thorpe, and Jackson, 2008).

State problems or challenge

Firstly, TCs is a well established pedagogic concept, while there has been research identifying TCs in variety of disciplines including some in Business, the author could find no work on Operations. Secondly, TCs can vary not only by discipline but also and significantly by type of previous education, with recent changes in UK secondary schooling it would seem sensible to review TCs on a regular basis. Thirdly, extant research on TCs tends to be time consuming often involving multiple stakeholders, methods and data sources this requires significant resources and would mitigate against regular reviews of TCs. Consequently, this research seeks to identify TCs in operations using pre existing data sources.

Data presentation and discussion

Portfolio Reflection

It should be noted that while SPC and service and five POs are, in the sense of being aspects of quality and performance measurement, typically small parts of an operations module, and therefore it might be questioned if they are threshold concepts. They can also be part of a more in depth module or even programmes e.g. in quality or operations strategy.

The results for portfolio reflection are divided into generic and topic specific. The generic issues raised as the most difficult were how to be critical 'evaluating critically', applying theory to practice, structure,

word count - usually deemed as tight e.g. 'low word count', and gathering data 'difficult to find organisational sources'. At this stage these were discarded as the purpose of the paper is to examine operations specific TCs.

The topic specific were for SPC: understanding SPC as a concept, with specific concerns about the complexity of statistics 'the mathematics of SPC', control charts how to apply SPC to service 'how SPC works in services' especially on the data aspect.

For the POs the exact definitions of POS 'the definitions of the performance objectives' including perceived overlap 'overlaps in the definitions of the terms' and trade offs between them 'interactions among the five performance objectives'.

Unfortunately, the comments on why a topic was difficult were of limited assistance as they were more likely to provide extra detail on the difficulty than the underlying reason why it was difficult. For example, what was difficult when identified as SPC statistics was typically accompanied by a why which covered issues with maths.

Taking each of the original five TCs in turn. *Transformative* where the learner starts to think like a professional (Meyer and Land, 2003) examples of this were deemed to be the integration of the performance objectives, a balancing act faced by professional operations managers and the understanding of SPC itself and with reference to service which could be a crucial part of assessing quality for an operations manager. *Troublesome* in one sense all aspects, however, if applying counter-intuitive, alien, tacit, ritualised, inert, conceptually difficult, super complex or a require a major change in ways of thinking (Perkins 2006, Land, Cousin, Meyer & Davies 2005, Land, Meyer & Baillie, 2010) it becomes difficult without more data given the brevity of the answers to why. *Irreversible* from anecdotal evidence of post exam discussion vary from those who appear to have very short term memories and those who make more use of long-term memories. *Integrative* this could be integrating five performance aspect and understanding SPC especially in relation to service.

Bounded - delineate a conceptual space with a specific purpose (Smith, 2006) may have a different meaning from everyday usage. This appeared to be quality where for example McDonalds (a case which could be used) has high conformance to quality but might be considered in general terms to provide low quality food.

Turning now to the three additional characteristics. *Discursive* with discipline specific language – here concepts in bounded might well apply. *Reconstitutive* reconfigure learning discarding earlier concepts, there is a second year operations module which covers SPC and service and integrating POs so this characteristic can be expected to be present. *Liminality* partial understanding (Land, Meyer and Baille, 2010) adolescent – part way between a child and an adult (Cousin, 2006), here some students clearly from their marks partially understood SPC, SPC as applied to service and integrated the five performance objectives.

All items mentioned were troublesome in the general meaning of the word, which Rowbottom (2007) appears to use. However, when applying the other characteristics tests other than irreversible, SPC, SPC and service and integration of the 5PoS appear to meet the other criteria for TCs. As this is the first piece of literature which looks at operations, there is no other literature to discuss. It confirms perhaps not unsurprisingly that TCs can be applied to another discipline though this is subjective (e.g. Rowbottom, 2007) and it is difficult to find a possible TC which meets all characteristics.

Module Feedback Questionnaire

There was a surprisingly low response with only 13 out of 45 who completed the feedback form completing this section, perhaps as was added at the end and this was at the start of a well attended revision session which was going to include guidance on what to study for the exam which might explain this. The results were 46% could identify why a topic was difficult 54% could not. Most difficult topic sin order were SPC 23%, Six Sigma and the assignment (a portfolio covering SPC and 5 performance objectives) (15%), and bottlenecks, calculations, JIT, service products, 'a lot of academic info', and transfer knowledge to case study (8%). Whys included 'complex business environment', distinguishing between conceptual and application especially in service industry, 'It's hard to analyse numbers', 'choosing a relative theory and making it applicable', 'lack of practice' and 'hard to get head around'. Overall, due to a lack of detail, it is very difficult to see how these can be used other than screening device.

Both methods raised aspects of operations which might be TCs with more detail in the reflective pieces. However, the resource 'lite' approach while producing some useful data has its limitations, and it would befit from more data.

Conclusion

This paper set out to mitigate two gaps one being the lack of work on TCs in operations and secondly to trail the identification of TCs solely from pre existing data in this case module feedback and assignment reflection.

The work on operations has identified three possible TCs the integration of the POs, the concept of SPC (especially the mathematics) and the application of SPC to service.

In terms of contribution to the literature, work has now started on new discipline with some tentative TCs identified. A 'lite' approach which facilitates data collections has had some success though follow up interviews with a smaller group of students, together with a readjustment of the module feedback form to give the questions more prominence is expected to increase response rates.

The reflection provides useful information on troublesome aspects of operations; this is however restricted by the area of the assessment and the conceptual issues with the identification of TCs. It would also be useful to follow up some of the key issues with a small number of interviews from a structured sample, though as this is final semester module, this might be difficult to achieve given pressure on student time, but may be more realistic with another module.

As the goal is to strive student learning, perhaps it is more important to gain an insight into student difficulties and their commonality and with an insight into their degree of difficulty than to precisely and confidently state whether they are TCs or perhaps core concepts etc.

Looking forward I contend that more work is needed on TCs in operations and gathering lite annual data alongside a more extensive exercise which might be better suited to a first semester module.

References

- Anderson, C. (2016), Learning to Think Like Linguists: A Think-Aloud Study of Novice Phonology Students, *Language* Vol 92, No 4, pp.274-291.
- Baillie, C., Bowden, J.A. & Meyer, J.H.F. (2013), Threshold Capabilities: Threshold Concepts and Knowledge Capability Linked Through Variation Theory, *Higher Education*, Vol 65, No 2 pp.227-246.
- Barradell, S. (2012), Using a Professional Community to Support the Identification of Threshold Concepts: A Physiotherapy Example, *Fourth Biennial Conference on Threshold Concepts: From personal practice to communities of practice*, Trinity College, Dublin, 28-29 June 2012.

- Barradell, S. & Peseta, T. (2014), Promise and Challenge of Identifying Threshold Concepts: A Cautionary Account of Using Transactional Curriculum Inquiry, *Journal of Further and Higher Education*: http://dx.doi.org/10.1080/0309877X.2014.971105.
- Cronin, J. (2014), 'Doing' History: What May Liminal Space and Transition Time Expose During the Process of Mentoring New Graduate Tutors in the Discipline of History?, *Fourth Biennial Conference on Threshold Concepts: From Personal Practice to Communities of Practice*, Trinity College, Dublin, 28-29 June 2012.
- Davies, P. and Mangan, J. (2005) Recognising Threshold Concepts: An Exploration Of Different Approaches, Paper presented at the *European Association in Learning and Instruction Conference (EARLI)* August 23 - 37th 2005, Nicosia, Cyprus.
- Davies, P. and Mangan, J. (2008), Embedding Threshold Concepts: From Theory to Pedagogical Principles to Learning Activities. *In Threshold Concepts Within the Disciplines*, Land, R., Meyer, J.H.F. and Smith, J., (eds), Sense Publishers, Rotterdam, pp. 37-50.
- Easterby-Smith, M Thorpe, R and Jackson P, (2008), *Management Research*, Sage Publications.
- Gronow, E. and Morrison, A. (2017), Accounting in Tourism and Hospitality Degrees: Threshold Barriers and Threshold Conceptions. In: CAUTHE 2017: *Time For Big Ideas? Re-thinking The Field For Tomorrow*, Dunedin, New Zealand: Department of Tourism, University of Otago, 2017, pp 588-591.
- Lucas, U. and Mladenovic, R. (2007), The Potential of Threshold Concepts: An Emerging Framework for Educational Research and Practice, *London Review of Education*, Vol. 5, No. 3, November 2007, pp. 237-248.
- von der Heidt, T. (2014), Concept Maps for Assessing Change In Learning: A Study of Undergraduate Business Students In First-Year Marketing In China, *Assessment & Evaluation in Higher Education*, DOI: 10.1080/02602938.2014.910637.
- Knight, David B., Meyer, Jan H. F., Baldock, Tom E., Callaghan, David P. and McCredden, Julie (2013). *Embedding Metacognitive Exercises in The Curriculum to Boost Students' Conceptual Understanding*. AAEE 2013: 24th Annual Conference of the Australasian Association for Engineering Education, Gold Coast, QLD, Australia, 8-11 December, 2013. Nathan, QLD, Australia: Griffith School of Engineering, Griffith University.
- Land, R., Cousin, G., Meyer, J.H.F. and Davies, P. (2005), Threshold Concepts and Troublesome Knowledge (3): Implications For Course Design And Evaluation. In: C. Rust (ed.), *Improving Student Learning - Diversity and Inclusivity*, Proceedings of the 12th Improving Student Learning Conference. Oxford: Oxford Centre for Staff and Learning Development (OCSLD), pp. 53-64.
- McLean, J. (2009), Triggering Engagement in Scholarship of Teaching and Learning Through Threshold Concepts, *International Journal for the Scholarship of Teaching and Learning*, doi.org/10.20429/ijsotl.2009.03022.
- McMahon, P. (2011), Chinese Learners and Their Experiences of Living and Studying in the United Kingdom. *Journal of Higher Education Policy and Management,* Vol 33, No 4, pp. 401-414.
- Meyer, J.H.F. and Land, R. (2003), Threshold Concepts and Troublesome Knowledge: Linkages to Ways of Thinking and Practising, In: Rust, C. (ed.), *Improving Student Learning - Theory and Practice Ten Years On.* Oxford: Oxford Centre for Staff and Learning Development (OCSLD), pp. 412-424.
- Meyer, J.H.F. and Land, R. (2005), Threshold Concepts and Troublesome Knowledge: Epistemological Considerations and a Conceptual Framework for Teaching and Learning, *Higher Education*, Vol 49, No. 3, pp. 373-388.
- Meyer, J. H. F., Land, R. and Baillie, C. (2010), *Threshold Concepts and Transformational Learning* Edited by Jan H. F. Meyer, Ray Land and Caroline Baillie, Sense Publishers, Rotterdam, 2010.
- Nicola-Richmond, K, Pépin, G Larkin, H & Taylor, C (2018), Threshold Concepts in Higher Education: A Synthesis of the Literature Relating to Measurement of Threshold Crossing, *Higher Education Research & Development*,

doi/abs/10.1080/07294360.2017.1339181?journalCode=cher20.

- O'Donnell, E. (2012), Personalised E-Learning: Facilitating Students' Understanding and Mastery of New Concepts*, in Fourth Biennial Conference on Threshold Concepts*: From personal practice to communities of practice, Trinity College, Dublin, 28-29 June 2012.
- Quinlan, M., Male, S., Baillie, C., Stamboulis, A., Fill, J. and Jaffer, Z. (2013), Methodological Challenges in Researching Threshold Concepts: A Comparative Analysis of Three Projects, *Higher Education,* DOI 10.1007/s10734-013-9623-y.
- Perkins, D. (2006), Constructivism and Troublesome Knowledge in: *Overcoming Barriers To Student Understanding: Threshold Concepts and Troublesome Knowledge*, edited by Jan H. F. Meyer and Ray Land, Routledge - Taylor & Francis Group, London and New York, pp. 33-47.
- Rowbottom, D. P. (2007), Demystifying Threshold Concepts*, Journal of Philosophy of Education*, Vol, 41, No. 2, pp.263-270.
- Saunders M, Lewis, P and Thornhill, A (2016) *Research Methods for Business Students*, Pearson.
- Slack, N, Brandon-Jones, A. and Johnston, R (2016) *Operations Management* (8th Edition) Pearson.
- Shanahan, M., Foster, G. and Meyer, J.H.F. (2006), Operationalising a Threshold Concept in Economics: A Pilot Study Using Multiple Choice Questions on Opportunity Cost *International Review of Economics Education*, Vol, 5 No.2, pp.29-57.
- Walker G (2013), A Cognitive Approach to Threshold Concepts, *Higher Education,* Vol. 65 pp.247-263.

SOCIAL MEDIA IN SUPPLY CHAIN AND OPERATIONS MANAGEMENT: STATE-OF-THE-ART AND RESEARCH DIRECTIONS

Shupeng Huang, Andrew Potter and Daniel Eyers
Cardiff Business School, Cardiff University, UK

1. Introduction

Social media has become one of the most important information technologies, with the potential to transform how business is conducted (Aral et al., 2013). In the operations and supply chain management (OSCM) field, scholars have suggested the potential of social media to improve OSCM efficiency (Melnyk et al., 2018), but in practice the value to OSCM is far less fully clear (Cui et al., 2017; Chae 2015). For example, in a survey of 77 companies, Natoli (2013) identified that just 1% integrated social media within their supply chain planning. This paper therefore aims to more clearly explore how social media can improve OSCM efficiency, providing a detailed synthesis of existing research that fully investigates the value of social media for OSCM, paving the way for future research and practice. Specifically, this paper attempts to explore and answer three questions:

- **Q1**) What aspects of OSCM can benefit from social media?;
- **Q2**) What are the benefits that arise?; and
- **Q3**) What is the current landscape of research methods in exploring the usage of social media to improve OSCM efficiency? Through these research questions we develop a detailed research agenda for future pursuit.

2. Literature review

The term 'social media' is widely used, but with little precision. According to Kaplan and Haenlein (2010), social media is defined as "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content". Based on their social presence/media richness and self-presentation/self-disclosure matrix, Kaplan and Haenlein (2010) listed six distinct categorises of social media: blogs, collaborative projects, social networking sites, content communities, virtual social worlds and virtual game worlds. Sterne (2010) proposed a similar categorisation of social media, namely forums and messages board, review and opinion sites, social networking sites, blogs, micro-blogs, bookmarking sites and media sharing sites. Built on the different functions of social media, Kietzmann et al. (2010) defined it based on its seven functional blocks, including identity, conversations, sharing, presence, relationships, reputation, and groups.

Social media has been widely applied in business, such as finance (e.g. Bollen et al., 2011), marketing (e.g. Kaplan and Haenlein, 2011) and management information system (e.g. Leonardi et al., 2013). In OSCM, scholars have indicated that the operations management focuses more on the *organisational* activities and functions to transform inputs to products and services, while supply chain management focuses more the activities and processes to deliver products or services from suppliers to end users *across the organisations* (e.g. Slack et al., 2010; Mentzer et al.,2008). Kaplan and Haenlein's (2010) definition of social media reveals social media usage can facilitate the information exchange among different parties. Thus, the value of social media on information exchange can be promising for enhancing information flow within and across organisations, improving OSCM efficiency.

3. Methodology

3.1 Paper selection

The authors conducted a systematic review of English language articles using the technique prescribed by Denyer and Tranfield (2009), locating studies published and in press through to the end of 2017.

The combinations of keywords related to social media ("social media", "social networking site", "user generated content", "web 2.0", "online community", "Facebook", "Twitter", "Tweet", "YouTube") and OSCM ("operations", "supply chain") were used to search papers in their *title, abstract and keywords* from three frequently used databases, namely EBSCO, ABI/INFORM, and Scopus. The authors then supplemented the literature by searching for papers from the main OSCM journals, focusing on articles that contain the search terms in *all article text*.

An initial search identified 862 papers in databases, and 385 in journals; after duplication this was reduced to 642 papers from databases and 362 papers from journals. A relevance check was undertaken for all papers to identify 1) that the research context was related to OSCM, and 2) that there was substantive evidence regarding OSCM efficiency improvement through social media usage in the paper. Papers were first filtered by reviewing abstracts and, where necessary, full text reading. Those papers with a research context irrelevant to OSCM, or just containing passing reference about social media usage in OSCM to support paper arguments were omitted from the analysis. Finally, 120 relevant articles were selected (Figure 1).

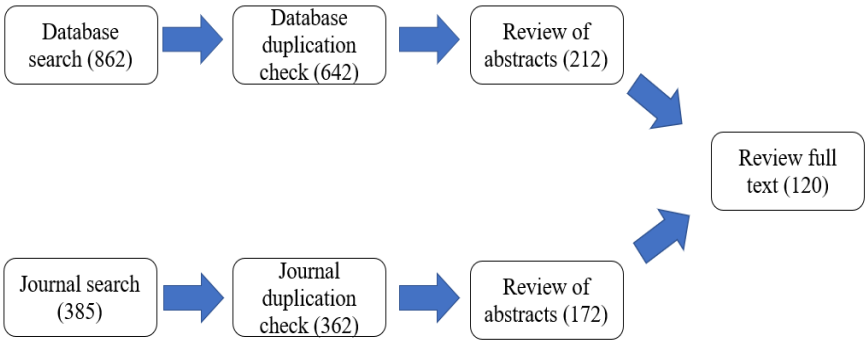


Figure 1: Literature selection process

3.2 Coding framework

The development of codes was achieved through an inductive approach. These were then located and adjusted within a framework developed from commonly used business models in both physical and service OSCM, including Slack et al. (2010), Mentzer et al. (2001), Cooper and Lambert (1997), Ellram et al. (2004), Baltaciogu et al. (2007), and Supply Chain Council (2014). Eleven distinct topics resulted from this process: (1) Demand forecasting and inventory management; (2) Demand shaping and marketing; (3) Sourcing management; (4) Product development and quality management; (5) Production and manufacturing management; (6) Distribution and logistics management; (7) Service delivery and customer relationship management; (8) Return management; (9) OSCM human resource management; (10) OSCM risk management; (11) Others.

4. Results

4.1 Descriptive overview

It can be identified in figure 2 that the research in this field experienced an increase from 2013. Especially in the recent two years (2016 and 2017), there are much more articles published than before. Figure 3 illustrates the focal industry/industries for each paper, and highlights that both physical OSCM (e.g. Manufacturing) and service OSCM (e.g. Education) have been explored in the research. The number of publications in each sector indicates that manufacturing, health care and social assistance, and retailing were three main areas of application, although there is a breadth of sectors within the sample. Finally, based on the coding framework, the topics of social media usage in OSCM are summarised in Table 1.

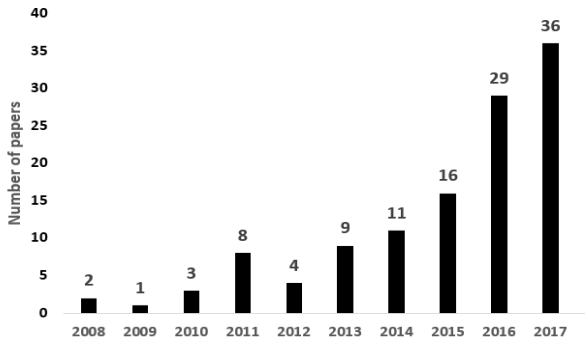


Figure 2: Publication distribution from 2008 to 2017

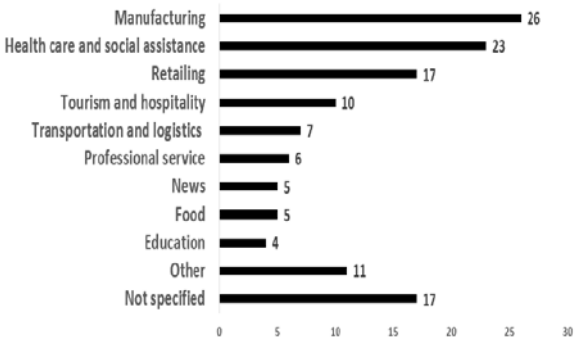


Figure 3: Industry distribution

Topics	Social media is used to…	Count
1.Demand forecasting and inventory management	Inform or facilitate demand forecasting and inventory management decisions.	14
2.Demand management and marketing	Promote products or manipulate customers' demand of the products.	29
3.Product development and quality management	Facilitate product design and product quality improvement.	34
4.Manufacturing and production management	Improve the efficiency of production and manufacturing processes, such as assembly, maintenance, etc.	9
5.Distribution and logistics management	Facilitate the decision of product deliver, route scheduling, fleet arrangement, etc.	10
6.Service delivery and customer relationship management	Facilitate the service provision and customer communication and to build good supplier-customer relationship.	29
7.Sourcing management	Manage supply source and facilitate the supplier relationship management.	5
8.Return	Facilitate the return and reverse logistics activities.	3
9.Risk management	Inform the OSCM risk decisions or to detect and response the disruptions.	33
10.Human resource management	Hire or train the employees whose work is related to OSCM.	9
11.Others	Address other topics broadly related to OSCM, such that social media can improve OSCM innovation, sustainability, knowledge management, etc.	16

Table 1: Topics for social media usage in OSCM

4.2 Research approaches

From the literature reviewed, two streams of papers can be identified. In the first stream, social media is used as a kind of information application and its influence on OSCM is explored. In other words, the social media in such research is a *research object*. Another stream research focuses not on social media itself but on social media information, such as Tweets from Twitter, comments from Facebook and posts on the Blogs where social media is used as a *data source*. Such research tries to extract the value from the social media information to improve the OSCM efficiency. In reflection of both approaches Figure 4 provides an overview of how the methods have been employed.

4.2.1 Social media as a research object

The methods employed vary widely over all papers, and examples from conceptual, quantitative and qualitative methods are identified. Among those methods, case studies, conceptual articles, and

review papers are dominant. Case studies are either used for theory building (e.g. Fan and Niu, 2016) or theory validation (e.g. Chan et al., 2017), with both qualitative and quantitative approaches taken. For the empirical research interviews and focus group can be identified as most popular qualitative methods; for quantitative research surveys/questionnaires are the most popular.

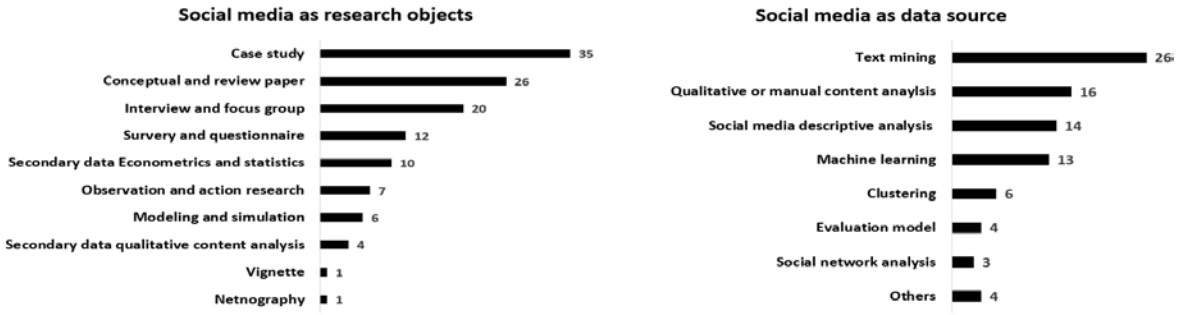


Figure 4: Research methods for social media as a research object and data source

4.2.2 Social media as a data source

In this category, one of the most popular methods is social media text mining, which includes social media sentiment analysis, word frequency analysis, natural language processing etc. (e.g. Lau et al., 2017; Sodero and Rabinovich, 2017). Another popular method is qualitative or manual social media content analysis. This method is essentially the traditional content analysis method used in social science and applied in social media setting (e.g. Fan and Niu, 2016). Other popular methods include using econometrics and machine learning techniques to automatically analyse social media information (e.g. Cui et al., 2017). The method summary shows, except from qualitative or manual content analysis, all other methods are facilitated by computer algorithms. As social media is an important part of "big data" (Chae, 2015), compared with the traditional manual content analysis methods, the methods facilitated by computer algorithm can be more intelligent and efficient when processing the large volume of data. Therefore, it is not surprising that these algorithm-aided methods are dominant in the literatures.

5. Developing a Social Media OSCM Reference Model

To better position the OSCM activities generated from the literature review, we locate our work within an adaptation of the Supply Chain Operations-Reference (SCOR) model. Recognizing that SCOR "does not address: sales and marketing (demand generation), product development, research and development, and some elements of post-delivery customer support" (Supply Chain Council, 2014), we employ six adjusted constructs to include all activities generated from literature review:

1) Planning and demand shaping (including demand forecasting and inventory management, and demand management and marketing);
2) Product management (including manufacturing and production, and product development and quality management);
3) Sourcing (sourcing management);
4) Delivery and provision (including distribution and logistics management, and service delivery and customer relationship management);
5) Return (including return management);
6) Enabling (including human resource management and risk management).

Additionally, three different social media functions can be identified from the reviewed literature (Figure 5). The first function of social media in OSCM is communication, or information exchange as suggested from the definition of Kaplan and Haenlein (2010). This function suggests the information flow among organisations/companies and other parties are multi-directional. The second function of

social media in OSCM is it performs as a source of user generated content (UGC), which provides opportunities for UGC mining. This is in line with the recent literature stream in "big data" analytics in OSCM (e.g. Choi et al., 2018; Wang et al.,2016). The third function in OSCM is the function of traditional media which is the information broadcasting and dissemination, as social media is still a type of media by its nature. Compared with the first function, the information flow between organisations/companies and other parties triggered by the second and third function is unidirectional. Based on the information flow directions, the three functions are then abbreviated as "**MULTI**","**IN**" and "**OUT**", respectively, and are indicated in figure 5.

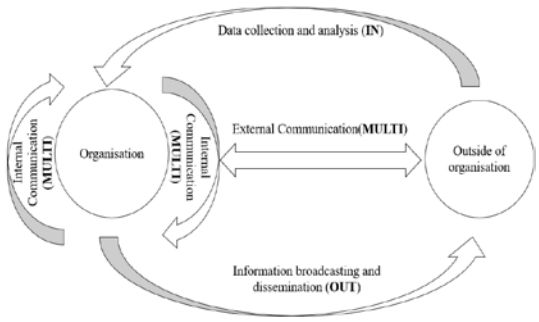


Figure 5: Social media functions in OSCM

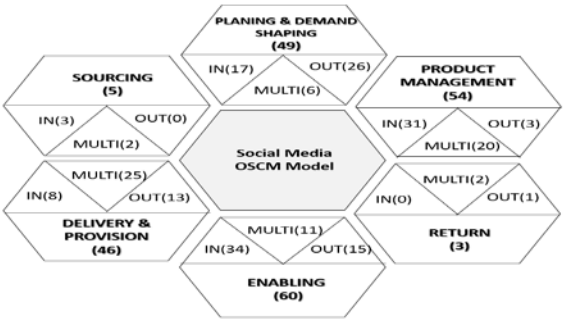


Figure 6: A Social Media OSCM model

Based on the two dimensions described above, in Figure 6 a *Social Media OSCM* model is built by combining the social media functional dimension and the OSCM activity dimension. This model depicts that the OSCM activities related to social media can be specifically categorised into the six adjusted constructs. Within the model the number of relevant papers is shown. However, it must be noted that as social media research in OSCM is in its infancy, more elements can be added into this framework to enrich the functions and activities in social media and OSCM interaction. Figure 8 shows that Enabling and Product Management are the most researched areas, and particularly in terms of information flowing in to an organisation. Planning & Demand Shaping and Delivery & Provision are also well researched, but focus on information flows into and out of an organisation. However, only in the latter of these were the two directions connected to form an interactive flow.

6. An agenda for future research

6.1 Social media in sourcing and procurement

The literature review identified just five articles considering the value of social media in sourcing and procurement management. From the limited research on social media in sourcing and procurement, at least two research directions can be identified. First, using social media as a tool to select suppliers and evaluate suppliers' performance needs to be further explored. The articles of O'Leary (2011) and Lin et al. (2017) reveal that as social media contains rich information, supplier performance evaluation based on social media data can supplement traditional qualitative supplier selection decision making. Another pertinent direction could consider social media's function in supplier relationship management. As Irani et al. (2017) show, creating communities between companies and their suppliers can facilitate communication and reduce supply risk. However, as the conceptual and empirical research on social media in supplier relationship management is highly limited, this topic needs further exploration to fully demonstrate the power of social media in supplier relationship management.

6.2 Social media and product returns

Only three papers explicitly suggest the potential for social media to directly facilitate product returns (Orenstein et al., 2016; Irani et al., 2017; Bhattacharjya et al., 2016). Therefore, it may be a promising research direction to explore how social media can enhance the product return activities from both conceptual and empirical perspectives. Based on the strength of social media, two possible

connections between social media and product return can be estimated. On the one hand, as social media is a communication channel, companies can use social media to communicate with customers to gain timely and rich information about the status of product defect and estimate the potential risks of such defect. For regular product returns, companies can gain feedback of customers from social media about the process of product return to improve the efficiency of return operations. On the other hand, for defect product recalls, companies can discover the defective products from social media information and build an initial recall policy based on such information. Companies can even involve customers in recall policy making to "co-create" the return policy.

6.3 Social media influence on inventory control and bullwhip effect

Although there are many papers exploring the usage of social media information on demand forecasting and inventory management (e.g. O'Leary, 2011; Cui et al., 2017), there are few papers linking the forecasting power of social media to inventory control and replenishment decisions. Three exceptions are Choi (2018), Hoffman (2017), and Wood et al. (2017), but their research is still in its infancy. One of the most important topics in inventory control is bullwhip effect elimination. Hoffman (2017) and Wood et al. (2017) both suggested the value of social media information on eliminating bullwhip effect. They stated that as social media information, specifically customers' sentiment information, can be used to sense market better and faster and support better replenishment decisions, in which case social media can facilitate to mitigate bullwhip effect. However, there are many characteristics of social media such as social media data quality, social media influence on bounded rationality etc. (Choi 2018), but as yet these have not been considered. As a result, the relationship between social media and bullwhip effect merits further investigation.

7. Conclusion

This paper advances current literature by reviewing existing social media usage in OSCM. By systematically linking social media with different supply chain and operations activities, this article provides a framework to support future research. Additionally, this paper highlights the methods of investigating social media usage in OSCM, offering a toolkit for the future scholars who are interested in this area. Further, this paper can provide managers and practitioners with guidance about how to transfer social media value into their OSCM, rather than only use social media in marketing or branding. This can also provide helpful guidelines for them to build social media capabilities.

Reference

- Aral, S., Dellarocas, C. and Godes, D. (2013), 'Introduction to the special issue—social media and business transformation: a framework for research', *Information Systems Research*, Vol.24, pp.3-13.
- Baltacioglu, T., Ada, E., Kaplan, M.D., Yurt And, O. and Cem Kaplan, Y. (2007), 'A new framework for service supply chains', *Service Industries Journal*, Vol.27, pp.105-124.
- Bhattacharjya, J., Ellison, A. and Tripathi, S. (2016), 'An exploration of logistics-related customer service provision on Twitter: The case of e-retailers', *International Journal of Physical Distribution & Logistics Management*, Vol.46, pp.659-680.
- Bollen, J., Mao, H. and Zeng, X. (2011), 'Twitter mood predicts the stock market', *Journal of Computational Science*, Vol.2, pp.1-8.
- Chae, B.K. (2015), 'Insights from hashtag# supplychain and Twitter Analytics: Considering Twitter and Twitter data for supply chain practice and research', *International Journal of Production Economics*, Vol.165, pp.247-259.
- Chan, H.K., Wang, X., Lacka, E. and Zhang, M. (2016), 'A Mixed-Method Approach to Extracting the Value of Social Media Data', *Production and Operations Management*, Vol.25, pp.568-583.
- Choi, T.M. (2018), 'Incorporating social media observations and bounded rationality into fashion quick response supply chains in the big data era', *Transportation Research Part E: Logistics and Transportation Review*, Vol.114, pp.386-397.

- Choi, T.M., Wallace, S.W. and Wang, Y. (2018), 'Big Data Analytics in Operations Management', *Production and Operations Management,* in press, pp.1-16.
- Cooper, M.C., Lambert, D.M. and Pagh, J.D. (1997), 'Supply chain management: more than a new name for logistics', *International Journal of Logistics Management*, Vol. 8, pp.1-14.
- Cui, R., Gallino, S., Moreno, A. and Zhang, D.J. (2017), 'The operational value of social media information', *Production and Operations Management,* in press, pp.1-12.
- Denyer, D., Tranfield, D. (2009), '*Producing a Systematic Review',* Sage Publications Ltd, London, England.
- Ellram, L.M., Tate, W.L. and Billington, C. (2004), 'Understanding and managing the services supply chain', *Journal of Supply Chain Management*, Vol. 40, pp.17-32.
- Fan, Y. and Niu, R.H. (2016), 'To tweet or not to tweet? Exploring the effectiveness of service recovery strategies using social media', *International Journal of Operations & Production Management*, Vol. 36, pp.1014-1036.
- Hofmann, E. (2017), 'Big data and supply chain decisions: the impact of volume, variety and velocity properties on the bullwhip effect', *International Journal of Production Research*, Vol. 55, pp.5108-5126.
- Irani, Z., Sharif, A.M., Papadopoulos, T. and Love, P.E. (2017), 'Social media and Web 2.0 for knowledge sharing in product design', *Production Planning & Control*, Vol. 28, pp.1047-1065.
- Jafari, H., Nyberg, A., Osnes, T.L. and Schmitz, A. (2015), 'Customization in bicycle retailing', *Journal of Retailing and Consumer Services*, Vol. 23, pp.77-90.
- Kaplan, A.M. and Haenlein, M. (2010), 'Users of the world, unite! The challenges and opportunities of Social Media', *Business Horizons*, Vol. 53, pp.59-68.
- Kaplan, A.M. and Haenlein, M. (2011), 'Two hearts in three-quarter time: How to waltz the social media/viral marketing dance', *Business Horizons*, Vol. 54, pp.253-263.
- Kietzmann, J.H., Hermkens, K., McCarthy, I.P. and Silvestre, B.S. (2011), 'Social media? Get serious! Understanding the functional building blocks of social media', *Business horizons*, Vol. 54, pp.241-251.
- Lau, R.Y.K., Zhang, W. and Xu, W. (2017), 'Parallel Aspect-oriented Sentiment Analysis for Sales Forecasting with Big Data', *Production and Operations Management,* in press, pp.1-12.
- Leonardi, P.M., Huysman, M. and Steinfield, C. (2013), 'Enterprise social media: Definition, history, and prospects for the study of social technologies in organizations'. *Journal of Computer-Mediated Communication*, Vol. 19, pp.1-19.
- Lin, K.P., Hung, K.C., Lin, Y.T. and Hsieh, Y.H. (2017), 'Green Suppliers Performance Evaluation in Belt and Road Using Fuzzy Weighted Average with Social Media Information', *Sustainability*, Vol. 10, p.5.
- Melnyk, S.A., Flynn, B.B. and Awaysheh, A. (2018), 'The best of times and the worst of times: empirical operations and supply chain management research', *International Journal of Production Research*, Vol. 56*,* pp.164-192.
- Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zacharia, Z.G. (2001), 'Defining supply chain management', *Journal of Business Logistics*, Vol. 22, pp.1-25.
- Natoli, P. (2013), 'The Impact of Social Media on the Supply Chain: Is There One?', https://blog.jda.com/the-impact-of-social-media-on-the-supply-chain-is-there-one/ [Accessed: 19 April 2018].
- O'leary, D.E. (2011), 'The use of social media in the supply chain: Survey and extensions', *Intelligent Systems in Accounting, Finance and Management*, Vol. 18, pp.121-144.
- Orenstein, P., Ladik, D. and Rainford, S., 2016. 'What are the key drivers of future Supply Chains?', *Journal of Accounting, Business & Management*, Vol. 23, pp.31-40.
- Slack, N., Chambers, S. and Johnston, R. (2010), '*Operations management'*, Pearson Education.
- Sodero, A.C. and Rabinovich, E. (2017), 'Demand and Revenue Management of Deteriorating Inventory on the Internet: An Empirical Study of Flash Sales Markets', *Journal of Business Logistics*, Vol. 38 pp.170-183.

- Sterne, J. (2010), '*Social media metrics: How to measure and optimize your marketing investment'*, John Wiley & Sons.
- Supply Chain Council, (2014), 'Supply-chain operations reference-model', *Overview of SCOR version 11.*
- Wang, G., Gunasekaran, A., Ngai, E.W. and Papadopoulos, T. (2016), 'Big data analytics in logistics and supply chain management: Certain investigations for research and applications', International Journal of Production Economics, Vol. 176, pp.98-110.
- Wood, L.C., Reiners, T. and Srivastava, H.S. (2017), 'Think exogenous to excel: alternative supply chain data to improve transparency and decisions', *International Journal of Logistics Research and Applications*, Vol. 20, pp.426-443.

DEVELOPMENT OF A MATURITY MODEL TO ASSESS SUPPLIER RELATIONSHIP MANAGEMENT (SRM) PRACTICES IN EGYPTIAN FOOD PROCESSING SECTOR

Lobna A. Hafez[1] and Shunmugham G. Pandian[2]
[1]College of International Transport and Logistics, Arab Academy for Science, Technology and Maritime Transport, Egypt
[2]Postgraduate School of Management, Plymouth Business School, Plymouth University, UK

Introduction

Supplier Relationship Management (SRM) is a business process that provides a structure for relationships between buyer and suppliers and indicates how these relationships will be developed and maintained (Lambert and Schwieterman, 2012). SRM is one of the capabilities that a firm need to achieve competitive advantage in today's fast paced business environment (Forkmann *et al.*, 2016).The effect of SRM practices have proven on different operational performance measures, including quality performance, delivery, flexibility and cost performance (Prajogo *et al.*, 2012). Relationships with suppliers exist with different maturity levels and the level of maturity determines the extent of benefits that a firm can achieve.

The food processing sector in Egypt is the least affected by the economic changes due to the wide base of consumption. This sector has attracted global players, who, with their improved supply chain management practices, are aiming to expand their presence in the Egyptian market. The local producers face severe competition with the arrival of global players in Egyptian food processing sector. Therefore, local food producers find it increasingly difficult to survive this competition unless they recognise that the supply chain collaboration is a core strategy, and develop adequate supplier management strategies and continuously follow up and monitor their supplier performance.

Literature Review

Supplier Relationship Management

SRM, over the decades, has been viewed in different ways. In the 1960s it was a traditional relationship, then a logistics relationship in the 1980s, then it developed into a partnership relationship in the 1990s (Imanipour, Rahimi and Akhondi, 2012).

Different types of buyer supplier relationships were identified by several authors (Cox, 1996; Robert, John Jr. and Niklas, 1998; Trent, 2005), the latest was the one introduced by Rahimi *et al.* (2008) which is described in the following table.

Transactional	Short-term relationship Allocating limited resources to supplier Simple buy-sell relationship Change supplier easily Local suppliers Standard commodities No need for innovation Stability of demand Lack of tendency to investment
Friendly	Suppliers depend on buyers Multi suppliers for every product High competition between suppliers Necessity of high-ranked engineering experiences

Business partnership	Buyers depend on suppliers Development of supplier's competition power by buyer High level value of buying High level creativity of supplier Supplier's technology ownership High-ranked bargaining power of supplier Variety of supplier's product
Familiar	1. Long-term relationship 2. Buyer's investment on supplier's innovation 3. Powerful joint venture with supplier 4. Development of supplier's technical skills by buyer 5. High level of purchasing value 6. International suppliers 7. R&D planning for suppliers 8. Complex commodity's production 9. High competition power of suppliers 10. Extensive cost of changing supplier 11. Product development planning 12. Limited number of suppliers

Table 1: Types of buyer supplier relationships (Rahimi et al., 2008)

Supplier Relationship Management Practices

Various aspects of managing relationships with suppliers have been identified in the literature. Bemelmans et al. (2012) identified some aspects that are important in determining the effectiveness of buyer supplier relationship (BSR). Those aspects included optimisation of supply base in terms of number and quality, managing supplier relationships, integrating supplier into operational and value creation process and finally developing suppliers.

Kumar and Rahman (2016) argued that sustainable BSRs include three tasks: supplier selection, supplier development and supplier performance review.

Kam and Lai (2018)investigated the factors that can affect BSRs and he listed them as the use of contracts, transaction specific investment, trust, cooperative norms, social bonds, long term orientation and information quality.

Other SRM variables are commitment, cooperation, dependence/power, communication, functional conflict, shared values/mutual goals, relationship termination costs, and opportunistic behaviour (Chen, Smith and Thomchick, 2017) .

Maturity Models

Maturity models, also known as stages of growth models, stage models, and stage theories, are used by different industries and disciplines to measure the level of sophistication of their organisational processes and facilitate the implementation of the best practices (Cienfuegos, 2013).

A maturity model can be defined as a staged structure of maturity levels, which defines the extent to which a specific process is defined, managed, measured, controlled and/or effective, assuming the organization develops and adopts new processes and practices, from which it learns, optimizes and moves on to the next level, until the desired level is reached. Thus, are enlisted the following objectives of the maturity models: (1) to measure the maturity of the process under consideration, i.e. assign a level to the existing process; (2) to compare the maturity of an organization to other organizations and with best practices; and (3) to provide a mechanism of learning to improve the maturity level (Randeree, Mahal and Narwani, 2012).

Supplier Management Group in 2008 developed an SRM maturity model. The model is intended to assist companies, regardless of industry, through providing methods for assessing and developing

capabilities that enhance an organization's ability to manage its suppliers successfully, consistently and predictably in order to accomplish the mission of the organization and improve organizational effectiveness. The model measures five categories; spend visibility, supplier segmentation, collaboration, performance and risk management across five levels of maturity: limited, need identified, implemented, utilized and leveraged (Birmingham, 2008).

Bemelmans *et al.* (2012) developed a maturity model to assess the BSRs in the Dutch construction industry. The model assessed the maturity level of five constructs which are optimizing supply base, managing supplier relationships, integrating suppliers into operational process, integrating suppliers into value creation process and developing suppliers. These aspects were measured though four levels of maturity identified as: project level, regional level, business level and corporate level.

Another maturity model designed to assess the SRM in the construction industry was the one developed by Zhang et al. (2010). The model measures six categories: trust, objective, cooperation, risk allocation, capability of communication and procuring across four level of maturity: traditional rivalry, limited partnership, short term cooperation relationship, long term cooperation relationship.

PricewaterhouseCoopers (PwC) introduced a maturity model in 2013, the model that measures seven categories: strategy and governance, structure, processes, people, technology, performance management and risk management. They identified four different levels of maturity which are No SRM, Exploring, Established and World Class SRM (PwC, 2013).

Through comparing the four models, it was possible to detect the following areas and indicators of high levels of SRM maturity.

Areas of Maturity	**Indicators of High Maturity Levels**
Spend visibility	Aligns with enterprise strategy Insight into total cost of ownership
Supplier Segmentation	Drives behaviour of sourcing organization
Collaboration	Continuous improvement efforts Advanced relationship
Performance	Recognition program in place 360 evaluations
Risk management	Monitor supply chain risk status and contingency plans.
Strategy and Governance	Full focus on value creation SRM strategy fully integrated with business strategies
Process	SRM process fully integrated Partnership strategy jointly defined and managed
Structure	SRM through centralized SRM office with SRM roles and responsibilities
People	All SRM stakeholders have deep SRM competences and there is tailored SRM training
Technology	Real time exchange of operational, tactical and strategic information
Performance management	Performance measures are jointly developed with suppliers and cover all SRM aspects
Risk management	Full visibility on relevant risks Mitigation approach developed with suppliers
Optimize supply base	Differentiated commodity/product group strategies in place to optimize the supplier base and to maximize performance with the correct number and correct suppliers.
Manage Supplier relationships	There is a formal alignment of mutual future plans on technologies, objectives, and strategies.

	Complete openness to share future product and technology information.
Integrating suppliers into the operational process	Information systems allow information sharing across the full supply chain with multiple tier suppliers and clients. Cross-organizational supply chain benchmarking resulting in permanent improvement programs
Integrate suppliers into value creation process	Preferred supplier lists are available per product group, supported by worldwide searches, continuous industry monitoring, and joint technology roadmap discussions.
Develop suppliers	Supplier assessment and joint/mutual trainings are organized to learn in two directions and to establish common improvement programs (with targets and follow-up). Trained and dedicated personnel are accessible for supplier quality and development.
Trust	Emphasize and build the high trust mechanism and mutual assistance mechanism
Objective	Goals are consistent not only in a single project, but also in the process of long-term cooperation
Cooperation	Both sides play their roles actively, and maintain close cooperation and exchanges to promote their cooperative performances through mutual learning and innovation
Risk allocation	Establish fair and reasonable profit-sharing and risk-allocation mechanism
Capability of communication	Close relationships with suppliers Deep sharing and cooperation in the aspect of information resource, seek ways to solve problems.
Procuring	Deep sharing and cooperation in the aspect of material resource

Table 2: Indicators of SRM maturity

Problem

Supplier relationship management is an area of immense importance in supply chain management as it plays an important role in reduction of cost and optimisation of supply chain performance in manufacturing firms. This research is motivated by two gaps. The first is that literature includes relatively few studies on maturity models in the area of supplier relationship management (Birmingham, 2008; Zhang et al., 2010; PwC, 2013). The second gap is most of the studies conducted in this area have focused on investigating the application of SRM practices either in automotive sector(Turnbull, Oliver and wilkinson, 1992; Wang, 2004; Imanipour, Rahimi and Akhondi, 2012; Brandes, Brege and Brehmer, 2013; Imam, Hussain and Raza, 2015) or in construction industry (Jiang, Henneberg and Naudé, 2011; Bemelmans, 2012; Pala *et al.*, 2012; Nikinosheri and Staxang, 2016). Meanwhile, the applicability of SRM in Food processing sector is not clear enough.

This research currently in progress is seeking to fill in these gaps through developing a maturity model to asses SRM practices in the food processing sector in Egypt and answering the following research questions.

RQ 1: What are different practices of supplier relationship management?

RQ 2: How mature are the supplier relationship management practices in the food processing sector in Egypt?

The investigation will be conducted on Egypt's food processing sector. This sector is a very dynamic sector, accounting for five per cent of the country's GDP and averaging a compound annual growth

rate of 12 per cent in the last five years as indicated by the Global Agricultural Information Network (GAIN) in its latest report in 2015.

With the exception of the chilled processed food sector, the food processing industry in Egypt, in contrast to many other countries, is not controlled by a few big players (Vasquez and Mohamed, 2015). The industry is classified based on ownership to publicly owned factories, private factories and jointly owned factories. Domestic food production is dominated by micro, small and medium-sized family owned companies. Only 11 are listed on the stock exchange.

The food processing sector in Egypt is one of the industries that has proven to be immune against economic changes. The food industry enjoyed a good run from 2012 to 2016 as consumer prices did not increase enough to affect the consumption patterns. However, in 2017, the inflation rated for food increased from 14% to 40% which lead consumers to start minimising the amounts of foodstuff consumed (Hafez, 2018).

In a new competitive business environment, the Egyptian food processing companies face challenges on many fronts. These companies now need to concentrate on providing niche filling products rather than using their existing products portfolios. Another issue facing the food industry in Egypt is food safety. Media has been giving considerable coverage to food safety recently due to the increasing number of safety problems in food production and the rejection of food shipments sent to US and EU. The fear of reduction in consumption and the food safety concerns can both be faced through managing supplier relationships which can grant food processing companies an advantage and bring benefits in areas of growth and innovation, sustainability, risk management, product quality, safety and long-term cost (Donnan *et al.*, 2014).

Research work

Proposed SRM maturity model

In the guide issued by the institute of internal auditors (2013), the process of developing a maturity model was explained. Three steps were included in the process starting with determining the purpose of the model then determining the scale and developing the expectation for each component level (Rose, 2013).

The purpose of this model is to compare an organization's existing SRM practices with the best practices, this will be achieved through:

1. Defining key SRM practices
2. evaluate the maturity of the organization's existing SRM practices through the proposed model
3. provide guidance to organizations to improve their application of SRM

Assessment indicators:

Based on the four models reviewed, an integrated framework is currently developed. In this phase, the framework incorporates contents of the reviewed models. In the second phase of this research, focus groups will be conducted including purchasing experts in the food processing sector for the purpose of prioritising the assessment indicators through assigning a relative weight for each of them. Experts can add new contents to the model as well. The content of this framework is the activities and practices that best capture the maturity of buyer supplier relationships.

Supplier selection and optimising supply base: It includes the process the firms undertake to select their supplier and determine their targeted supply base number.

Integrating supplier into operational process: This includes different perspectives of integration between buyer and suppliers which are: technological, supply, information technology, process, logistics, collaboration and lean perspective (Bennett and Klug, 2012).

Governance: This describes the manner in which supplier relationships are managed either formally or on a relational basis.

*Control: T*his indicates the level of control exercised in buyer supplier relationships, which is classified into private control and collective control. Three structural conditions characterize the level of control which are the goal congruence, power asymmetry and justice (Liu *et al.*, 2017).

*Risk management***:** This indicates how the firm identify and deal with supplier related risks before starting any kind of collaboration.

Supplier development: Supplier development was defined as any effort of a buying firm on a supplier to increase the performance and capabilities of the supplier to meet the buying firm's short and /or long-term supply needs (Krause and Ellram, 1997). This indicator will identify the strategies adopted by the buying firms to develop their suppliers.

Spend visibility: Better visibility of supplier spend is a critical requirement for the success of today's supplier management programs. This indicator will assess to what extent is the buying firm is involved in spend analysis of their suppliers.

Structure and People: This will indicate the role and responsibilities of procurement department in managing relationships and the readiness of staff to manage SRM programs.

Performance management: This indicates the process undertaken by firms to measure their supplier performance and KPIs they use whether these were administrative or performance KPIs.

Measurement and Scale:
An assessment tool would be developed that indicates the level of maturity of SRM application in the food processing sector in Egypt. Firms are expected to rate their level of implementation on a scale from 1 to 4 indicating the different levels of maturity. Based on the previously developed models, the four levels of maturity will be as follows: No SRM, Initial SRM, Established SRM and Advanced SRM.

Level 1 "NO SRM": This level indicates that the firm is unaware or is not applying any of the SRM practices.

Level 2 "Initial SRM": This level indicates that the firm is applying some of the SRM practices but in an isolated way.

Level 3 "Established SRM": This level indicates that the firm is applying all of the SRM practices but more integration between practices is still needed.

Level 4 "Advanced SRM": This level indicates that the firm is applying all of the practices in an integrated way which characterise the firm as a world class model.

Conclusion

This paper outlines the development of an SRM maturity model and highlights the area of its implementation. Once this research is complete, it will have both theoretical and practical implications. The maturity model developed in this study will help researchers as it provides a framework that defines the different level of SRM maturity in the food processing sector which was not clearly presented in the literature. Practically, this research will allow purchasing practitioners to assess their SRM practices and direct them to methods of sound implementation of these practices which will eventually affect their whole supply chain performance.

References:

- Bemelmans, joreon (2012) *buyer supplier relationship management in the construction industry*. university of Twente. doi: 10.3990/1.9789036533041.
- Bemelmans, J. *et al.* (2012) 'Assessing Buyer-Supplier Relationship Management: Multiple Case-Study in the Dutch Construction Industry', *Journal of Construction Engineering and Management*, 138(1), pp. 163–176. doi: 10.1061/(ASCE)CO.1943-7862.0000418.
- Bennett, D. and Klug, F. (2012) 'Logistics supplier integration in the automotive industry', *International Journal of Operations & Production Management*, 32(11), pp. 1281–1305. doi: 10.1108/ 01443571211274558.
- Birmingham, P. A. (2008) 'Supplier Relationship Management Maturity Model', in *93rd Annual International Supply Management Conference*. St. Louis: Institute for Supply Management.
- Brandes, O., Brege, S. and Brehmer, P. O. (2013) 'The strategic importance of supplier relationships in the automotive industry', *International Journal of Engineering Business Management*, 5(1), pp. 1–10. doi: 10.5772/56257.
- Chen, M., Smith, P. M. and Thomchick, E. (2017) 'Qualitative insights into buyer – supplier relationship attributes in the U.S. biofuels industry', *Reinforced Plastics*. Elsevier Ltd., 22–23 (December), pp. 1–9. doi: 10.1016/j.ref.2017.09.001.
- Cienfuegos, I. (2013) *Developing a Risk Maturity Model: a comprehensive risk maturity model for Dutch municipalities*. University of Twente. Available at: https://www.utwente.nl/en/bms/pa/upload s/Cienfuegos-Developing a Risk Maturity Model.pdf.
- Cox, A. (1996) 'Relational competence and strategic procurement management towards an entrepreneurial and contractual theory of the firm', *European Journal of Purchasing and Supply Management*, 2(1), pp. 57–70. doi: 10.1016/0969-7012(95)00019-4.
- Donnan, D. *et al.* (2014) *Rethinking Supply in Food and Beverage*. Available at: http://www.atkearney.co.uk/documents/10192/5304443/Rethinking+Supply+in+Food+and+Beverage.pdf/f801e3a7-e9d3-45eb-84c1-f05fb73b736c.
- Forkmann, S. *et al.* (2016) 'Supplier relationship management capability: a qualification and extension', *Industrial Marketing Management*, 57, pp. 185–200. doi: 10.1016/j.indmarman.2016.02.0 03.
- Imam, A., Hussain, N. and Raza, A. (2015) 'Effective Supplier Management in Automobile Industry in Pakistan.pdf', 5(12), pp. 167–177.
- Imanipour, N., Rahimi, M. and Akhondi, N. (2012) 'An Empirical Research on Supplier Relationship Management in Automotive Industry', *International Journal of Business and Management*, 7(9), pp. 85–95. doi: 10.5539/ijbm.v7n9p85.
- Jiang, Z., Henneberg, S. C. and Naudé, P. (2011) 'Supplier relationship management in the construction industry: the effects of trust and dependence', *Journal of Business & Industrial Marketing*, 27(1), pp. 3–15. doi: 10.1108/08858621211188920.
- Kam, B.H. and Lai, M.K. (2018) 'Buyer-supplier exchange relationship: How do exchange partners behave across the relationship life-cycle?', *Transportation Research Part E: Logistics and Transportation Review*. (November 2016), pp. 0-1. doi: 10.1016/j.tre.2017.12.007.
- Kumar, D. and Rahman, Z. (2016) 'Buyer supplier relationship and supply chain sustainability: Empirical study of Indian automobile industry', *Journal of Cleaner Production*. Elsevier Ltd, 131, pp. 8 36–848. doi: 10.1016/j.jclepro.2016.04.007.
- Lambert, D. M. and Schwieterman, M. A. (2012) 'Supplier relationship management as a macro business process', *Supply Chain Management: An International Journal*, 17(3), pp. 337–352. doi: 10.1 108/13598541211227153.
- Liu, Y. *et al.* (2017) 'A diagnostic model of private control and collective control in buyer-supplier relationships', *Industrial Marketing Management*. Elsevier Inc., 63, pp. 116–128. doi: 1 0.1016/j.indm arman.2016.11.003.
- Nikinosheri, R. and Staxang, F. (2016) *Contractor-supplier relationships in the construction industry A case study*. Chalmers univeristy of technology. Available at: http://publications.lib.chalmers.se/recor ds/fulltext/242084/242084.pdf.

- Pala, M. *et al.* (2012) 'Improving Supplier Relationship Management Within the AEC Sector', in *Association of Researchers in Construction Management (ARCOM)*. Edinburgh: Association of researchers in construction management, pp. 707–717. Available at: http://www.scopus.com/inward/record.url?eid=2-s2.0-84892429062&partnerID=40&md5=b666280a60cef7f2031ffc710b147581.
- Prajogo, D. *et al.* (2012) 'The relationship between supplier management and firms operational performance: A multi-dimensional perspective', *International Journal of Production Economics*. Elsevier, 136(1), pp. 123–130. doi: 10.1016/j.ijpe.2011.09.022.
- PwC (2013) *Supplier Relationship Management How key suppliers drive your company's competitive advantage*. Available at: https://www.pwc.nl/nl/assets/documents/pwc-supplier-relationship- mana gement.pdf.
- Rahimi, M. *et al.* (2008) 'SUPPLIER SEGMENTATION IN IRANIAN AUTOMOTIVE INDUSTRY', in *International Conference on Value Chain Sustainability, Logistics and Design*. Turkey. Available at: https://www.researchgate.net/publication/286622775_SUPPLIER_SEGMENTATION_IN_IRANIAN_AUTOMOTIVE_INDUSTRY?_iepl%5BviewId%5D=TDAGUw6520hDdqxrWUdEIpiN&_iepl%5BprofilePublicationItemVariant%5D=default&_iepl%5Bcontexts%5D%5B0%5D=prfpi&_iepl%5BtargetEntityId%5D=.
- Randeree, K., Mahal, A. and Narwani, A. (2012) 'A business continuity management maturity model for the UAE banking sector', *Business Process Management Journal*, 18(3), pp. 472–492. doi: 10.1108 /14637151211232650.
- Robert, E. S., John Jr., W. K. and Niklas, M. (1998) 'An empirical investigation into supply chain management: A perspective on partnerships', *International Journal of Physical Distribution & Logistics Management*, 28(8), pp. 630–650. Available at: http://dx.doi.org.proxy1-bib.sdu.dk:2048/1 0.1108/09600039810247542.
- Rose, J. (2013) 'Selecting, Using, and creating Maturity Models: a tool for assurance and consulting engagements', (July), pp. 1–27. Available at: https://www.iia.org.uk/media/358857/selecting_using_and_creating_maturity_models_a_tool_for_assurance_and_consulting_engagements.pdf.
- Trent, R. J. (2005) 'Why Relationships Matter', *Supply Chain Management Review*, 9(8), pp. 53–59. doi: 10.1080/13632750300507016.
- Turnbull, P., Oliver, N. and wilkinson, barry (1992) 'Buyer- supplier relations in the UK automotive industry- strategic implication of the japanese manufacturing model', *strategic management journal*, 13(2), pp. 159–168. doi: doi:10.1002/smj.4250130207.
- Vasquez, O. and Mohamed, I. (2015) *GAIN report*. Egypt. Available at: https://g ain.fas.usda.gov/Recent GAIN Publications/Food Processing Ingredients_Cairo_Egypt_11-9- 2015.pdf.
- Wang, W. (2004) 'Management of Buyer-Supplier Relationships in the Supply Chain - Case Studies of Automotive and Telecom Supply Chains', pp. 1–270. Available at: https://www.diva-portal.org/smas h/get/diva2:9688/FULLTEXT01.pdf.

COLLABORATION IN THE LAST MILE DELIVERY OF GROCERIES

Emel Aktas[1], Michael Bourlakis[1], Dimitris Zissis[2]
[1]Cranfield University, Cranfield School of Management, Cranfield, MK43 0AL, UK
[2]Athens University of Economics and Business, Department of Management Science and Technology, Athens, 11362, Greece

Abstract

Purpose: Owing to the intense competition in the British grocery retail sector, many large and small retailers offer to their customers, the option to purchase groceries online coupled with a home delivery service. However, this service results in inefficiencies such as low utilisation of vehicles and high operating costs especially when nearby locations are visited by multiple independent retailers' vans within the same time windows (for example 13:00 – 14:00). The aim of this study is to estimate efficiency improvements from collaboration through an innovative idea of micro hubs, which are envisaged to be placed in residential areas and serve 3-mile radius with shared vehicles fulfilling grocery deliveries.

Research Approach: The methods employed comprise Monte Carlo simulation for grocery demand estimation and vehicle routing problem to estimate collaboration in the last mile distribution; this materialises by using empirical data from an online grocery retailer and secondary data synthesised from annual reports of grocery retailers and the Office of National Statistics. Design of experiments is used to test the impact of collaboration among two retailers and the vehicle capacity on the distance reduction and vehicle utilisation.

Findings and Originality: We investigate N17 6 postcode sector covering the areas of Tottenham, South Tottenham, Haringey containing approximately 7,568 households with a population of about 19,968 (2011 census). Our experimental setup includes two vehicle capacities: 10 and 15 orders per route. We find that when two retailers collaborate distance savings are 23% on average, with a standard deviation of 7% under 10 orders / route vehicle capacity. The distance savings rise to 25% on average, with a standard deviation of 9% when the vehicles can deliver 15 orders / route. This difference is significant at alpha = 0.05 for days where any of the retailer has at least 3 orders to deliver in the postcode sector.

Research Impact: We investigate an emerging area of vehicle sharing for the last mile delivery of grocery orders. We find the range for distance savings from collaboration and the circumstances where collaboration does not lead to savings: this happens when a collaborating retailer has very low demand, i.e., one or two orders per day, for home deliveries. Theoretically, collaboration is expected to reduce total distance covered and we show empirically when and by how much it reduces the total distance.

Practical Impact: Our findings inform retailers about likely savings and efficiency increases from collaboration, paving the way for changing mindset around vehicle sharing in the last mile distribution. The competitive nature of the market puts extra pressure on retailers with own vehicle fleets. These results can support policies incentivising vehicle sharing schemes and decoupling the last mile delivery from core grocery retail service provided by UK retailers.

Keywords: Collaboration, Last mile delivery, UK grocery sector, E-commerce, Vehicle routing, Monte Carlo simulation

THE ROLE OF APPLIED THEORY TO DELIVER SAFETY, COMPLIANCE, AIR QUALITY AND COMPETITIVE BENEFITS TO THE UK ROAD FREIGHT TRANSPORT SECTOR

Erica Ballantyne[1] and Graeme Heron[2]
[1]The University of Sheffield, UK
[2]Newcastle University, UK

INTRODUCTION

Operator recognition and compliance schemes are not a new phenomenon, with many such schemes being established during the last decade; each existing scheme is organised slightly differently, principle drivers behind their creation has usually been one or a combination of the following objectives: to address political targets around air quality and sustainability; to improve the operational efficiency and performance of commercial vehicle fleets; to improve road safety and, to adhere to industry best practice standards. The focus of this paper is on two established schemes in the UK.

As economies have evolved and supply chains advanced on a global scale our reliance on road transportation has increased. These demands on the freight transport sector in particular can lead to various degrees of operational inefficiencies that operator recognition schemes seek to improve. However, the benefits of scheme membership are potentially far more reaching than simply short term operational improvements, as inherent in their design, is the possibility to act as interventions to help policymakers achieve longer term impacts around sustainability and air quality targets. In the UK context there exist a number of membership accreditation schemes targeted at vehicle fleet operators including: ECOSTARS; Fleet Operator Recognition Scheme (FORS); Van and Truck Excellence schemes. Whilst these schemes initially developed as being purely for the freight sector, the larger schemes (ECOSTARS and FORS) have since widened their participation to be more inclusive of fleet operators more generally, such as the bus and coach sectors, and licensed taxi firms. Interest in such schemes and their potential benefits is not wholly confined to the UK; there are ECOSTARS schemes operating in various European locations. The EU's Transport Commission's role is to promote mobility that is efficient, safe, secure and environmentally friendly (EU Transport Commission, 2011). ECOSTARS and FORS have their genesis in initiatives such as the Operator Compliance Risk Scores programme (DVSA, 2006), the Sustainable Urban Movement Plan, the Sustainable Urban Goods Logistics Achieved by Regional & Local polices (SUGAR) (Interreg, 2013), as well as the Reward and Recognition Scheme (RECODRIVE) and the Auditing & Certification Scheme (ADVANCE).

Air quality and sustainability are key drivers behind the establishment of industry recognition and compliance schemes, with road freight transport being directly responsible for Particulate Matter (PM), nitrogen dioxide (NO_2), and carbon dioxide (CO_2) emissions leading to poor air quality, especially in urban environments (Dablanc, 2008). With the development of concerns over urban sustainability and air quality, particularly in Western Europe, freight transport has faced increasing criticism. The introduction of some EU legislation (e.g. EU Council Directive 96/62) have imposed specific responsibilities on transport policy makers to implement the necessary measures to ensure compliance with EU limits (Dablanc, 2008). Such legislation has prompted the establishment of Low Emission Zones (LEZs) in major cities and urban conurbations to restrict the most polluting vehicles (freight vehicles are the primary target for LEZ policies) by setting standards according to vehicle age and type (Cruz and Montenon, 2016). The UK government has recently set the goal of achieving >40μg/m^3 annual mean NO_2 in its 43 UK air quality reporting zones by 2021, to address findings from 2015, which revealed that 37 of the 43 pre-established air quality management zones still exceeded the upper thresholds measure of 40μg/m^3 annual mean NO2 limit (DEFRA, 2017).

LITERATURE REVIEW

We posit that antecedent service operations management theory forms the basis of operator recognition schemes, but this has been implicit rather than explicit, thereby stifling the development of the concept

of Transport Total Quality Management, further evidenced by our own search of extant literature across several academic databases. TQM research in a transport context remains both under-developed and elusive, limited to TQM application in public transport systems (Andrle, 1994; Tam and Hui, 1996), service level agreements (Parish, 1997) and transport sector employee job satisfaction (Morrow et al., 2011). Grant (2012) records a possible reason for this situation in that a 'non-unionist' perspective prevails in the freight transport sector as operators being 'for hire' either within an organisation or as an external supplier. Another aspect working against historical adoption of TQM is relative scale; an important factor given the profile of the freight industry in which the majority of operators are classed as Micro, Small or Medium sized enterprises (MSMEs). These MSME's are structurally different from large organisations; they are disadvantaged through restricted horizontal and vertical integration in the ability to 'scale down' quality management systems (Ahire and Golhar, 1996; McAdam, 2000). The wider concept of quality management is centred upon the proactive management and control of dynamic multiple variables (Sousa and Voss, 2002), this suggests that Transport TQM can be a business process improvement framework, offering much potential value to the freight and transport sector where continuous improvement cycles can offer more comprehensive quality management regulation through driving innovation rather than imitation.

Ebrahimi and Sadeghi's (2013) argue that TQM represents an integrated management philosophy, whereby quality is mandatory in meeting customer expectations through retaining customer focus (Sousa and Voss, 2002; Kaynak, 2003; Asif et al., 2013; Coimbra, 2013; Oakland, 2014). Meanwhile, Kumar *et al*. (2009) record that the multidimensional aspects of TQM indicating its ability to be 'cherry picked' for application by small businesses, also previously identified in the research of Parish (1997). This concept of a customised performance management approach is further developed by Ates *et al* (2013) as an iterative closed-loop process. Therefore, TQM can be viewed from differing perspectives in relation to corporate culture (Dahlgaard, et al., 1998), cycles of continuous improvement (Hellsten and Klefsjo, 2000), and as an overarching paradigm (Besterfield et al., 2008), to ultimately improve continuously to satisfy customer demands (Deepika, et al., 2016). This culture of continuous improvement in relation to the value of customers requires a rolling programme of development for colleagues (Al-Bourini, et al., 2013), indicating that service quality satisfies demands and expectations for both internal and external customers. The transport sector as a service provider has definable service measures related to time, destination, quality of shipment upon receipt and driver / vehicle performance regarded as a totality of features by Islam and Zunder (2014). TQM remains a paradigm of objective intentions to improve customer service (Karuppusami and Gandhinathan, 2006), contemporaneously delivering competitive advantage (Reed et al., 2000), reinforcing our proposition that a Transport TQM framework can offer significant benefit to the sector.

An overview of the two identified Operator Schemes

The Freight Operator Recognition Scheme (FORS) was initially established in 2008 by Transport for London (TfL) in response to the introduction of London's Urban Low Emission Zone. The original FORS scheme under TfL was a free, voluntary accreditation membership scheme that aimed to improve the delivery of freight across central London, where it formed part of the wider London Freight Plan, providing the freight industry with a quality and performance benchmark (TFL, 2010). The TfL funding and subsidy for the FORS scheme came to an end in 2014/15, at which point it was transferred out of TfL to become the commercially operated Fleet Operator Recognition Scheme (still known as FORS). Although no longer a free scheme, it remains voluntary and the benefits of FORS have been made more available to a wider population of fleet and freight operators following its re-launch on a national scale across the UK, and extension of the scheme to include coach and van operators. The FORS scheme still aims to assist vehicle fleet operators improve all aspects of their operations, including inter alia, road safety, fuel efficiency, reduce emissions, and cut costs. Fleet operators can apply for FORS accreditation on three levels – Bronze, Silver and Gold, following a formal company audit of the operator's premises by an independent FORS auditor.

The ECOSTARS scheme was established in 2009, set up by four local authorities in South Yorkshire

(Barnsley, Doncaster, Sheffield, and Rotherham) as part of a regional Air Quality Initiative to promote best practice in fleet operations and improved engagement between local/regional governments and commercial fleet operators (Fioretto, 2014). Unlike FORS, the ECO Stars scheme continues to remain free for operators to join and aims to help them improve efficiency, reduce fuel consumption and emissions, and achieve cost savings (ECOSTARS, 2016). Like FORS, ECOSTARS has also expanded in the UK beyond the South Yorkshire region, and has been adopted by numerous local authorities across the UK including extensively take-up throughout Scotland, and migrating to some European cities as a mechanism to help address their air quality issues. The scheme is open to fleet operators of HGVs, buses, coaches, vans or taxis either based or operating in an area with a local ECOSTARS scheme. The ECOSTARS accreditation process involves an initial assessment against six key pillars of fleet operational efficiency. Depending on each assessed operators current operational and environmental performance, a star rating (ranging from 1 star to 5 stars) is awarded.

We acknowledge that there are other recognition schemes in the UK such as the Freight Transport Association's 'Truck Excellence' and 'Van Excellence'. The Truck Excellence certification scheme audits an operator's compliance with their Operator licence undertakings. Similarly, Van Excellence is designed to allow operators to ensure their standards of operation meet the best practice requirements determined in the Van Excellence Code, which we believe represents a local derivation of the previously identified Sustainable Urban Goods Logistics Achieved by Regional & Local polices. The FTA schemes can also arguably demonstrate the development of a scheme by a professional body that has adopted what the industry deemed to be the 'prime cuts' of the previously mentioned EU initiatives and the original TfL FORS scheme prior to its nationwide adaptation.

RESEARCH APPROACH

We conducted a comparative analysis of two major recognition schemes in the UK. The research approach has incorporated an industry survey and qualitative interviews which has led to the ongoing development of a multi-criteria decision analysis tool. Purposive sampling was utilised from the outset (Easterby-Smith *et al*., 2015), commencing with an examination of scheme membership across a fixed period of time. Both operational and strategic roles were identified for participation in the research; they are of equal and critical importance, especially in relation to emerging phenomena, and the role of tacit knowledge in scheme adoption in relation to scale. The findings presented in this paper are drawn from current, lapsed and aspiring scheme members, scheme administrators, local authority policy makers and other stakeholders. This selection of current, lapsed and aspiring scheme members was driven by the need to comprehend 'same but different' operations in the freight sectors, whereby a comparative analysis allowed comprehension of to what extent advantage, if any, is gained in scheme membership. Initial data collection occurred via an autonomous self-administered questionnaire which was sent electronically to both current and past recognition scheme members, as well as to a wider population of freight transport operators (some of which were not a member of any scheme). To a certain extent the survey represents a repeat experiment of the Transport for London Report: Attitudes to TfL's Freight Operator Recognition Scheme, however the original questions posed were de-constructed and reposed to give greater contextual and contemporary relevance to the respondents, to capture both views on historical and future attitudes (Piecyk and McKinnon, 2010). Further questions were also added with respect to exploring the role of such schemes in facilitating Transport TQM; operator views on the perceived benefits and disadvantages of freight fleet operator schemes; and questions to help determine potential areas for scheme improvements and recommendations for increasing uptake.

The semi-structured interviews were based on *a priori* themes extracted from academic and grey literatures and was used to supplement the quantitative survey data, to allow recording of particular occurrences, phenomena and underlying constructs (Jonsen and Jehn, 2009) in relation to the different schemes. The semi-structured interview approach, is an essential source of information gathering for rich, textual data in case studies (Yin, 2014; Silverman, 2004), in conjunction with an interview guide informed by our literature research, it enabled our research to explore relevant topics whilst not conforming to a rigid set of questions (Easterby-Smith, et al., 2015).

Given our analysis, we reasonably presuppose that compliance schemes are more valuable tools as a locus across sustainability agendas and delivered in partnership for wider stakeholder good; to proffer for, rather than profit from. This further positions the importance and potential benefits of Transport Total Quality Management, based upon the preponderance of our evidence as a theoretical position requiring further research. TTQM involves the commoditisation of both autonomously generated data and implicit organisational skills to the overall benefit of customers, be they private or as regulatory bodies. TTQM is not negatively influenced by scale, but improved upon by skill recognition and data optimization. Additionally, our research findings reveal that a 'one size fits all's policy' of one scheme works against innovation and continuous improvement. Industry interests are not practically addressed at both extremes of scale, here, a homogeneous approach does little more than deliver imitation rather than the innovative approaches required to improve customer satisfaction. TTQM becomes more valuable in relation to scale, when framed within structured continuous improvements, responding to internal and external customer feedback in a quality management system. Our research therefore suggests that TTQM as a construct and theory development, depends upon all colleagues in a transport operational agency, whether publicly or privately owned, to advance incrementally and sustainably, with due consideration of all stakeholders via a series of measurements and initiatives.

CONCLUSIONS

There is competition for members across these two schemes. Although there is no limit of number of schemes an operator can join, there is often an economic limit set by organisations regarding affordability of membership of multiple schemes and potential conflicting levels of accreditation etc.

The different EU schemes aforementioned have been fixed term, time defined and financially determined projects. However, these incremental steps forward in the evolution of transport, under the auspices and sponsorship of the European Commission can arguably be positioned within TQM itself based upon a cumulative set of improvement measures. Nevertheless, the level of disconnection between each scheme given the various lead project institutions has worked against the emergence of a Transport TQM approach to longer-term success. This research goes some way in addressing these shortfalls by revealing both the barriers to, and opportunities offered by operator recognition schemes to address organisational sub-optimisation. With respect to one scheme there is a majority view amongst interviewees and survey respondents that there is a lack of consultation regardless of the scale of member organisations. An analysis of the Governance and Standards Advisory Group, set up to monitor operational compliance with the scheme's standards reveals a lack of sector representativeness; consultation itself is meaningless unless it is in conjunction with a range of members who are representative across the scheme's membership scale and profiles. The arbitrary nature of scheme amendments also adds to the feelings of member disenfranchisement. Notwithstanding these factors, a member profile with high levels of satisfaction did emerge; medium sized enterprises who were mainly involved in day work in support of major civil engineering projects.

Geographical saturation of schemes is not a necessity for success with regards to environmental benefits; the nature of freight transport operations is that vehicles and operators within a membership accreditation scheme frequently cross geographical boundaries regardless of any schemes in place, thus spreading the reach and impact brought about by scheme membership (e.g. cleaner vehicles, fuel efficient and safe driving practices etc.) and disseminated beyond any regional boundaries. We have identified synergies between these schemes and the American SmartWay (2017) scheme, where it is anticipated that operational and environmental benefits will be achieved on a greater scale as trucks travel across state boundaries, whereby fixed and determined geo-spatiality can be seen as a scheme attribute rather than deserts between scheme fixed areas. Whilst there is some operational cost associated with becoming a member of a voluntary operator recognition scheme, membership has the potential to be a win-win for both operators and policy makers. With operators seeking to improve efficiency and promote best practice; whilst policy makers are tasked with achieving reductions in emissions and addressing sustainability targets. It comes down to getting the right balance so that a natural settlement occurs which reflects the needs of operators and stakeholders.

Given our findings, we reasonably presuppose that compliance schemes are more valuable tools as a locus across sustainability agendas and delivered in partnership for wider stakeholder good. This further positions the importance and potential benefits of Transport Total Quality Management, based upon the preponderance of our evidence as a theoretical position requiring further research. TTQM involves the commoditisation of both autonomously generated data and implicit organisational skills to the overall benefit of customers, be they private or as regulatory bodies. TTQM is not negatively influenced by scale, but improved upon by skill recognition and data optimization. Additionally, our research reveals that a 'one size fits all's policy' of one scheme works against innovation and continuous improvement. Industry interests are not practically addressed at both extremes of scale, here, a homogeneous approach does little more than deliver imitation rather than the innovative approaches required to improve customer satisfaction. To this end, there are alternative government funded schemes which create more value of shared data and performance indicators, leading to 'earned recognition', positive profiling and less likelihood of being stopped and inspected by vehicle and operator inspection agencies such as VOSA in the United Kingdom. These relatively low-cost schemes can autonomously generate performance data on a periodic basis to 'report upon' therefore indicating that these extensible enterprise data sets provide more value in real terms to an organisation than commercial schemes, in which many memberships are at the first or introductory level, that has been sought to satisfy customer and project requirements. TTQM becomes more valuable in relation to scale, when framed within structured continuous improvements, responding to internal and external customer feedback in a quality management system. Our research therefore suggests that TTQM as a construct and theory development, depends upon all colleagues in a transport operational agency, whether publicly or privately owned, to advance incrementally and sustainably, with due consideration of all stakeholders via a series of measurements and initiatives.

REFERENCES

- *Ahire, S.L. and Golhar, D.Y., (1996) "Quality management in large vs small firms". Journal of Small Business Management, 34(2), p.1.*
- *Al-Bourini, F., Al-Abdallah, G. and Abou-Moghli, A. (2013) "Organizational Culture and Total Quality Management (TQM)". International Journal of Business and Management, 8(24), pp. 95-106.*
- *Andrle, S.J. (1994) "Total Quality Management in Public Transportation". Research Results Digest #3 of the Federal Transit Administration's Transit Cooperative Research Program. National Research Council, USA*
- *Asif, M. and Gouthier, M.H., (2014) "What service excellence can learn from business excellence models". Total Quality Management & Business Excellence, 25(5-6), 511-531.*
- *Ates, A., Garengo, P., Cocca, P. and Bititci, U., (2013) "The development of SME managerial practice for effective performance management". Journal of Small Business and Enterprise Development, 20(1), pp.28-54.*
- *Besterfield, D. H., Michna, C. B., Besterfield, G.H. and Sacre, M. B. (2008) Total quality management (3rd edn). New Delhi: Pearson Education.*
- *Coimbra, E., (2013) Kaizen in logistics and supply chains. McGraw Hill Professional.*
- *Cruz, C. and Montenon, A. (2016) "Implementation and impacts of low emission zones on freight activities in Europe: Local schemes versus national schemes". Transportation Research Procedia (12), pp.544 – 556.*
- *Dablanc, L. (2008) "Urban goods movement and air quality policy and regulation issues in European Cities", Journal of Environmental Law, 20 (2), pp. 245-266.*
- *Dahlgaard, J.J. and Mi Dahlgaard-Park, S. (2006) "Lean production, six sigma quality, TQM and company culture". The TQM magazine, 18(3), pp.263-281.*
- *Deepika, S., Anandakumar, D. and Krishnamoorthy, D. (2016) "Study on Factors Influencing the TQM Practices and its Consequences". International Journal of Industrial Engineering and Management Science, 6(2), pp. 48-52.*
- *DEFRA (2017) Air quality plan for nitrogen dioxide (NO2) in the UK: setting out the UK's plan for*

reducing roadside nitrogen dioxide concentrations. https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in- uk-2017.

- *Diez, J. and Mohr, R. (2017) "Down to the Wire: Are you ELD-ready?", Food Logistics, 13 Nov 2017, http://www.foodlogistics.com/article/12380804/down-to-the-wire-are-you-eld-ready.*
- *Driver and Vehicle Standards Authority UK (2006) The Operator Compliance Risk Score Scheme. https://www.gov.uk/operator-compliance-risk-score.*
- *European Union Transport Commission (2011) Road Freight Transport Vadenecum: Market Trend & Structureof the Road Haulage Sector in the EU 2010. https://ec.europa.eu/transport/sites/transport/files/modes/road/doc/2010-road-freight-vademecum.pdf.*
- *Easterby-Smith, M., Thorpe, R. and Jackson, P.R., (2015) Management and business research. Sage.*
- *Ebrahimi, M. and Sadeghi, M., (2013) "Quality management and performance: An annotated review". International Journal of Production Research, 51(18), pp.5625-5643.*
- *Hellsten, U. and Klefsjö, B. (2000) "TQM as a management system consisting of values, techniques and tools". The TQM Magazine, 12(4), pp. 238-244.*
- *Islam, Z. D. M., Zunder, T. H. (2014) "The necessity for a new quality standard for freight transport and logistics in Europe", European Transportation Research Review, 6, pp.397-410.*
- *INTEREG (2013) Sustainable Urban Goods logistics Achieved by Regional and local policies. http://www.sugarlogistics.eu/.*
- *Jonsen, K. and Jehn, K.A., (2009) "Using triangulation to validate themes in qualitative studies". Qualitative Research in Organizations and Management: An International Journal, 4(2), 123-150.*
- *Karuppusami, G. & Gandhinathan, R. (2006) "Pareto analysis of critical success factors of total quality management: A literature review and analysis", The TQM Magazine, 18(4), pp. 372- 385.*
- *Kaynak, H., (2003) "The relationship between total quality management practices and their effects on firm performance". Journal of Operations Management, 21(4), pp.405-435.*

- *Oakland, J.S. (2014) Total quality management and operational excellence: text with cases. Routledge.*
- *Parish, R. J. (1997) "Service level agreements as a contributor to TQM goals", Logistics Information Management, 10(6), pp. 284-288.*
- *Piecyk, M.I. and McKinnon, A.C. (2010) "Forecasting the carbon footprint of road freight transport in 2020". International Journal of Production Economics,128(1), 31-42.*
- *SmartWay (2017) 'Learn about SmartWay', United States Environmental Protection Agency, 18 Sept 2017, https://www.epa.gov/smartway/learn-about-smartway*
- *Sousa, R. and Voss, C.A., (2002) "Quality management re-visited: a reflective review and agenda for future research". Journal of Operations Management, 20(1), pp.91-109.*
- *Tam. C.M. and Moses, Y.T. Hui (1996) "Total quality management in a public transport organisation in Hong Kong". International Journal of Project Management Vol. 14, No. 5, pp. 311-315.*
- *TFL (2010) Freight Operator Recognition Scheme. Transport for London.*
- *Yin, R. K. (2014) Case study research: design and methods. 5th edn. Thousand Oaks, Calif.: Sage Publications, Applied social research methods series.*

AN OPTIMISATION BIG DATA ANALYTICS MODEL FOR A MARITIME SUPPLY CHAIN BY USING MULTI-DIMENSIONAL ANALYTICAL (MDA)

Khaled EL-Sakty
Arab Academy for Science and Technology and Maritime Transport, P.Box 2033-Horia, Heliopolis, Cairo, Egypt

Introduction

Seaborne trade constitutes almost 90% of world trade in term of volume and about 80% in term of value. It is linked almost in every international supply chain. Hence, a maritime supply chain is facing a challenge to cope with the vast size of the network that global carriers operate. Regarding the trends in port container traffic in 2016, 701 million Twenty-foot Equivalent Units (TEU) of containers were handled on ports worldwide. Also, 10.3 billion metric tonnes of goods shipped, 1.9 billion dead-weight tonnes constitute the world commercial fleet, and the growth commercial fleet shipping capacity is about +3.1% (UNCTAD, 2017). Leading companies and shipping lines may operate a fleet of more than 500 vessels annually. There is an enormous pressure to fill this capacity of seaborne trade and utilise the efficiency benefits of the world fleet. Operating a liner shipping network is truly a big-data problem. Hence, information are a key success performance indicator of decision makers and the quality of decisions. Industries such as a maritime industry are rich with amounts of data available to be analysed. Different data analytics, tools, models and applications need to be developed and applied in order to handle the value and knowledge of datasets (Elgendy and Elragal, 2016). At ports, managers and authorities need to reach valuable insights from high volume, velocity, variety and value of data using such reliable data analytical approach. Accordingly, data applications play an important role in present and future research applications. Overall, these applications can be divided into two different categories including Database Management (DM) and Data Analytics (DA). This paper aims to discuss the DA concept in a maritime industry. The remaining sections of the paper are as follows: section two displays the available literature of big data and its applications in supply chain and ports, sections three reveals the research work in term of big data measures and dimensions, section four represents the multidimensional data integration with analytics over big data, followed by conclusion.

Literature Review

Big data *The* concept of big data refers to complex sets of data, which exceeds the space of technical ability of storage system, processing, managing, interpreting and visualising of a traditional system. Also, big data can be defined as a study of skills, technologies and practices used to evaluate businesses' strategies (Wang et al., 2016). This has led many companies to develop their big data analytics capabilities. Big data analytics refers to an application of advanced analytic techniques including data mining, statistical analysis and predictive analytics. However, Tiwari et al. (2018) claimed that there is a limited performance of big data that support supply chain. Addo-Tenkorang and Helo (2016) explained five main attributes of big data “5Vs” concept; including volume, velocity, variety, verification/veracity, and value. On the other hand, Wang et al. (2016) classified big data business analytics (BDBA) into two dimensions: big data (BD) and business analytics (BA). BD refers to the ability to process data with the following qualities: velocity, variety, and volume. While, BA refers to the ability to gain insight from data by applying statistics, mathematics, econometrics, simulations, optimisations, or other techniques to help business organisations make better decisions.

Gunther et al. (2017) clarified that big data is based on large *volumes* of extensively *varied* data that are generated, captured and processed at high *velocity*. Gandomi and Haider (2015) identified five main attributes "5Vs" of big data, including big data development sources (variety), big data acquisition (velocity), big data storage (volume), big data analysis (veracity), and big data value-adding benefits to industry (value). These attributed can be displayed in supply chain as follows:

- *Variety;* it refers to big data development sources, including upstream sources, which are the consolidation points, and downstream sources, which are the logistics and distribution sides.
- *Velocity*; it refers to an efficient application of analysing big date for value-adding.
- *Volume*; it refers to an effective management of voluminous data-clusters in order to provide a real-time accessible way.
- *Veracity*; it refers to big data analytical processing tools that provides high capability of achieving veracious data.
- *Value*; it refers to a strategic application of big data for enhancing the flow of data (velocity) and veracity.

Gandomi and Haider (2015) discussed two additional dimensions of big data including *Variability* and *Complexity*. Variability refers to the variation in the data flow rates, while complexity refers to the fact that big data are generated through a myriad of sources. This imposes a critical challenge to connect, match, and transform data received from different sources. On the other hand, Oussous et al. (2017) underlined more attributes for improved define Big Data, including *Vision* (a purpose), *Verification* (processed data conformed to some specifications), *Validation* (the purpose is fulfilled), and *Immutability* (collected and stored Big data can be permanent if well managed). This paper is considering the 5Vs according to Gunther et al. (2017) and Addo-Tenkorang and Helo (2016) as discussed above as they are common attributes in different articles and industries.

Supply Chain Analytics Supply chain analytics are categorised into three main categories (W*ang* et al., 2016) including descriptive, predictive and prescriptive analytics. The descriptive analytics aim at identifying problems and opportunities within existing processes and functions using different tools such as online-analytical process. The predictive analytics aim to project what will happen in the future and why it is happening using such as mathematical algorithms. The prescriptive analytics aim to improve business performance by assessing alternative decisions. Sivarajah et al. (2017) grouped the data analytics into (1) descriptive analytics that scrutinises data and information to define the current state of a business situation, (2) inquisitive analytics that is about probing data to certify/reject business propositions, (3) predictive analytics is concerned with forecasting and statistical modelling to determine the future possibilities, (4) prescriptive analytics that is about optimisation and randomised testing to assess how businesses enhance their service levels, and (5) pre-emptive analytics that is about having the capacity to take precautionary actions on events that may undesirably influence the organisational performance. On the other hand, Wang et al. (2016) clarified that statistical analysis, simulation and optimisation are common techniques in supply chain analytics. However, Tiwari et al. (2018) argued that traditional statistical methods become invalid for mining big data in supply chain analytics, considering volume, velocity, variety and veracity.

Maritime Big data *Different* maritime frameworks of big data have been recently developed. Yang et al. (2018) developed an innovative framework labelled as cooperative cognitive maritime big data systems (CCMBDSs) on the sea. They aimed to provide a more secured communication networks between ports' users. However, their model is limited to small fish boats. In addition, the China Automatic Identification System (AIS) Asia-Pacific Data Centre was established and its network with IALA-Net. The AIS's purpose is to make the worldwide ship data increasingly available. Zhang et al. (2018) proposed an automatic maritime route generation algorithm that takes ship AIS trajectories as input, designed to consume low memory, mitigate AIS noise and disparity, and scale to a large database. Vouros et al. (2018) discussed data sources addressed in the European datAcron project in order to support specific maritime situation. They discussed both data-at-rest (archival data) and data-in-motion (streaming data) sources. The purpose was to improve the capacities of surveillance systems to promote safety and effectiveness of critical operations and forecasting for large numbers of moving entities in large geographical areas. They integrated the heterogeneous data coming from various data sources in order to provide a unified and combined view in maritime.

Multi-dimensional Analytics

Semenov (2008) discussed the Polish maritime transport situation that is facing some problems in term of insufficient competitiveness and low operational flexibility. He started to discuss the obstacles facing the Polish maritime industry and the associated causes. A multidimensional approach was applied where a structuration of collected data about administrative barriers to innovative development of the Polish marine industry was developed, and a multilevel hierarchy of barriers to activity was used.

Research Problem

In a maritime supply chain where operations are characterised by complexity and uncertainty, ports' managers are facing several challenges when exploring Big Data sets and when extracting value and knowledge from such mines of information. The difficulties can be displayed at different levels including data capture, storage, searching, sharing, analysis, management and visualisation (Oussous et al., 2017; Gandomi and Haider, 2015). Hence, this paper has addressed the following problem: *how can ports be more responsive by leveraging the advantages of the big data analytics?*

A Maritime Big Data Model Development

Multidimensional Analytical approach has been applied for a maritime data analysis including two data categories; data dimensions and data measures. Data of ports' operations have been selected for data dimensions. While, big data five attributes were used as data measures including volume, velocity, variety, verification and value. The following part aims to discuss the 5Vs attributes and their measures at ports as shown in Table 1.

Big Data Attributes	Measures	Given Symbols
Variety (V_1)	- Technological advances - Type of data	- t_1 - t_2
Velocity (V_2)	- Data generated rate - Real time analytics	- d_1 - r_1
Volume (V_3)	- Time for gathering data - Data management technology	- t_3 - d_2
Veracity (V_4)	- Analysis tools - Valuable information generation - Management of uncertain data	- a_1 - i_1 - m_1
Value (V_5)	- Analysing large volume of data	- a_2

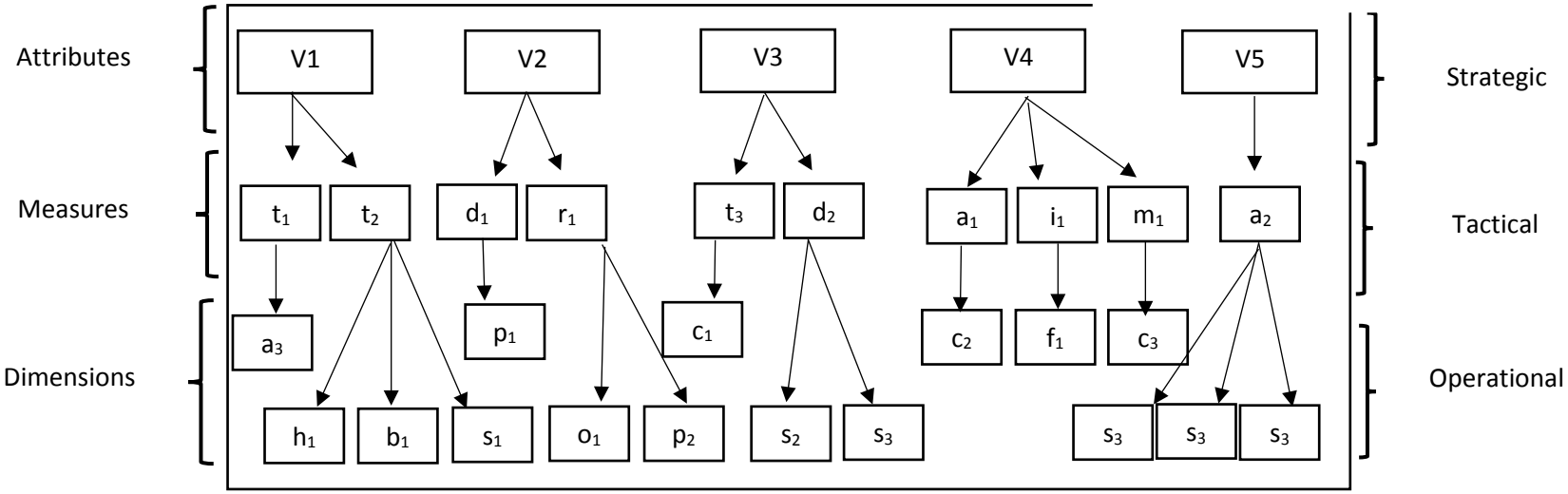
Source: developed by the researcher

Table 1: Measures of Big Data 5Vs Attributes

Data and information in maritime supply chain play indispensable role in quantifying performance and cost of port operations and as a support to decision-making. The virtual and digital flows of information put a huge challenge along with global shipping and carriers (Ducruet, 2017). Regarding the measures of big data 5Vs attributes in ports in Table 1, different dimensions can be founded as follows:

- Technological advances
  - ability to provide cargo tracing (a_3)
  - Type of data dimension
  - high frequency of sailing (h_1)
  - berthing the vessels in ports (b_1)
  - stowage of containers on vessels (s_1).
- Data generated rate
  - prompt response to claim (p_1)
- Real time analytics
- on-time pick-up (o_1)
- routing containers through the physical transportation networks (p_2)

- Time for gathering data
  - courtesy of inquiry (c_1)
- Data management technology
  - ability to provide door-to-door service (s_2)
  - schedule for individual service in ports (s_3)
- Analysis tools
  - good condition of containers (c_2)
- Valuable information
  - good financial condition (f_1)
- Management of uncertain data
  - ability to provide customs clearance service (c_3).
- Analysing large volume of data
  - Port related data (p_3)
  - Vessel related data (v_1)
  - Goods related data (g_1)



Source: developed by the researcher

Figure 1: BIG Data Attributes and Associated Measures and Dimensions in Ports Operations

Most data in maritime industry are associated with some degree of uncertainty. Accordingly, maritime supply chain is facing planning problems and challenges. Focus has been on addressing strategic, tactical and operational problems by modern large-scale optimisation models. Therefore, Figure 1 displays an optimisation big data analytics framework in ports where the 5Vs attributes constitute data required for the strategic level and decision makers at ports, the measures display the tactical level data, while the dimensions refer to the operations data in ports. In ports, the related dimensions and measures of the 5Vs attributes applied in maritime supply chain received from terminals can be used for example to predict delays and help ships adjust sailing speed to save fuel (Lu, 2000; Brouer et al., 2016). Data at terminals can also lead to better predictions of what will happen in the future. However, optimisation within maritime logistics is complicated by the uncertainty and difficult accessibility of data.

Research Results

This paper has addressed three results. First, the optimisation big data analytics framework in ports is developed as big data analytics in order help decision makers identify the value-creating big data sources and the capabilities of the future big data practitioners (see Figure 1). Second, there are many tools of big data such as storage and management, data cleaning, datamining and data analysis. Also, there are various trends of big data including displacement to the cloud, integration with Internet of Things (IoT), and security improvement. Third, big data analytics in maritime is generally facing many challenges in which can be presented in four groups (Nita and Mihailescu, 2017) as follows:

- Security challenges where data are collected and shared by many entities in ports' community.
- Technological challenges in term of difficulties of data integration, analytical tools and flexibility.
- Human resources where there is a lack of specialised persons who handle and analyse data.
- Data governance where data are highly secured.

Multidimensional Data and Analytics

Regarding the challenges discussed above, the developed optimisation big data analytics framework needs to be adopted using big multidimensional data approach. Indeed, multidimensional data represent an add-on value for analytics models and methodologies. Different multidimensional data models can integrate with analytics including multidimensional abstractions, hierarchy-based dimensional tables, multi-resolution fact tables, multi-way aggregations (Cuzzocrea et al., 2011). This integration attains more powerful analytics capable of enhancing the developed framework in this paper. Optimisation, evaluation aspects, advanced decision support tools, building multidimensional data structures, integrating multidimensional sources, developing languages of multidimensional data, and visualisation issues, represent the second-generation big data revolution in the future. Huang et al. (2015) developed a maritime big data management architecture which includes data provision, data preprocessing, data storage, data analysis, and data application as well as quality control and data security. Their architecture aims to enhance integration between multidimensional data with analytics as represented in the following equation. The question raised is *how to achieve an effective integration of multidimensional data models with analytics over big data?* From Figure 1, datasets are divided into several layers according to attributes, measures and dimensions where are stored in clouds. In order to improve the query efficiency on cloud storage, it is essential to assure the optimal utilisation of storage resource and data migration. Things like data sensitivity, data access frequency, data time length, and data size should be fully considered when performing data migration. The migration function can be presented as follows:

$$D\ (V_1, V_2 \ldots, V_n) = \sum_{i=1}^{n} \frac{1}{Ti} \text{ X } \sum_{K=1}^{n} fk \text{ X } \frac{1}{S}$$

Where Ti represents time-length of the ith access of the marine dataset D per attribute V_n, fk represents access frequency of marine dataset D over the period of Tk, and S is the size of marine dataset D. Along with a maritime big data analytics model, the previous migration function supports dynamic data migration in a maritime supply chain, where integration between multidimensional data with analytics can be attained over big data. On the other hand, operations at ports are characterised by complexity and high uncertainty. So, it is essential for turning maritime big data into maritime big value. Information entropy can be applied for this purpose as it is a logarithmic measure of the rate of transfer of information in a particular message or language. Entropy refers to disorder or uncertainty associated with each possible data value. The entropy function is shown as follows:

$$H\ (X) = E\ (I(X))$$

where *H* represents entropy, *E* is the expected big value of data, *I* is the information contents of *X*, and *X* is itself refers to the predefined dimensions of 5Vs attributes in a maritime supply chain.

According to the huge data collected from different sources in a maritime supply chain, the maximum rate at which information can be transmitted over a communication channel can be formulated as follows:

$$C\ (V_1, V_2 \ldots\ldots V_n) = B \log_2 (1+\frac{S}{N})$$

where *C* is the channel capacity of 5Vs dimensions, *B* is the bandwidth, *S* is the average received signal power over the bandwidth, and *N* is the average power of interface over the bandwidth. It is evident that big value of big data in a maritime era requires enablers in order to qualify fact-based decision making, provide local performance monitoring and optimisation, and provide opportunity to explore bigger picture. Various enablers are highly required in maritime supply chain such as increased connectivity, increased cloud storage and computing, and new technologies for capturing, storing and analysing vast amount of data.

Conclusion

In recent years, new concepts and technologies received a wide attention such as big data, data mining, and data migration and data query efficiency. Existing challenges in different fields and industries are presented in term of data storage, data analysis and data security. Big data is not a single technology, technique or initiative rather it is a trend across many areas of businesses.

In a maritime supply chain, there is no doubt that study on maritime big data management is still in the initial stage of development. Hence, optimisation a maritime big data analytics model was the main purpose of this paper. The developed model aims to discover accessible maritime big data, its measures and dimensions, and the possible values that could be obtained from it. It helps to improve ports' strategic, tactical and operational planning. A migration function can be used by ports' authorities and managers to assure the optimal utilisation of data storage resources.

For further and future researches, practical and theoretical challenges in the existence of marine big data management need to be investigated. Future challenges include data dynamic scalability, controllable maritime data size, maritime database consistency, maritime database usability, maritime data analysis algorithms, and quality of maritime big data.

References

- Addo-Tenkorang, R. & Helo, P.T. (2016), 'Big data applications in operations/supply-chain management: A literature review', Computers & Industrial Engineering, vol. 101, pp. 528-543.
- Braganza, A., Brooks, L., Nepelski, D., Ali, M. and Moro, R., (2017), 'Resource management in big data initiatives: Processes and dynamic capabilities'. *Journal of Business Research*, *70*, pp.328-337.
- Brouer, B.D., Karsten, C.V. and Pisinger, D., (2016), 'Big data optimization in maritime logistics'. In *Big data optimization: Recent developments and challenges* (pp. 319-344). Springer, Cham.
- Cuzzocrea, A., Song, I.Y. and Davis, K.C., (2011), 'October. Analytics over large-scale multidimensional data: the big data revolution'. In *Proceedings of the ACM 14th international workshop on Data Warehousing and OLAP* (pp. 101-104). ACM.
- Ducruet, C. ed., (2017), 'Advances in Shipping Data Analysis and Modeling: Tracking and Mapping Maritime Flows in the Age of Big Data'. Routledge.
- Elgendy, N. and Elragal, A., (2016), 'Big data analytics in support of the decision-making process'. *Procedia Computer Science*, *100*, pp.1071-1084.
- Gandomi, A. and Haider, M., (2015), 'Beyond the hype: Big data concepts, methods, and analytics'. *International Journal of Information Management*, *35*(2), pp.137-144.

- Günther, W.A., Rezazade Mehrizi, M.H., Huysman, M. & Feldberg, F. (2017), 'Debating big data: A literature review on realizing value from big data', Journal of Strategic Information Systems, vol. 26, no. 3, pp. 191-209.
- Huang, D., Zhao, D., Wei, L., Wang, Z. & Du, Y. (2015), 'Modeling and Analysis in Marine Big Data: Advances and Challenges', Mathematical Problems in Engineering, vol. 2015, pp. 1-13.
- Lu, C.S., (2000), 'Logistics services in Taiwanese maritime firms'. *Transportation Research Part E: Logistics and Transportation Review*, *36*(2), pp.79-96.
- Nita, S.L. and Mihailescu, M.I., (2017), 'Importance of Big Data in Maritime Transport'. *Scientific Bulletin" Mircea cel Batran" Naval Academy*, *20*(1), p.556.
- Oussous, A., Benjelloun, F.Z., Lahcen, A.A. and Belfkih, S., (2017), 'Big Data technologies: A survey'. *Journal of King Saud University-Computer and Information Sciences*.
- Semenov, I. (2008), 'The multidimensional approach to development strategy of marine industry: Part II. Multifaceted analysis of the development outlook for the polish marine industry'. *Polish Maritime Research* 15, 4, 85-95, Available From: De Gruyter - Sciendo<https://doi.org/10.2478/v10012-008-0001-0> [Accessed 03 June 2018].
- Sivarajah, U., Kamal, M.M., Irani, Z. and Weerakkody, V., (2017), 'Critical analysis of Big Data challenges and analytical methods'. *Journal of Business Research*, *70*, pp.263-286.
- Tiwari, S., Wee, H.M. and Daryanto, Y., (2018), 'Big data analytics in supply chain management between 2010 and 2016: Insights to industries'. *Computers & Industrial Engineering*, *115*, pp.319-330.
- UNCTAD (2017), 'Handbook of Statistics 2017', United Nations.
- Vouros, G.A., Doulkeridis, C., Santipantakis, G. and Vlachou, A., (2018), 'Taming Big Maritime Data to Support Analytics'. In *Information Fusion and Intelligent Geographic Information Systems (IF&IGIS'17)* (pp. 15-27). Springer, Cham.
- Wang, G., Gunasekaran, A., Ngai, E.W.T. & Papadopoulos, T. (2016), 'Big data analytics in logistics and supply chain management: Certain investigations for research and applications', International Journal of Production Economics, vol. 176, pp. 98-110.
- Yang, T., Feng, H., Yang, C., Deng, R., Guo, G. & Li, T. (2018), 'Resource allocation in cooperative cognitive radio networks towards secure communications for maritime big data systems', Peer-to-Peer Networking and Applications, vol. 11, no. 2, pp. 265-276.
- Zhang, S., Shi, G., Liu, Z., Zhao, Z. & Wu, Z. (2018), 'Data-driven based automatic maritime routing from massive AIS trajectories in the face of disparity', Ocean Engineering, vol. 155, pp. 240-250.

TESTBED SIMULATION IN BUSINESS ECOSYSTEM CONTEXT – BENCHMARKING LOGISTICS PERFORMANCE

Kari Uusitalo[1] and Petri Laine[2]
[1]Business Finland – The Finnish Funding Agency for Innovation (Tekes), Helsinki, Finland
[2]VTT Technical Research Centre of Finland, Espoo, Finland

Introduction

Performance measurement

Main purpose of company control system is to direct organisational decision making towards completion of defined organisational goals. Measurement on the other hand directs into actions that clarify goals. In that sense measurement and indicators are an integral part of company control system. When developing indicators company future vision, strategy and critical success factors must be taken into consideration (Bierbusse 1999). Performance indicators can be divided into strategic and operative categories. Strategic indicator can be defined to be based on critical success factors and through which completion of strategic goals are evaluated (Shanks 1997). Drucker (1991) connects performance measurement to company profitability.

Strategies involving measurement typically only emphasise either customer satisfaction aspect or cost efficiency aspect of indicators application. However both aspects should be equally represented in business model measurement. (Day & Wensley 1988) Non-economic indicators provide information on customer satisfaction, company image, experienced quality and internal learning and development within the company (Smith 1990). It's typical for strategic indicators to include quality and customer satisfaction (Bromwich & Bhimani 1994; Kaplan & Norton 1997; Perera et al. 1997).

Process Thinking

Core principle of process thinking is to identify those processes that generate most added value to the product in a value chain. A score of business management doctrines have been developed around or leaning on process thinking. These include among other Lean management (LEAN), Just in Time production (JIT), activity based costing (ABC) and related activity based management (ABM), continuous improvement (CI), business process reorganisation (BPR) and supply chain management (SCM) doctrines (Doctoroff 1998; Gopal & Cypress 1993; Hammer 1990; Harrison et al. 2003; Lillrank & Kano 1989; Miller 1991; Shapiro & Varian 1999; Simchi-Levi et al. 2003; Taylor 1999).

Process thinking leans heavily on doctrine of continuous improvement that can be understood as an independent and functional doctrine for business management but on the other hand is represented and sought for in many other doctrines and practices. Continuous improvement emphasises action planning, decision making and action (Earl & Khan 1994; Evans & Lindsay 2002; Lillrank & Kano 1989; Mizuno 1992).

Customer orientation

Principle of market orientation is based on assumption that increasing customer satisfaction leads to increased customer loyalty that in turn increases profitability (Anderson et al. 1997; Bhote 1996;). According to Ricci (2004) business units that receive best customer loyalty feedback also produced best economical result. Customer value generation is crucial success factor in business.

In customer orientated business every successful business strategy is built on the grounds of how well a business can manage its customer satisfaction and how well it succeeds in listening customers. Poorly performing companies do not utilise different approaches to listen to customer or have failed to understand received information as a part of their strategy (Jones & Sasser 1995).

This paper argues that in the logistics performance measurement an investigation of deeper customer centric system requirements, measurement and development are equally important than cost

efficiency in process thinking, when companies strive to satisfy increasing customer value expectations.

The contribution of this paper is two-fold. Firstly, it introduces a novel construction of virtual testbed and performance measurement tool. Secondly the paper describes how process efficiency and customer value generation are taken into account systematically in managerial decision making process by utilising developed performance measurement tool.

Holistic business perspective as a basis for logistics performance measurement

Generally systems thinking (cybernetics) includes few defining characteristics and emphasises. Firstly the focus is directed in relations between objects instead of the objects themselves. Secondly phenomena are analysed as a whole formed by dependent parts of the whole, a system, instead of separate phenomena independent of the whole. Thirdly these systems are analysed within a context and not separate from it. Systems theory is defined as a way to understand the surrounding reality, as a solution and mapping method, for development and problem solving and simply as research method.

Systems theory includes the concepts of hard – and soft systems thinking. Clear distinction between hard and soft systems thinking is made (Checkland 1983). With hard systems thinking it is possible to solve well defined and clear problems, while in comparison soft systems thinking would be better suited for investigation of complex and abstract situations (Tegegne et al. 2018). According to Checkland the most important difference is that in soft systems thinking the system is the process used to organise this complex world.

While hard systems thinking is used to solve different problems efficiently and these competences of engineering are very important in providing concrete results, in business hard systems thinking is associated with shortcomings and problems (Jackson 1991). As a criticism towards hard systems thinking can be seen the concern that it has tendency towards reductionism in paradox against the founding principles of systems thinking (Jackson 1991). While hard systems thinking disregards subjectivity of situations, the soft systems thinking acknowledges that there are in fact multiple divergent perceptions about the reality and helps to process them.

Systemic approach and analytic approach

The difference between the systemic and analytic approaches is explained as follows: "The analytic and systemic approaches are complementary more than opposed. However they are not reducible to each other. The analytic approach aims at reducing a system to its most simple constitutive elements, in order to study them in detail and understand the types of interactions which exist among them" (Rosnay 1975). It is notable that analytic approach can also take a qualitative (Wiek et al. 2008) as well as quantitative perspective.

By modifying one variable at a time, analytic approach tries to create general laws that will enable one to predict the properties of a system under very different conditions. To make this prediction possible, the laws of the additivity of elementary properties must be invoked. This is the case in homogeneous systems, those composed of similar elements and having weak interactions among them.

The laws of the additivity of elementary properties do not apply in highly complex systems composed of a large diversity of elements linked together by strong interactions. These systems must be approached by new way that considers a system holism, complexity and its dynamics. Through *simulation* the different kinds of interactions among its elements can be studied.

Activity Based Costing (ABC)

The doctrine was developed as the essential framework for management accounting. Activity based costing referrers only to the actual technique that is used to determine activities and costs produced by these activities. Activity based costing is designed to provide more refined costs data for operation management in companies, with more accurate allocation of overhead costs (Cooper & Turney 1989; Cooper 1990).

Activity based costing provides good basis for development of different kinds of performance indicators (Swenson 1995). Measurement provides information on the current performance level creating an understanding to think about improvement of activities and their content (Ittner & Larcker 1996). In addition to cost they can take account other important factors of activity like customer. Measurement related to customer and quality can include customer satisfaction. In activity based costing the focus is directed non-value generating activities where related processes are selected for continuous improvement. Activity based costing supports continuous improvement process that is performed from all business perspectives (e.g. Cokins 1999; Drucker 1991; Mecimore & Bell 1995; Swenson 1995).

Basic tools of activity based management are various analyses such as activity analysis, strategic analysis and process value analysis. In addition to technical specification of activities the activity analysis tries to uncover value generating, non-value generating and destructive activities (Drucker 1954). The purpose is to analyse the activities that can be developed and to benchmark company activities with those of other companies.

Business activity based costing systems have evolved from product level focus towards the observation of process focus and in the third stage towards value chain analysis of profit units. Development activity based costing towards a model where by using the systems all customer demands could be satisfied as well as possible is seen as fourth. (Mecimore & Bell 1995).

Kingcott (1991) criticises that activity based costing tries to achieve goals through theories that simplify business extensively. Johnson (1992) criticises that the system does not sufficiently reflect customer perspective which might lead to misinterpretation. Swenson (1995) has observed that paying attention to product costs in activity based costing leads to decreased attention to non-monetary performance indicators. Johnson (1992) has claimed that business employing activity based costing extensively even lose real connection and view to the customer.

Soft Systems Methodology (SSM)

Soft Systems Methodology created by Checkland (1981) to provide means for investigating an unstructured problem situation where different stakeholders have divergent views on what constitutes the system, the purpose of the system and therefore the problem.

Unlike hard systems and analysis tools which allow the designer to model how the system should work, soft systems methodology focuses on what operations the system should perform and why. Methodology takes the messy arguments of the real world and creates holistic and rational models, conceptual models (Human activity systems), for comparison to help decision making on the issue or the problem. These conceptual models are models of what logically needs to be done to achieve the purpose of new system.

It is most useful in abstract problem situations where analytic systems approach is not enough to provide a solution in the organisation. The advantage of soft systems methodology in such cases is that it models explicitly the different perspectives (value-systems) of various stakeholders in the organisation, representing different opinions about the effectiveness and purpose of the organisation and their perceptions of current systems within it. When organisational problems are difficult to define, many problems arise from a part of the system prioritising one set of organisational objectives at the expense of another set of objectives without holistic view[1].

At its foundations soft systems methodology is an investigative (Jackson 1991) and facilitative method where the investigator does not model the system in isolation, but facilitates organisational actors in

[1] Seven stage model of SSM: 1.Entering the problem situation, 2.Expressing the problem situation , 3.Deriving root definitions of relevant systems, 4.Deriving conceptual models from root definitions, 5.Comparison of conceptual models and real world, 6. Analysis of feasible and desirable change, 7. Taking action

their modelling of it. The idea of a system is based upon a holistic understanding of interactions, where the whole is greater than the sum of its parts. Facilitator provides support to organisational actors as they themselves define their system's purposes and functions. However analyst-derived alternate perspectives are suggested as a way of deriving system definitions as the theoretical approach might not be effective in practice.

As a summary the focus in the following research case is on the connections between systems approach (SSM) and analytic approach (ABC) in logistics performance measurement. Systems approach includes both hard systems and soft systems thinking.

We argue that adopting SSM the logistics performance measurement can be developed in a way that emphasises holistic business value opportunities (e.g. Jackson 2006) and ABC to support business decision making analytically. Purposeful technique to achieve this goal is simulation in virtual testbed like systemic and analytic approaches implicate.

Method and Data

Best Practice Case Study in Logistics

Case study can be summarised as follows "an empirical inquiry that investigates a contemporary phenomenon in depth and within real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin 2009). Logistics is considered as an applied discipline where researchers are working in close co-operation with industry and trade. This explains why case study is the most common methodology for empirical data collection, where companies are identified as representatives of best practise. A best practise case study requires that it is possible to prove that the case is representing outstanding performance. In logistics this can be done both in qualitative descriptions of what they have done and quantitative key figures such as logistics costs, lead times or delivery service. (Abrahamsson 2003; Abrahamsson et al. 2003)

Knowledge developed by the systems approach cannot be generalised in the same way as knowledge generated by the analytical approach but in logistics the components or different activities are very often similar, independent the class of the system, which in most cases makes the possibility to generalise rather extensively. We utilise systems approach and complement this with doctrine of activity based costing to avoid generalisation issues (Abrahamsson 2003; Abrahamsson et al. 2003).

In this research case companies are in fact creating entirely new business environment and logistics in it that doesn't exist. The focus of the research is to analyse and measure alternative logistics models defined by case companies though value chain simulation. The goal is to develop a purposeful tool called the virtual testbed. In Virtual testbed simulation qualitative investigation of logistics performance is based on soft systems methodology and quantitative analytics to measure logistics performance is based on activity based costing.

Case

Simulation in virtual testbed is related to an ongoing national research agenda "T*owards supply space management and open digital ecosystem"*[2] in Finland. Vision of open business ecosystem (adopted by Moore 1993) is a sustainable, innovative and customer centric business environment operating across business sectors with global scalability[3]. This ecosystem goal will be constructed and implemented in open and digital business platform in organisational theory context.

2 Laine, P - Uusitalo, K., (2017), LRN Conference 2017, Southampton, Towards Supply Space Management and Open Digital Ecosystem

[3] Principles of open ecosystem are that any willing actor can utilize open data from different business sectors to create new disruptive services and pilot new innovative business concepts. The research envisions a future business environment and logistics model in the context of a changing world where benchmarking is executed between contemporary supply chains and future modular logistics systems. The research models a construct of future open ecosystem enabled by concept vision of supply space management.

The implementation of best practice case study became relevant when multiple companies committed to open ecosystem phenomena and wanted to advance the new business opportunities including a new logistics paradigm[4]. Simulation in virtual testbed was defined in three distinct organisation models between actors. a) Baseline data was generated from the existing value chain process charts. b) Simulation of organisation model where actors join into a same digital platform while the actual resources remain the same. c) Simulation of business model of digital platforms joining together over business sector boundaries in market driven business environment where all resources on the market are available.

At the first stage of open ecosystem agenda two networks in retail and food industry were identified. The target was set to develop whole value systems in them[5] holistically from production to the consumer. Open Ecosystem vision states that traditional supply channels are not capable enough to answer future customer demand in the changing global market. The underlying thinking was that customers want more and better service, more information about the product origins and capability to influence both the offering and methods of distribution.

The problem identified in the case was the lack of information to support decision making especially considering that no knowledge on the benefits of the new paradigm existed also piloting such extensive development wasn't realistic and neither were investment decisions. Through virtual testbed the baseline value chain is analysed using existing baseline data collected from the actors and subsequent organisation models are modelled by case companies[6] as a shared iteration process.

Concept of virtual testbed was selected as the development technique and tool that would help to solve the complex problem the development process imposed.

Results

Virtual testbed was developed as a tool to measure three alternative value generating business models. Soft systems methodology focuses on what operations the system should perform and why while hard systems analysis tools allow the designer to model how the system should work. Virtual testbed provided a performance measurement synthesis of each business model entity. The synthesis is a combination of qualitative conceptual modelling of soft systems methodology and quantitative analytics of activity based costing. Thus the business modelling is based on both soft systems thinking and hard systems thinking.

Conventional seven stage model of soft systems methodology was applied in business modelling as described in the methodology and activity based costing was applied as doctrine dictates. SSM provided the means to define value generation and system organisation holistically based on how actors wanted to define them. ABC offered the means to analyse cost efficiency and detailed process, activity and resource construction of observed organisation models. These syntheses brought up both holistic qualitative perspective and analytic quantitative perspective for performance evaluation and measurement and provided relevant information for managerial decision making processes (See figure 1).

---

[4] The first phase of the ecosystem "Towards supply space management and open digital ecosystem" research in early 2017 investigated the potential of ecosystems and platform economy from the perspective of production, trade and logistics. At this time 13 companies funded the development agenda. The results were encouraging and led to the second phase when 44 companies in the network with 21 directly funding the agenda and of which 5 were large actors. The second phase received a new finance approval from Business Finland (Tekes) in September 2017. By the end of year 2018 the size of the ecosystem R&D-network is estimated to reach over 200 companies and third sector stakeholders.

5 Baseline value chain includes multiple actors: a production company of meat products (large size), a dairy production company (large size), food producer (small size), a retail store chain (large size), an online retail store (medium size), an open hub operator (small size), a cattle feed producer (medium size), a meat products breeders (medium size), a logistics company (large size), a carrier (small size), a last mile carrier 1 (small size), a last mile carrier 2 (small size).

6 The Development process started with workshop with case actors. The purpose of the workshop was to engage actors in systemic thinking of the problem. The agenda of the workshop was to establish a systematic view on how different actors affected the creation of added customer value and how this value was in fact created from different perspectives, and define the processes along the product path.

The simulation and benchmarking in the case comprised of three business models with logistics performance as an essential element in value creation. Performance measurement syntheses were made for each business models and benchmarking was performed between them.

Organisation model 1 - Current state of supply chain: Virtual testbed models the current state of value chain that was observed as is. Case companies wanted to analyse the current supply chain as whole instead of separate investigation of individual companies as usual. The organisational modelling and innovation are restricted to definite form of existing processes and activities. Thus the synthesis for model 1 was mostly unilateral considering only analytical aspect. Activity based costing allows only analytics of cost efficiency and provided information for some continuous improvement and lean management actions only. Synthesis reflected through activity based costing only few activity costs could be decreased in existing processes. Deriving systemic value added as a consequence of continuous improvement and lean management actions only incremental service factor improvements were recognised. These factors were related to distribution quality like more homogenous service quality to customers.

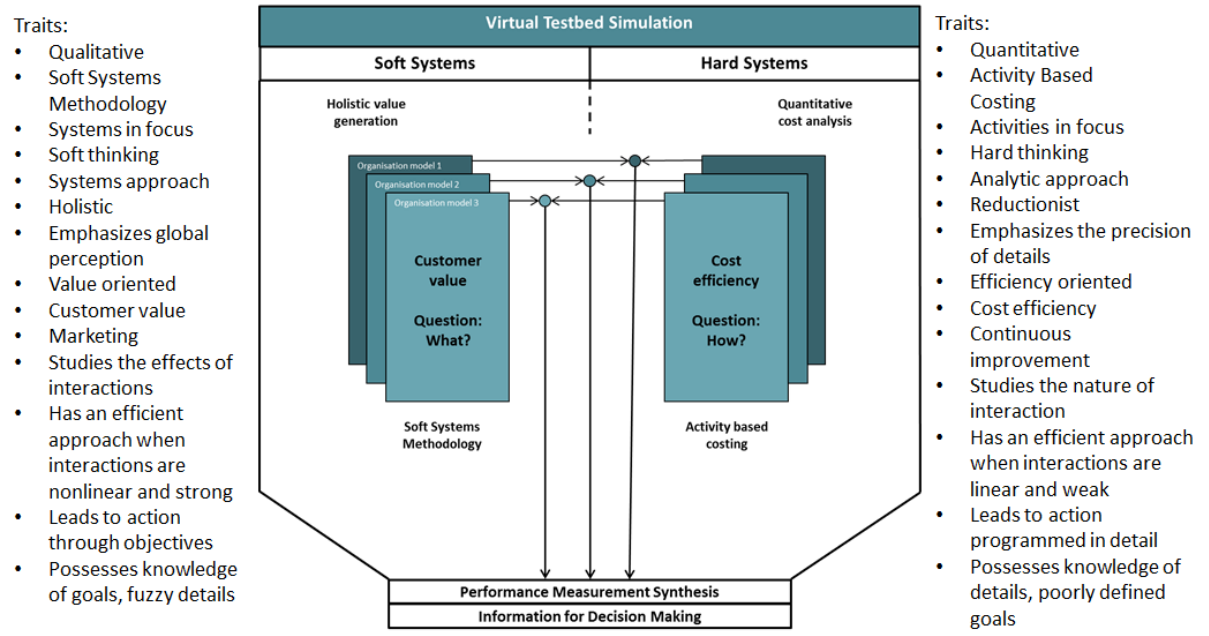


Figure 1: Virtual testbed architecture

Organisation model 2 - Value network, platform: In model 2 simulation was based on conviction that the future logistics is formulated by digital platforms instead of supply chains. All actors on the platform receive all the information transparently and in real time. At this model platforms compete with each other as closed systems. The actors and available resources are definite and limited. In the synthesis of model 2 it was possible to include both value generation and cost efficiency like intended. In other words synthesis reflected through soft systems methodology the model of the platform could be defined freely in the limits of available resources. Synthesis reflected through activity based costing more activity costs could be decreased as some overlapping activities could be removed through business process re-engineering. These activities are related to transportation, handling and hub storage. Systemic value is derived from added value generated from delivery capabilities, delivery timing and delivery reliability. Total logistics performance level increases significantly as actors identify more options to combine services.

Organisation model 3 - Open ecosystem: In model 3 simulation was based on the open ecosystem vision in which the broker sector is resourced and market oriented with any actor having access to demand-supply information. Actors could offer new customer centric service innovations without restrictions. Logics of unused resources and crowdsourcing were possible to implement as a part of stochastic and momentary distribution functions. In the synthesis of model 3 reflected through soft systems methodology the actors had an opportunity to define an ideal and maximum value generating model as platforms communicate with each other creating the open ecosystem. Synthesis reflected through activity based costing allowed resource costs to be selected freely and priced as low as market offered them at the time of simulation. New process options allowed decreasing the costs when process could be streamlined by eliminating non-value generating activities. Extreme example is when products and services flow directly from supplier to customer. Systemic value is derived through increase of logistics service level through multiple factors: delivery capability, delivery accuracy, delivery timing, delivery reliability, delivery quality and other factors like service interaction possibilities.

Significant holistic finding in this simulation and benchmarking process was that the model 2 was not in conflict with model 3. Instead model 2 can be seen as a development stage towards supply space management and open digital ecosystem.

Conclusions

Considering extensive development efforts in companies the management faces difficulty in deciding whether or not a given development path will be successful in creating new business or improving the existing. This is especially true when development is focused on new organisation models from which data is scarce or even non-existent. Virtual testbed can be understood as one of the contributions of this research. The developed strategic tool (Vuorinen et al. 2017) allows business actor to systematically design a new organisation model from holistic perspective defining the goals of the new system. Creating a conceptual model of the desired state to determine what parts of the real life system should be improved or changed. The performance of the changes can be analysed as a part of the systematic whole and thus produce information for the decision making on whether or not the changes are strategically desirable or applicable.

Virtual testbed can be used to simulate existing value and supply chains to create deeper understanding of this systematic whole. Analysis of current state already provides added value to operators and allows limited lean management actions to be performed. Baseline data received from this analysis serves as starting point to redesign value chains processes and activities.

Measurement of logistics performance in new developed processes in virtual testbed leans on activity based costing doctrine and can be performed before actual implementation following the logics of simulation. Virtual testbed allows for logistics performance simulation on different organisational models e.g. supply chain, platforms and ecosystem. New processes and development ideas can be flexibly simulated and the effect can be measured as a part of whole value chain for holistic perspective.

For performance measurement doctrine the research implication is that simulation in virtual testbed and ensuing managerial decision making in the context of systems thinking is a valid method to utilise performance measurement in business development and in analysis of new business and customer value.

For process thinking doctrine the implication of research is that activity based costing can be applied in virtual testbed simulation performed in systems thinking context to redesign processes with customer orientation and to create customer value.

For customer orientation the implication is that simulation in virtual testbed in the context of systems thinking and applying activity based costing enables analysis of customer value and related cost factors in a novel way.

Implication for systems theory is that activity based costing offers effective means to utilise analytic approach to complete systems approach of Soft Systems Methodology.

Finally, summarising the conclusions of this research, through systems thinking the evaluation of logistics performance can be connected to more holistic view of customer value and business development allowing for the logistics performance to be optimised not only through efficiency but also through evolving customer demand and network level development.

Reference

- Abrahamsson, M. (2003). Best Practise Case Studies. Published in: Case Study Reseach in Logistics, Ojala, L. & Hilmola, O-P. Publications of The Turku School of Economics and Business Administration, series B 1:2003. ISBN 951-564-102-0.
- Abrahamsson, M., Aldin, N., & Stahre, F. (2003). Logistics platforms for improved strategic flexibility. International Journal of Logistics: Research and Applications, 6(3), 85-106.
- Anderson, E.W., Fornell, C , Lehmann, D.R., Rust, R.T. (1997). Customer Satisfaction, Productivity and Profitability: Differences between Goods and Ser-vices. Marketing Science, Vol. 16, No 2, pp. 129,145.
- Bhote, K.R. (1996). Beyond customer satisfaction to customer loyalty. American Management Accociation.
- Bierbusse, P. (1999). Using Performance Management to Focus Data Ware-house/ Data Mart Investments. Journal of Strategic Performance Management. January, pp. 19,23.
- Bromwich, M., Bhimani, A. (1994). Management Accounting: Pathways to Progress. CIMA, London.
- Checkland, P.B. (1981). Systems Thinking, Systems Practice. Chichester, John Wiley & Sons.
- Checkland, P.B. (1983). OR and the systems movement: mappings and conflicts,Journal of the Operational Research Society, 34, 661675.
- Cokins, G. (1999). Using ABC to become ABM. Journal of Cost Management, January/February, pp. 29,35.
- Cooper R. (1990). Cost classification in unit-based and activity-based manufac-turing cost systems. Journal of Cost Management, Fall, pp. 4,14.
- Cooper, R., Turney, P.B.B. (1989). Hewlett-Packard: The Roseville Network Division. Boston, MA: Harvard Business School, case 9-188-117.
- Day, G.S., Wensley, R. (1988). Assessing Advantage: A Framework for Diag-nosing Competitive Superiority. Journal of Marketing, April, Vol. 52, pp. 1,20.
- Doctoroff, S. (1998). Reengineering Negotations. Spring 1998, Vol. 39, No 3, pp. 63,71.
- Drucker, P.F. (1991). The New Productivity Challenge. Harvard Business Re-view, November/December 1991.
- Earl, M., Khan, B. (1994). How New is Business Process Redesign? European Management Journal, Vol. 12, No 1. pp. 20,30.
- Evans, J.R., Lindsay, W.M. (2002). Management and Control of Quality. 5th edition. West Publishing Company.
- Gopal, C., Cypress, H. (1993). Integration Distribution Management: Compet-ing on Customer Service, Time and Cost, the Book Press, USA.
- Hammer, M. (1990). Reengineering Work: Don´t Automate, Obliterate. Harvard Business Review. July-August, pp. 104,112.
- Harrison, T.P., Lee, H.L. - Neale, J.J (eds) (2003). The Practice of Supply Chain Management: Where Theory and application Converge. Kluwer Academ-ics Publishers. Boston, MA. ISBN: 1-4020-7441-7.

- Ittner, C. , Larcker, D. (1996). Measuring the Impact of Quality Initiatives on Firm Financial Performance. Advances in the Management of Organizational Quality, Vol. 1, pp. 1,37.
- Jackson M.C. (1991). Systems Methodology for the Management Sciences Contemporary, Systems Thinking. Plenum, New York.
- Jackson M.C. (2006). Creative Holism: A Critical Systems Approach to Complex Problem Situations.The Business School, University of Hull, Cottingham Road, Hull, UK.
- Johnson, H.T. (1992). It's Time to Stop Overselling Activity-Based Concepts. Management Accounting (New York), September, pp. 26,35.
- Jones, T.O., Sasser, W.E.jr. (1995). Why Satisfied Customers Defect? Harvard Business Review, November/December, pp. 88,89.
- Kaplan, R.S. , Norton D.P. (1996). Strategic learning and the Balanced Score-card. Strategy & Leadership, September/October, pp. 18,24.
- Kingcott, T. (1991). Opportunity based accounting: Better approach than ABC? Management Accounting, London, October 1991.
- Lillrank, P., Kano, N. (1989). Continuous Improvement , Quality Control Cir-cles in Japanese Industry. Michigan Papers in Japanese Studies No 19. Center for Japanese Studies, the University of Michigan, 108 Lane Hall.
- Mecimore, C. D., Bell, A. T. (1995). Are we ready for fourth-generation ABC? Management Accounting (US), January, pp. 22,26.
- Miller, J.G. (1991). Reengeneering work: who will do it? Letters, Harvard Business Review. January-February, p. 190.
- Mizuno, S. (1992). Company-Wide Total Quality Control. Asian Productivity Organization, 6th printing, ISBN: 92-833-1099-3.
- Moore, J.F. (1993) Predators and Prey: A New Ecology of Competition. Harvard Business Review, 71, 75-86.
- Perera, S. , Harrison, G. , Poole, M. (1997). Customer-Focused manufacturing strategy and the use of operations-based non-financial performance measures: a research note. Accounting, Organizations and Society, 22 (6), pp. 557,572.
- Ricci, R. (2004). Move From Product To Customer Centric. November 2003, Quality Progress.
- Rosnay, J. (1975). The Macroscope: a New World Scientific System (ch. 3: Energy and Survival, pgs. 97-129). Harper & Row Publishers (1979 Eng. Trans.).
- Shanks, G. (1997). The challenges of strategic data planning in practice: an in-terpretative case study. Journal of Strategic Information Systems, Vol. 6: pp. 69,90.
- Shapiro. C. , Varian, H.R. (1999). Information Rules, A Strategic Guide to the Network Economy. Harvard Business School Press. ISBN: 0-87584-863-X.
- Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E. (2003). Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies. Irwin/McGraw-Hill. ISBN: 0-07-249256-2
- Smith, M. (1990). Management accounting for total quality management. Man-agement Accounting (UK), June, pp. 44,46
- Swenson, D. (1995). The Benefits of Activity-Based Cost Management to the Manufacturing Industry. Journal of Management Accounting Research, Fall, Vol. 7, pp. 167,180.
- Taylor, D. (1999). Supply-chain improvement: The lean approach. Logistics Focus, Vol. 7, No 1.
- Tegegne, W. A., Moyle, B. D., Becken, S. (2018). A qualitative system dynamics approach to understanding destination image.Journal of Destination Marketing & Management Volume 8, June 2018, Pages 14-22
- Wiek, A., Lang, D.J., Siegrist, M. (2008). Qualitative system analysis as a means for sustainable governance of emerging technologies: the case of nanotechnology. Journal of Cleaner Production Volume 16, Issues 8–9, May–June 2008, Pages 988-999
- Vuorinen, T., Hakala, H., Uusitalo, K. (2017). Mapping the landscape of strategy tools: A review on strategy tools published in leading journals within the past 25 years. Long Range Planning, 2017
- Yin, R. K. (2009). Case study research: Design and methods (4th ed.). Thousand Oaks, CA: Sage

MODIFICATION OF PORT SUSTAINABILITY MANAGEMENT SYSTEM (PSMS)

Ridvan Karacay , John Dinwoodie and Lynne Butel
Department of International Shipping, Logistics and Operations, Plymouth Business School

Introduction

This project aims to investigate the systems and processes which ports deploy to investigate and manage sustainability issues. As the largest ports industry in Europe, the UK hosts over 700 smaller and medium sized ports (Ports UK, 2014). This project builds on award winning research (Kuznetsov, 2014), which aimed to assist smaller ports in Cornwall and Devon (CAD) to ensure more sustainable maritime operations and development, helping them to survive and grow by safeguarding vital commercial revenue streams. This work will assess the planning, processes and systems required to disseminate PSMS beyond CAD into the UK and Turkey by assessing any requirements for modifications, the benefits offered, and barriers to implementation.

The importance of sustainability is continuously increasing in the ports industry. Several port sustainability systems are designed to assist ports to become more sustainable by putting the environment first as their priority. One of these sustainability management systems is the Port Sustainability Management System (PSMS). PSMS is designed to assist harbour masters to identify and document any concerns they may have (Kuznetsov, 2014). PSMS is a system, which is designed to help harbour masters to execute their practical responsibilities in managing ports sustainably. PSMS assists harbour masters to see their organisation's current achievement level in terms of sustainability, based on eleven pillars, which encourage harbour masters to plan future development within areas that need to be improved. The eleven-pillars (Figure 1) relate to harbour operations, to achieve the goal of a sustainable harbour (Kuznetsov, 2014). The aim of the PSMS is to create a system that assists harbour masters to self-evaluate the sustainability of their organisation and to designate priority areas that require improvement, indicated by a system that is designed to be appropriate for a range of ports.

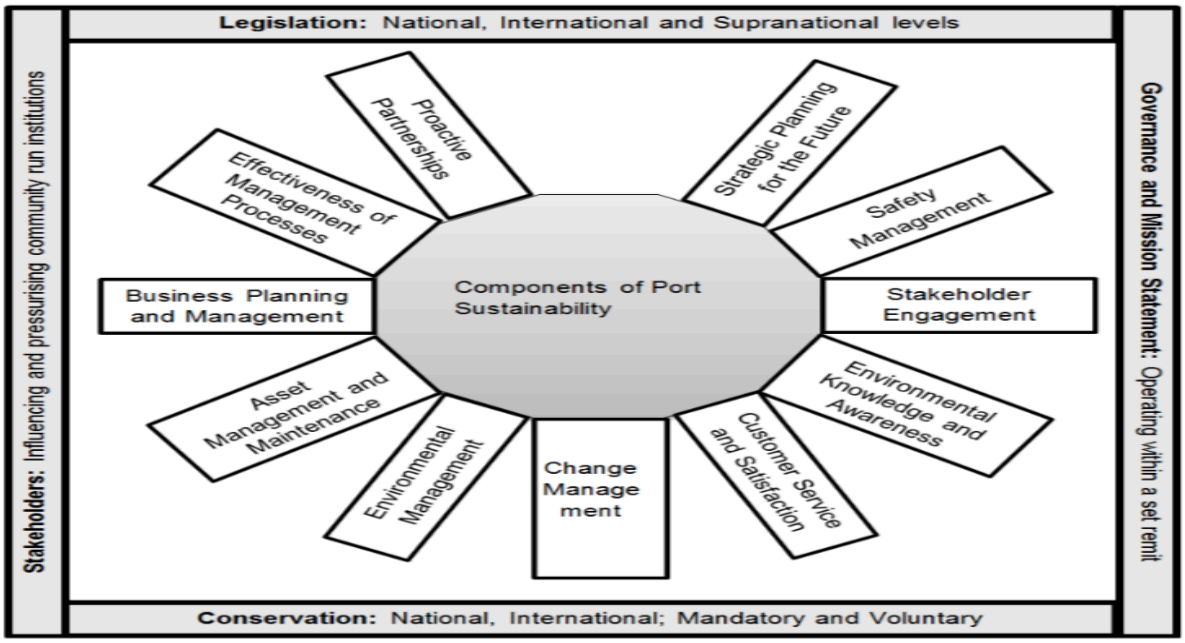


Figure 1: Eleven Components of port sustainability Source: Kuznetsov, 2014 p.161.

PSMS invites harbour masters to select scores to rate the sustainability of their organisation after undertaking a self-evaluation procedure using a bulls-eye chart (Figure 2). This chart assists harbour masters to assess their organisation's current situation and the areas that need to be improved.

Harbour masters can review previous charts to check for on-going improvements. In this way PSMS charts an endless circle of development for harbour masters.

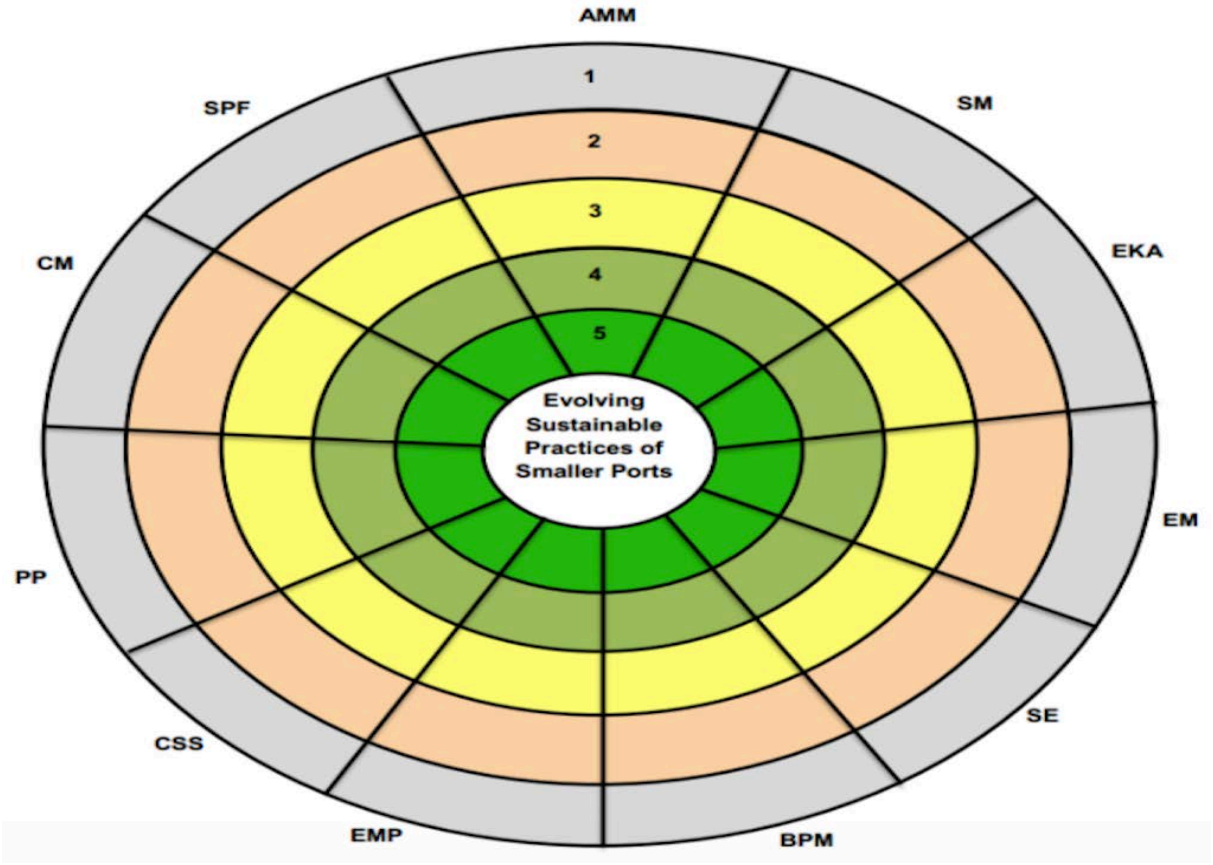


Figure 2: PSMS v5 Source: Kuznetsov, 2014, p.398.

Acronym	Description	Score
AMM	Asset Management and Maintenance	
SM	Safety Management	
EKA	Environmental Knowledge and Awareness	
EM	Environmental Management	
SE	Stakeholder Management	
BPM	Business Planning and Management	
EMP	Effectiveness of Management Processes	
CSS	Customer Service and Satisfaction	
PP	Proactive Partnerships	
CM	Change Management	
SPF	Strategic Planning for the Future	

Table 1: Score Sheet of Eleven Pillars in PSMS v5 Source: Kuznetsov, 2014, p.398.

Table 1 above illustrates the PSMS v5 score sheet of eleven pillars . After the self-evaluation process of the PSMS, harbour masters add up the scores and then divide the total score by 11 to get the overall average rating of their harbour results. PSMS also lets harbour masters to focus on their missing pillar and show harbour masters to fix/improve the required pillars.

PSMS also facilitates comparisons of port performance if ports are willing to set benchmarking standards against, which to compare their performance. Alternatively, PSMS offers a tool to self-evaluate a port's sustainability.

The research problem

To assess the extent to which PSMS offers a self-evaluation tool to assess port sustainability, nine interviews were conducted either face-to-face or by telephone and email. Interviews were undertaken in three British ports, five Turkish ports and with one lecturer in a Turkish university to combine practitioner and academic perspectives. From the nine interviews, one interview is selected from both countries for this paper. The interviews reported engaged the chief executive of Poole Harbour Commissioners and the general manager of the Port of Akdeniz in Antalya, Turkey.

To assess the current level of sustainability awareness the Turkish and British ports were compared. Both ports are medium-sized port according to the definition of medium-sized port used by the European Union. The turnover of Poole port is around GBP 11 million, whereas the Port of Akdeniz turns over USD 53.4 million. Both ports deliver multiple services including commercial and cruise business. Both ports have development plans, which aim to be more sustainable and to benefit from the latest updates in the port industry, and both ports want to succeed through becoming more sustainable.

Antalya is one of the most desirable cities in Turkey and has seen remarkable improvements attracting tourists from around the world with its natural beaches. Port Akdeniz is one of the main actors in these improvements, delivering a quality service to its customers as a cruise port and dry bulk port. To deliver more quality service as commercial and cruise port, Global Investment Holdings (GIH, the owner of the port), made big investments to increase the port capacity of the Port of Akdeniz. With the investment the whole marine area is approximately 136,000 m^2 (Çaglayan, 2018).

Poole has one of the largest natural harbours and delivers several services in a conflicting interests situation involving commercial, recreational, military and environmental dimensions, and also has a significant importance for nature conservation, as most of the foreshore is designated a SPA (Special Protection Area) under the European Habitats Directive and sites around the harbour are also designated as Areas of Outstanding Natural Beauty whilst the southern shores have Heritage Coast status (Phc.co.uk, 2018).

Methodology

There are numerous ways to analyse the recordings of interviewees discussing their various experiences. Thematic analysis is one such method. Further, research discoveries can result from differing levels of data transformation undertaken during the process of data analysis, ranging from simple description through to interpretation (Vaismoradi et. al., 2013, p. 399). Thematic analysis is a qualitative descriptive approach, appropriate for researchers who seek to engage in low-level interpretation.

Thematic analysis is used to examine classifications and impart patterns (themes) that interact within a data set. Thematic analysis shows the data in detail and can cope with diverse subjects by interpretation (Alhojailan, 2012, p.40). Braun & Clarke (2006) view thematic analysis as theoretically flexible, because during the search for, and testing of themes, the use of language does not require any specific language theory, or particular framework within which to categorise the descriptive meaning of people, experiences or actions. Consequently, thematic analysis can be used within a variety of theoretical frameworks and even thematic discourse analysis is achievable. Thematic analysis can be studied without reference to some of the possibly confusing prior theoretical knowledge required in other qualitative approaches, thereby assisting new students (Braun & Clarke, 2013, p.120). Braun and Clarke (2006) identified six phases of thematic analysis. These 'six phases' should not be seen as a linear system, where one cannot continue to the next level without finishing the previous phase correctly; rather, analysis is a recursive process. Braun and Clarke's (2006, p.87) model is used to analyse the port interviews discussed below and spans six phases:

1- Familiarisation with the data
2- Coding
3- Searching for themes or patterns
4- Reviewing themes
5- Defining and naming themes
6- Writing up

The aim of data collection is to gather general data about sustainable port management and sustainability in port planning and to observe the level of awareness of sustainability in ports in the two case study ports. Data was collected in interviews with the Chief Executive of Poole Harbour Commissioners and the General Manager of the Port of Akdeniz, the leaders of these organisations, as primary data. Interview prompt sheets guided face-to-face meetings, which were recorded using a voice recorder after permission had been granted.

Problem Description or challenge

One aim of this paper is to capture industrial views of PSMS in relation to port management and another is to review the suitability of an existing bespoke PSMS with a view to further applications in the port industry involving wider perspectives for self-evaluation in terms of port size (small/ medium/ large), type (container/ dry bulk/ cruise) and governance (municipal/ trust/ private). Possible amendments to PSMS involve review of the 11 pillars of sustainability, with scope for adding an additional pillar(s) or sub-pillar(s) after reviewing the current PSMS systems from a wider set of perspectives.

Results/analysis

Whilst gathering data it emerged that each port has different priorities which depend on size, type and governance, which implies that a single inflexible PSMS is unlikely to be reliable given the differing size, type and governance of ports. Also by comparing British and Turkish ports, different levels of awareness emerged between the countries. In this paper, these differences are examined using the interview data gathered from Poole and Port Akdeniz (Antalya).

The interview with the General Manager of Port Akdeniz identified bureaucracy as a major obstacle to achieving sustainability goals as his organisation progresses in the port industry. Due to lengthy bureaucratic processes, it might take four years to conclude the paper work required for an investment, before construction can start or port infrastructure can be restructured. The length of the

bureaucratic process is becoming a crucial factor especially in a country such as Turkey, where medium and long-term planning is difficult.

Conversely, bureaucracy was not mentioned as an obstacle in the interview with the Chief Executive Officer of the Poole Harbour Commissioners. One of the reasons might relate to the market approach of the two countries. The UK government is happy to let industry lead the market, whereas in Turkey, government is reluctant to delegate that authority to industry, and seeks to retain more control over the market. For this reason, bureaucracy can be a potential addition to the PSMS to adapt it to suit the wider perspectives of countries, which have different levels of bureaucratic processes.

"Governance" emerged as a useful addition to the PSMS because it influences ports when setting their organisational priorities. Poole port is a trust port in which any profits have to be spent on new investments and improvements to the infrastructures. Conversely, Port Akdeniz is a private port. Global Ports Holding (GPH) acquired a 40% stake in Port Akdeniz in 2006 and subsequently increased its share to 100% in July 2010. Hence, GPH's priority is to recoup the costs of their investments as soon as possible for the purpose of satisfying their shareholders. These different priorities arise due to the governance type of the port, and as such governance offers an important potential addition to the PSMS to assist harbour masters in self-assessments of their organisations.

Culture emerges as the last potential addition to 11 pillars of PSMS. During the interviews with the Chief Executive of Poole Harbour Commissioners and the General Manager of Port Akdeniz, cultural differences were found to influence sustainability goals. Especially during the Port Akdeniz interview, responses to the prompt: "Do you believe that there is enough collaboration between organisations?' culture emerged as a potential addition to the PSMS. The reason proffered for a lack of healthy collaboration is the oriental working culture in Turkey.

One characteristic of Turkish industry is that typically, for many managers, incurring a capital loss is preferable to being forced into collaboration. This might reflect cultural influences of managing organisations within a one-man system, where everything is connected to that specific person who is in charge. The oriental working culture presents the biggest challenge for the industry. If a solution can be found to overcome the oriental working culture issue, other secondary issues will be resolved much more easily according to the general manager of Port Akdeniz.

Another type of culture, which has an impact on the industry, is the organisational culture. Organisational culture can be a good influence on sustainability in terms of efficiency. Organisations should consider oriental working culture while establishing an organisational culture especially in circumstances such as entering a new market in a new country in order to become more sustainable.

Discussion

The potential impact of this paper is to note that in modifying PSMS to suit possible applications globally, a broader perspective of sustainability is needed, compared with applications solely to smaller ports in the South West UK. Further, port self-assessments depend on geographic location, port size, port type and governance type.

The PSMS is a reliable self-assessment system for smaller ports in the South West UK. Modifying and adapting PSMS to suit more ports globally also assists in setting worldwide standards with which to compare ports from a broader perspective.

To ensure more reliable results, the systems for port self-assessments should consider the geographic location of ports. For instance, a reliable system will offer a different process of self- assessment for a port with a deep berth depth compared with a port, which is struggling with its berth depth. Also

geographic location is important due to external threats such as terrorism, which may arise far away from the main transportation routes.

Different size of ports should be evaluated using different standards. Small ports may have an overriding priority of survival, but medium or large sized ports probably prioritize shareholders' satisfaction. The reason for evaluating different size of ports using different standards is because their priorities and opportunities depend on their size. Similarly, different types of ports have different priorities concerning their infrastructure investments and customer satisfaction. Applying the same process to self-assessment of container ports, where most shipping transportation ends, and dry bulk ports, which are becoming less attractive to industry, may preclude reliable evaluation or reduce the validity of the evaluation. Lastly, there should be different standards for different governance type of ports. Evaluations of trust ports, which have no shareholders and plough back profits into organisational investments, differ from private ports, which strive to maximize shareholder satisfaction. One solution might be to vary the importance of one of the 11 pillars in a modified PSMS, as port governance varies. For instance, customer satisfaction may be weighted more highly when evaluating a private port because this pillar is crucial in achieving the sustainability aspirations of the port.

Conclusion

Bureaucracy, culture and governance are possible additions to the original 11 pillars of PSMS following the data analysis. Future outputs will include recommendations regarding how global applications of PSMS would require modifications to ensure reliability in terms of sustainability awareness, management, systems and processes in ports.

In these potential three additions, "culture" may be the 12th pillar of the system with two sub-pillars underneath, namely "organisational culture" and "oriental working culture". Bureaucracy can be added as a sub-pillar under the pillar of "effectiveness of management processes" because it affects the efficiency of the management processes. Regarding potential modification of "governance", it may be appropriate to modify the standards of the current 11 pillar PSMS dependant on the governance type of a port. Lastly, updated model of PSMS is illustrated in Figure 3 to give idea about the modified PSMS.

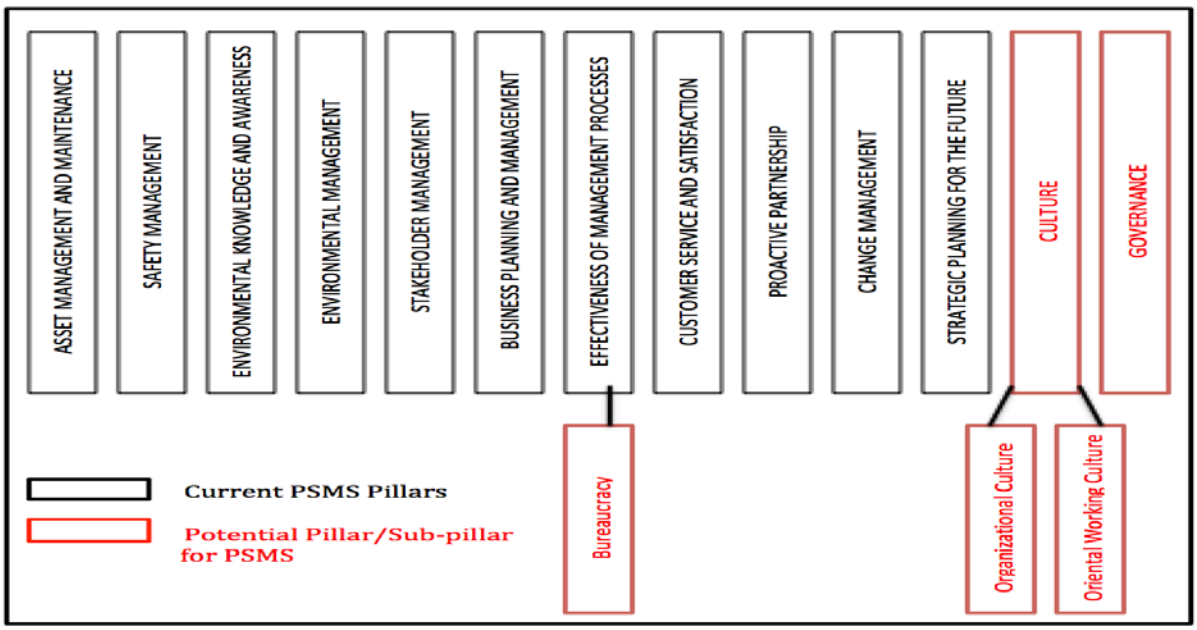


Figure 3: Potential Pillar/Sub-pillar Additions to PSMS

Ongoing research will be required to test potential additions and modifications to the PSMS to enable PSMS to reliably incorporate sustainability awareness, management, systems and processes in ports globally.

References

- Alhojailan, M. I. (2012), 'Thematic Analysis: A Critical Review of Its Process and Evaluation'. *West East Journal of Social Sciences* Vol. 1 No. 1 p.40.
- Braun, V. & Clarke V. (2006), 'Using Thematic Analysis in Psychology', *Qualitative Research in Psychology* Vol. 3, pp. 77-101.
- Çağlayan, E. (2018). Global Investment Holdings - Port Akdeniz. [online] Globalyatirim.com.tr. Available at: https://www.globalyatirim.com.tr/en/investments/ports/global-ports-holding/77-port-akdeniz [Accessed 7 Jun. 2018].
- Clarke, V. & Braun, V. (2013), 'Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning', *The Psychologist*, Vol. 26 No. 2, p. 120.
- Kuznetsov, A., (2014). Port Sustainability Management System for smaller ports in Cornwall and Devon. PhD thesis. Plymouth University. https://pearl.plymouth.ac.uk/handle/10026.1/3136
- Phc.co.uk. (2018). Poole Harbour Commissioners - About Us. [online] Available at: https://phc.co.uk/about.html [Accessed 12 Jun. 2018].
- Ports.Org (2014), Ports and Harbours of the UK, Available at: http://ports.org.uk/
- Vaismoradi, M., Turunen H. & Bondas T. (2013), 'Content Analysis and Thematic Analysis: Implications For Conducting a Qualitative Descriptive Study', *Nursing and Health Science*s Vol. 15, p. 399.

MEASURING THE EGYPTIAN CONTAINER PORTS' EFFECIECNY: A FUZZY AHP FRAMEWORK

Ahmed A. Ismail[1] and Sara H. Elgazzar[2]
[1]Maritime Postgraduate Studies Institutes, Arab Academy for Science, Technology and Maritime Transport, Alexandria - Egypt
[2]College of International Transport and Logistics, Arab Academy for Science, Technology and Maritime Transport, Alexandria - Egypt

1. Introduction

Efficiency is a fundamental concept in the field of economics; the concept is basically concerned with the economic use of frim resources for production (Lu and Wang, 2017). Moreover, it is an important contributor to a nation's international competitiveness (Elsayeh, 2015). Merk and Dang (2012) asserted that port efficiency is an important indicator of port performance; more efficient ports mean lower transportation costs.

There is downward pressure on efficiency and productivity in the Egyptian container ports due to a utilization rate of Egyptian container ports 73% (Maersk, 2015), which exceeds the maximum international accepted percent (70%) (Haralambides, 2012). Therefore, it will be important to measure the level of efficiency and quality of service provided in the Egyptian container ports, in order to define obstacles and improve their performance and productivity.

The purpose of this research is to propose a performance measurement framework to assess the level of efficiency of the container ports using Fuzzy Analytic Hierarchy Process (FAHP) approach. To demonstrate the applicability of the proposed framework, an empirical study on the Egyptian container ports was conducted for the period from 2012 to 2016. This framework will help port managers to evaluate the level of efficiency in container ports and define areas that need improvement. The paper starts with literature review in section two, section three will propose the framework, then section four will illustrate the empirical study, and finally conclusion will be presented in section five.

2. Literature review

Monitoring a port's performance in an ever-changing environment is crucial for measuring its efficiency levels as well as its competitiveness (Jimenez et al., 2013). Efficiency is one of the two most important concepts in measuring performance in container ports. Recently, the efficiency of container ports has become more important since it is one of the key factors of survival in the current competitive business environment in the shipping industry and a way to reduce maritime cost. Moreover, container ports are vital to the efficiency of the whole global logistics chain since they act as the connecting link between different transportation modes in the global logistics chain (Wang et al., 2005; Elsayeh, 2015).

Different approaches and techniques have been used to measure, assess, evaluate and benchmark the port efficiency from different perspectives depending on the aim, objective or the hypotheses of the study. Stochastic Frontier Analysis (SFA) technique was used by (Liu, 1995; Cullinane and Song, 2006; Sarriera et al., 2013); Free Disposal Hull (FDH) technique was used by (Cullinane et al., 2005; Herrera and Pang, 2008); Data Envelopment Analysis (DEA) technique was used by (Poitras et al., 1996; Tongzon, 2001; Al-Eraqi et al., 2008; Merk and Dang, 2012; Kutin et al., 2017); while other researchers have used integrated approaches combing several techniques such as DEA, SFA, FDH and Malmquist Productivity Index (MPI) (Cullinane et al., 2002; Wang et al., 2003; Cullinane et al., 2005; Wanke et al., 2011; Ding et al., 2015; Serebrisky et al., 2016; Hlali, 2018).

The Analytic Hierarchy Process (AHP) approach has not been utilized by previous studies to assess, evaluate or rank the performance of container ports (Al-Harbi, 2001; Cabała, 2010; Li and Yang, 2010; Sumi and Kabir, 2010; Elgazzar et al., 2010; Kousalya et al., 2012; Muhisn et al., 2015). AHP is a decision making technique for establishing priorities in multi-criteria decision making (Al-Harbi, 2001). AHP is most widely used technique in decision making due to its promising accuracy, simplicity, ability to handle both qualitative and quantitative criteria or tangible and intangible aspects, also, its ability to measure the consistency of judgment of respondents (Muhisn et al., 2015).

Using FAHP as a multi criteria decision making technique can help container ports' managers to enhance ports' technical efficiency through identifying the relative importance weight of each dimension of efficiency and define dimensions that are working well and those need improvements. There is no previous research used the FAHP technique to rank the Egyptian container ports. Moreover, limited studies have been conducted to measure the efficiency of the Egyptian container ports (Elsayeh, 2015). In this context, next section will propose a framework to measure the efficiency of container ports using FAHP approach, followed by an empirical study on the Egyptian container ports.

3. The proposed framework

The paper proposes a framework to rank port efficiency using FAHP technique based on the following four steps:

Step one: Identifying the criteria used to evaluate the level of efficiency in a container port

A review of previous studies was conducted to define main criteria reflect the level of container port efficiency. The review concluded with five main criteria to measure the container port efficiency; namely: storage capacity, terminal area, berth length, draught and handling equipment (Tongzon, 2001; Cullinane et al., 2005; Cullinane and Wang, 2010; Nwanosike, 2014; Elsayeh, 2015).

Step two: Developing a FAHP survey to identify the relative importance of the selected criteria

FAHP survey was developed to determine the relative importance weight of the efficiency criteria in a container port based on a pairwise comparison scale ranging from 1 to 9, where 1 denotes equally important, 3 denotes moderately more important, 5 denotes strongly more important, 7 denotes very strongly more important, 9 denotes extremely important (Al-Harbi, 2001; Muhisn et al., 2015). Table 1 illustrates the survey form to prioritise the criteria of a container port's efficiency.

To determine the relative importance weight (W) of the selected criteria, survey will be distributed to group of experts in the field (port authority, shipping companies, shipping agencies, academic experts and other decision-makers in the field).

With respect to (Port efficiency)	***Importance or preference of one factor over the frame of discernment (Decision Alternatives D.A.'s)***									
	Absolutely more important (9)	**Demonstrably more important (7)**	**Strongly more important (5)**	**Slightly more important (3)**	**Equally important (1)**	**Slightly more important (3)**	**Strongly more important (5)**	**Demonstrably more important (7)**	**Absolutely more important (9)**	
Storage capacity	9	7	5	3	1	3	5	7	9	Terminal area
	9	7	5	3	1	3	5	7	9	Berth length
	9	7	5	3	1	3	5	7	9	Draught
	9	7	5	3	1	3	5	7	9	Handling equipment
Terminal area	9	7	5	3	1	3	5	7	9	Storage capacity
	9	7	5	3	1	3	5	7	9	Berth length
	9	7	5	3	1	3	5	7	9	Draught
	9	7	5	3	1	3	5	7	9	Handling equipment
Berth length	9	7	5	3	1	3	5	7	9	Storage capacity
	9	7	5	3	1	3	5	7	9	Terminal area
	9	7	5	3	1	3	5	7	9	Draught
	9	7	5	3	1	3	5	7	9	Handling equipment
Draught	9	7	5	3	1	3	5	7	9	Storage capacity
	9	7	5	3	1	3	5	7	9	Terminal area
	9	7	5	3	1	3	5	7	9	Berth length
	9	7	5	3	1	3	5	7	9	Handling equipment
Handling equipment	9	7	5	3	1	3	5	7	9	Storage capacity
	9	7	5	3	1	3	5	7	9	Terminal area
	9	7	5	3	1	3	5	7	9	Berth length
	9	7	5	3	1	3	5	7	9	Draught

Table 1: FAHP Questionnaire Form

Once judgments are entered by the group of experts, the level of consistency of responses will be tested. To verify the consistency of the comparison matrix, consistency index (CI) and consistency ratio (CR) are calculated using Saaty's method (Saaty and Kearns, 1985).

For any metrics, if the value of the CR is smaller or equal to 10%, the inconsistency is acceptable (Mu and Rojas, 2017); while if the CR is greater than 10%, the pair-wise comparison processes should be repeated until the consistency ratio reaches less than 0.1 (Triantaphyllou and Mann, 1995).

Step three: Establish a performance rating scale to evaluate each efficiency criterion

A five-point performance rating scale (very poor, poor, good, very good and excellent) is established based on container ship features to evaluate the five efficiency criteria in order to assess the efficiency of a

container port. A performance rate (R) is assigned for each criteria (0.2, 0.4, 0.6, 0.8 or 1), where 0.2 denotes very poor performance, 0.4 denotes poor performance, 0.6 denotes good performance, 0.8 denotes very good performance and 1 denotes excellent performance.

Step four: Calculate the efficiency index of a container port

After determining the performance rate (R) and the relative weight (W) of each criterion, the weighted rate (WR) of each criterion is calculated by multiplying the relative weight of each criterion by its performance rate. Finally, the weighted rates of all criteria are aggregated using a weighted average aggregation method to determine the efficiency index of a container port and rank it compared to indices of other ports.

4. Empirical study

Egypt has a primary role in the world supply chain because of its geographic position, being at the intersection of the main maritime flows between East and West of the northern hemisphere. Furthermore, it features some of the major African ports such as Alexandria, Damietta and Port Said (Elsayeh, 2015). Egypt is identified as one of the busiest parts of the continent for maritime trade. The position of countries within global container shipping networks is reflected in the UNCTAD liner shipping connectivity index. In May 2016, Egypt was one of the best-connected countries in Africa (UNCTAD, 2017).

Egypt has six main container ports as clarified in Egyptian Maritime Data Bank (EMDB) (2015): Alexandria port, El Dekheila port, Damietta port, Port Said port, East Port Said port and Sokhna port. Alexandria port is situated on the western end of the Nile Delta between the Mediterranean Sea and the Mariut Lake. It is considered the main port in Egypt and handles over three-quarters of Egypt's foreign trade. El Dekheila port is a natural extension of Alexandria port. Damietta port is located at about 10 Km west of the Nile River and about 70 Km west of Port Said port. Port Said port is located on the northern entrance of the Gulf of Suez. It is considered one of the most important Egyptian ports on the Mediterranean Sea due to its geographical site where it is located on the Eastern entrance of the Suez Canal. East Port Said port has ranked number 41 of the top 50 world container ports in 2015 with 3.60 million TEUs (worldshipping.org, 2018). Sokhna port is located on the western coast of the Gulf ofSuez.

This paper focuses on the six main container ports in Egypt to conduct the empirical study. To demonstrate the applicability of the developed framework, it has been applied on the six main Egyptian container ports based on port capacity data between 2012 and 2016 collected from Egyptian Maritime Data Bank.

The FAHP survey was carried out to determine the relative importance weight (W) of efficiency criteria in the Egyptian container ports. The survey was conducted with a group of 52 experts and decision- makers in the field from: (Egyptian navy, Egyptian Port Authority, shipping companies, shipping agencies and Academic experts in the field). After removing the invalid surveys, responses were analysed using Microsoft Excel Spreadsheets and PopTools add-in (version 3.2 (build 5)) to determine the relative importance weight of each criterion (Hood, 2010).

Table 2 illustrates the relative importance weights of the five main criteria based on survey responses. The results revealed that draught has the highest relative importance weight since draft is a significant factor limiting navigable waterways, especially for large vessels which require deeper draft to attract bigger ships. Handling equipment had the second priority with relative importance weight 29% since effective handling equipment reduces time in port and increases ships call numbers. Storage capacity was placed in the third position with 17% relative importance weight, while both terminal area and berth length approximately had the same relative importance weight presenting the fourth priority.

Criteria	***Priority***	
Storage capacity	17%	3
Terminal area	11%	5
Berth length	11%	4
Draught	32%	1
Handling equipment	29%	2

Table 2: Relative Importance Weights of the Container Port Efficiency Criteria

To verify the consistency of responses, CR and CI were calculated. As illustrated in table 3, the results revealed CR 0.02 which is lower than the maximum accepted Consistency Ratio (0.1) and ensures the consistency of the survey findings.

Consistency test table				
EIGENVALUE	**N**	**CI**	**RI**	**CR**
5.090550009	5	0.0226375	1.12	0.020212056

*Where N presents the number of criteria

Table 3: Consistency Test Results

A five-point performance rating scale was established to evaluate the efficiency criteria based on the features of "the Triple E container ship" which is the biggest container ship that can be handled in the Egyptian container ports. Finally, the weighted rates of all criteria in each port were calculated and aggregated to determine the efficiency index of each port. Table 4 shows the efficiency index of the Egyptian container ports based on the aggregated weighted rates of the five efficiency criteria.

Egyptian container ports/ Criteria	Storage capacity			Terminal area			Berth length			Draught			Handling equipment			effici ency index	Rank
	W	R	WR	W	R	WR	W	R	WR	W	R	WR	W	R	WR		
Alexandria	0.17	0.2	0.03	0.11	0.2	0.02	0.11	0.4	0.05	0.32	0.4	0.13	0.29	0.2	0.06	0.287	6
El-Dekheila	0.17	0.4	0.07	0.11	0.4	0.04	0.11	0.6	0.07	0.32	0.2	0.06	0.29	0.4	0.12	0.359	5
Damietta	0.17	0.2	0.03	0.11	0.4	0.04	0.11	0.4	0.05	0.32	0.6	0.19	0.29	0.6	0.17	0.488	3
East Port Said	0.17	0.8	0.13	0.11	0.8	0.09	0.11	0.8	0.09	0.32	0.6	0.19	0.29	0.8	0.23	0.736	1
Port Said	0.17	0.2	0.03	0.11	0.4	0.04	0.11	0.2	0.02	0.32	0.4	0.13	0.29	0.6	0.17	0.401	4
El-Sokhna	0.17	0.2	0.03	0.11	0.4	0.04	0.11	0.4	0.05	0.32	0.8	0.25	0.29	0.4	0.12	0.494	2

Table 4: The Efficiency Index of the Egyptian Container Ports

The results revealed that East Port Said port has the highest score in the efficiency index (0.736), El-Sokhna port took the second position, Damietta port took the third position, Port Said port took the fourth position, El-Dekheila port took the fifth position and finally Alexandria port took the sixth position with the lowest efficiency index (0.287). The index can be disaggregated to identify criteria that need improvement in the Egyptian container ports.

5. Conclusions

The paper proposed a framework to measure the efficiency level in container ports. An empirical study was conducted on the Egyptian container ports for the period between 2012 and 2016.

This paper considered the first empirical study that assesses the efficiency of the Egyptian container ports using FAHP technique. The proposed framework presented in this research can be used in assessing, evaluating and ranking any container port around the world since the efficiency criteria used in this research are the most common criteria used in evaluating a container port. However, the relative importance weight of each criterion can be varied from one port to another, which can be adjusted using the FAHP survey. For further research, the new world container ships can be used to set higher performance rating scale. For example, OOCL Hong Kong which requires 32.5 m draught and 399.87 m berth length at least (Network, 2018), can be considered as a benchmark to establish international performance rating scale to assess any container port around the world in order to compete globally.

Reference

- Al-Eraqi, A. S., Mustafa, A., Khader, A. T. and Barros, C.P. (2008) "Efficiency of Middle Eastern and East African Seaports: Application of DEA Using Window Analysis", European Journal of Scientific Research, 23, pp. 597-612.
- Al-Harbi, K.M.A. (2001) "Application of the AHP in project management", *International Journal of Project Management.* 19 (1), pp.19-27.
- Cabała, A. (2010) "Using The Analytic Hierarchy Process in Evaluating Decision". *Operations Research and Decisions.* 1. pp. 5-23.
- Cullinane, K., Song, D-W and Gray, R. (2002) "A stochastic frontier model of the efficiency of major container terminals in Asia: assessing the influence of administrative and ownership structures", *Transportation Research,* Part A 36, pp. 743-762.
- Cullinane, K., Song, D-W and Wang. T-F. (2005) "The application of mathematical programming approaches to estimating container port production efficiency". *Journal of Productivity Analysis.* 24. pp. 73-92.
- Cullinane, K. and Song, D-W. (2006) "Estimating the relative efficiency of European container ports: a stochastic frontier analysis", Port Economics*, Research in Transportation Economics.* 16, pp. 85-115.
- Cullinane, K. and Wang, T-F. (2010) "The efficiency analysis of container port production using DEA panel data approaches". REGULAR ARTICLE (2010) 32. pp. 717-738.
- Ding, Z-Y.; JO, G-S.; Wang, y. and Yeo, G-T. (2015) "The Relative Efficiency of Container Terminals in Small and Medium-Sized Ports in China", The Asian journal of shipping and logistics, 31, pp. 231-251.
- Elgazzar, S., Tipi, N.S., Hubbard, N.J. and Leach, D.Z. (2010) "Incorporating fuzzy AHP in SCOR model for measuring supply chain operations performance: a case study of an Egyptian natural bottled water company". In: Proceedings of the 15th Annual Logistics Research Network Conference (LRN 2010), Harrogate, UK, 8-10 September 2010, pp.180-187.
- Elsayeh, M. (2015) "*The impact of port technical efficiency on Mediterranean container port competitiveness",* PhD Thesis. University of Huddersfield.
- EMDB, 2015. "*Maritime Ports Guide (commercial and specialized)".* EMDB management & operation project. Arab Republic of Egypt. Ministry of transport. Maritime transport sector.
- Hood, G. M. (2010) PopTools version 3.2.5. [on line] Available at: http://www.poptools.org
- Haralambides, E. H. (2012) "Ports: engines for growth and employment", European Ports Policy Review,Availablefrom:https://www.researchgate.net/publication/294872325_Ports_Engines_for_

Growth_and_Employment.
- Hlali, A. (2018) "Efficiency Analysis with Different Models: The Case of Container Ports". *Journal of Marine Science: Research & Development.* 8 (2).
- Herrera, S. and Pang, G. (2008) "Efficiency of Infrastructure: The Case of Container Ports", *EconomiA.* 9 (1), pp. 165-194
- Jimenez, Z. I., Gutiérrez, A. and Ortiz, C. (2013) "Port Efficiency in APEC", *México y la Cuenca del Pacífico,* 3, pp. 41-74.
- Kousalya, P., Reddy G. M., Supraja, S. and Prasad V. S. (2012) "Analytical Hierarchy Process approach – An application of engineering education", *Mathematica Aeterna.* 2 (10), pp. 861-878.
- Kutin, N., Nguyen, T., H. and Vallée, T. (2017) "Relative Efficiencies of ASEAN Container Ports based on Data Envelopment Analysis*", Asian Journal of Shipping and Logistics*. 33 (2), pp. 67-77.
- Li, T. G. and Yang, B. (2010) "Study on Green Logistics Operation System of Port Based on AHP-fuzzy
- Comprehensive Evaluation". *2nd International Conference on Industrial and Information Systems.*
- Liu, Z. (1995) "The comparative performance of public and private enterprises". *Journal of Transportation Economics and Policy.* September. pp. 263-274.
- Lu, B. and Wang, S. (2017) *Container Port Production and Management.* 1st ed. Beijing.
- Tongzon, J. L. (2001) "Efficiency measurement of selected Australian and other international ports using data envelopment analysis". *Transportation Research.* Part A 35. pp. 107-122
- Maersk (2015) Maersk Home Page, 1 August 2015, Available from: https://www.maersk.com/-/media/press/trade-reports/africa/egypt/connecting-markets---the-suez-view_large-version.ashx. [Accessed: 1st December 2017].
- Mu, E. and Rojas, M. P. (2017) "Understanding the Analytic Hierarchy Process". Practical Decision Making using Super Decisions. pp. 7-22.
- Muhisn, Z. A. L., Omar, M., Ahmad, M. and Muhisn, S. A. (2015) "Team Leader Selection by Using an Analytic Hierarchy Process (AHP) Technique", *Journal of Software,* 10 (10), pp. 1216-1227.
- Merk, O. and Dang, T. T. (2012) "Efficiency of world ports in container and bulk cargo (oil, coal, ores and grain)". *OECD Regional Development Working Papers.* 2012/09.
- Nwanosike, F. O. (2014) "*Evaluation of Nigerian Ports Post-concession Performance".* PhD Thesis. University of Huddersfield.
- Network, M. (2018). 10 World's Biggest Container Ships in 2017. [online] Marine Insight. Available at: https://www.marineinsight.com/know-more/10-worlds-biggest-container-ships-2017/.
- Poitras, G., Tongzon, J. and Li, H. (1999) Measuring Port Efficiency: An Application of Data Envelopment Analysis. *Department of Economics and Statistics,* National University of Singapore.
- Saaty, T. L. and Kearns, K. (1985) "*Analytical Planning; The Organization of Systems",* Oxford: Pergamon Press.
- Sarriera, J. M., Araya, G., Serebrisky, T., Briceñogarmendía, C. and Schwartz, J. (2013) "Benchmarking Container Port Technical Efficiency in Latin America and the Caribbean", *The World Bank Latin America and the Caribbean Region Sustainable Development Department.* Policy Research Working Paper 6680.
- Serebrisky, T., Sarriera, J. M., Suárez-Alemán, A., Araya, G., Briceño-Garmendía, C. and Schwartz, J. (2016) "Exploring the drivers of port efficiency in Latin America and the Caribbean". *Transport* Policy. 45. pp. 31-45.
- Sumi, R. S., and Kabir, G. (2010) "Analytical Hierarchy Process for Higher Effectiveness of Buyer Decision Process". *Global Journal of Management and Business Research,* 10 (2). pp. 1-9.
- Triantaphyllou, E. and Mann, S. H. (1995) "Using The Analytic Hierarchy Process for Decision Making in Engineering Applications: Some Challenges". *Inter'l Journal of Industrial Engineering: Applications and Practice*,2 (1). pp. 35-44.

- UNCTAD (2017) Review of Maritime Transport. United Nations. New York.
- Wanke, P. F., Barbastefano, R. G. and Hijjar, M. F. (2011) "Determinants of efficiency at major Brazilian port terminals", *Transport Reviews.* 31 (5), pp. 653-677.
- Wang, T. F., Song, D. W. and Cullinane, K. (2003) "Container Port Production Efficiency: A Comparative Study of DEA and FDH Approaches". *Journal of the Eastern Asia Society for Transportation Studies.* 5. pp. 698-713.
- Wang, T. F., Cullinane, K. and Song, D. W. (2005) "*Container Port Production and Economic Efficiency".* Palgrave Macmillan, Basingstoke, Hampshire; New York. DOI. 10.1057/9780230505971.
- Worldshipping.org. (2018*). Top 50 World Container Ports | World Shipping Council.* [online] Available at: http://www.worldshipping.org/about-the-industry/global-trade/top-50-world-container-ports.

ANALYSIS OF THE EFFECT OF REVERSE LOGISTICS ON CONTAINER SHIPPING IN NIGERIA

Geraldine N. Okeudo and Ibeawuchi C. Nze
Department of Transport Management Technology, Federal University of Technology, Owerri, Nigeria

1. Introduction

The genesis of reverse logistics has been attributed, at least in part, to the emergence of inexpensive materials and advanced technologies that accompanied the Industrial Revolution of the 1800's. Experts contend that during this time Western societies fell into a practice of mass production and routine throw away, with little concern for environmental matters or sustainable development. (De Brito and Dekker, 2003) The negative effects of such practices did not become readily apparent until nearly a century later.

By the 1970's, The Club of Rome, a non-profit, global think-tank, argued that there was a limit to the ongoing world growth trend. They concluded that if the then present trends in population, industrialization, pollution, and resource depletion continued unchanged, the limits to growth on this planet would be reached sometime within the next century, resulting in an uncontrollable decline in both population and industrial capacity. Throughout the decade that followed, this report along with several prominent environmental disasters kept the minds of academia, industry, and society in general, focused upon such environmental issues (De Brito and Dekker, 2003).

This increased social concern led to new laws and regulations that changed the relationship between business and the environment. Many companies quickly learned that the success of proactive and value-seeking waste reduction programs often hinged on effective logistics programs. Source reduction, recycling, and reuse posed new challenges to logistics professionals, who had generally not been involved with these types of environmental issues in the past. Because of these new challenges, the logistical management of environmental programs quickly became a new area of focus for both industry and academia.
As a result, the subject of reverse product and material flow began to surface in the academic arena during this same period of the 1970's. Some schools of thought had earlier identified distinct reverse channel structures and functions, as well as channel members that are unique to reverse distribution. Because of the environmental focus of this era, the topic of reverse channel management was often labelled green logistics or environmental logistics.

The actual term reverse logistics did not surface until a 1981 trade publication authored by Douglas Lambert and James Stock. In their article, Lambert and Stock described RL as "going the wrong way down a one-way street, because the majority of product shipments flow in one direction". Stock later published the first known formal definition of reverse logistics as '…the term used to refer to the role of logistics in recycling, waste disposal, and management of hazardous materials; a broader perspective includes all relating to logistics activities carried out in source reduction, recycling, substitution, reuse of materials and disposal (Stock, 1998).
Stock's definition was clearly environmentally focused. However, it is important to note that while modern RL practices have evolved from green logistics, the two differ significantly. Green logistics considers the environmental aspects of all logistics activities, and concentrates specifically on forward logistics operations rather than reverse channels (De Brito and Dekker 2003).

Similarly, Rogers and Tibben-Lembke (1999) describe green logistics as the efforts to minimize the environmental impact of logistics activities, while reverse logistics should be reserved for the flow of products or materials going "the wrong way on a one-way street".

Although green logistics and reverse logistics focus on distinctly different operations, the two can also be equally applied to many similar activities. For example, reusable shipping containers may be classified under either concept, as these containers tend to reduce waste and also cut costs when collected and reused.

1.1 Objectives of the study

In light of the research problems raised in the introductory part, the aim of this work is to determine the effect of reverse logistics in the container shipping industry in Nigeria having the following specific objectives;

i. To determine the rate of movement of empty and laden containers through Nigerian ports
ii. To determine the effect of reverse movement of containers through the Nigerian ports on the environment and balance of trade

1.2 Research questions

i. At what rate are the respective movement of empty and laden containers through the Nigerian ports?
ii. What is the effect of reverse container movement through the Nigerian ports on the environment and balance of trade?

1.3 Hypothesis

The hypothesis to be tested include

i. H_{0i} – There is no significant effect of reverse logistics on factors affecting container shipping in Nigeria

2. <u>Method of Data Analysis</u>

Data analysis is simply processing generated data. Method of data analysis on the other hand states how the processing will take place in other words, what technique will be used to achieve this processing. Data processing involves the transfer of collected data to coded data for further processing through the use of a data processing instrument. The data gathered will be presented in tables and further calculated using the method of Regression Analysis. The regression analysis will be performed by software for statistical analysis, SPSS version 20 (being the short form for statistical products and service solutions formerly known as Statistical package for Social Sciences).

Regression Analysis is a statistical tool for the investigation of relationships between variables. It can also be defined as a statistical tool that helps to predict one variable or variables on the basis of assumed nature of the relationship between the variables. It estimates the quantitative effect of the casual (independent) variables upon the variables that they influence (dependent variables). Usually, the investigator seeks to ascertain the casual effect of one variable upon another.

The variable being predicted is usually referred to as the unknown or dependent variable. This is because its variables are dependent on the values of other variables, called independent variables or explanatory variables. The relationship between dependent and independent variables is defined thus:

$Y_i = B_0 + B_1X_1 + B_2X_2 + ...+ b_kX_k + e_i$

For i=1, 2, 3, ..., n

Where:

$x_1, x_2, ..., x_k$ represents the independent variables;

Y represents the dependent variable;

e is the disturbance term (error);

$B_0, B_1, B_2 .....b_k$ are the co-efficient of the independent variable, X.

The hypothesis will be tested using f-test, t-test and Pearson's correlation-test to test hypothesis one because it seeks to discover individual significance of Reverse Logistics in container shipping. Pearson's correlation will also be used to test hypothesis one to show if any correlation exists with or to the dependent variable.

ANOVA f-test will be used to test hypothesis two as it seeks to show the effects of cargo throughput and logistics on the Nigerian economy.

The significance of the regression model will be tested using the co-efficient of determination (R^2) and ANOVA. The co-efficient of determination would give the proportion of total variation in Y that is responsible by X or by the regression equation. ANOVA on the other hand will be used to test the reliability of the regression model.

Decision Rule: the level of significance adopted for this research work is 0.05(i.e. the error permissible) and so for the tests (f-test and t-test), at a value less than 0.05 we reject the null hypothesis and accept the alternative hypothesis. For a value above 0.05, we accept the null hypothesis and reject the alternative hypothesis.

3. Results and Discussion

3.1 Descriptive Statistics

YEAR	INWARD				OUTWARD			
	NO. OF EMPTIES	LADEN		T.E.U	NO. OF EMPTIES	LADEN		T.E.U
		NO	TONS			NO.	TONS	
1995	1,201	93,379	1,355,828	108,446	50,650	26,166	371,222	88,442
1996	2,780	94,449	1,367,409	133,196	38,383	35, 858	533,587	86,648
1997	1,750	105,200	1,542,785	127,165	52,855	39,366	630,902	109,518
1998	2,698	127,884	1,847,386	157,491	69,004	38,542	627,608	129,166
1999	2,659	147,553	2,142,932	184,048	90,317	41,184	665,333	160,306
2000	9,133	162,534	2,355,540	214,873	90,317	37,501	603,336	129,356
2001	7,361	209,634	3,238,007	277,807	124,564	37,038	578,237	205,416
2002	1,270	227,102	3,860,339	293,909	159,726	34,103	528,429	251,888
2003	697	259,055	4,737,740	338,946	157,710	36,682	563,698	249,647
2004	886	230,098	4,007,486	306,762	124,748	32,087	494,036	207,192
2005	410	245,773	4,684,915	326,766	148,258	39,5494	629,847	248,476
2006	584	255,301	5,023,878	349,234	245,400	33,340	517,546	287,821
TOTAL	31,429	2,157,962	36,164,245	2,818,643	1,351,932	431,461	6,743,781	2,727,956
PERCENTAGE (%)	6.79	83.34	84.28	50.82	93.21	16.66	15.72	49.18

Table 1: Container Traffic Statistics at Nigerian Ports 1995-2006

Table 1 shows the container movement statistics through Nigeria ports for a 12 year period. This reveals a total number of 462,890 empty containers that moved through the ports both inward and out wards. This indicates a 6.79% inward empties and 93.21 out ward empties. Also from the table we deduce that a total number of 2,589,423 laden containers moved through the ports giving about 83.34% of inward laden containers and 16.66% of outward laden containers.

3.2 Correlations of the Variables

	Value	Ranking
Reverse Logistics	1.000	00
Exportation	0.70	1st
Environmental Hazard	-0.689	3rd
Balance of Trade	-0.332	2nd

Source: SPSS v20 Output

Table 2: Variables relationship derived from the correlation matrix

It can be seen from table 2 that when the independent variables are compared against the dependent variable it is found that Exportation has the highest effect on Reverse Logistics with a value of 0.70, followed by Balance of Trade with a value of - 0.332, then Environmental Hazard with a value of 0.689. Therefore, it can be deduced that Exportation having 0.70 effects on Reverse Logistics.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	39.275	2.602		15.092	.000
	Exportation	-.937	.096	-1.113	-9.799	.000
	environmentalHazard	-1.012	.079	-1.101	-12.875	.000
	balaceOfTrade	-.982	.129	-.739	-7.627	.000

Source: SPSS v 20.

Table 3: Coefficients

The Sig. column in table 4.3 above shows the significant difference in the variables being tested. For values less than 0.05 which is the level of significance adopted for this work, we interpret that a particular variable can stand alone without the combination of other variables. From the table above, all the variables have a value less than 0.05; which means that they can all impact or affect Reverse logistics. From table 2 we deduce that 0.70 gives the strongest correlation equivalent between the independent variables and the dependent variable when tested for its effect on the dependent variable. This change that exists in the correlation values tells us that there is a significant difference between variables and their effect on reverse Logistics.

To further buttress this, we use the 2-tail T-test. From table 3, the sig. column tells us the level of significance of each of the variables being tested. Because an error of 0.05 is permissible we conclude that values of a variable less than 0.05 means that the variable independently have significant impact the container shipping industry, while for values above 0.05 we say that the variability is about the same. The table shows us that reverse logistics has a value less than 0.05 meaning that reverse logistics alone can have significant impact the container shipping industry without a combination of the other variables. All other variables have values below 0.05 as well this also means that they have impact on container shipping. This further proves to us that there is a significant difference between these factors and their effect on container shipping. Based on this analysis, we therefore reject the null hypothesis H_{01} and accept the alternative hypothesis H_{A1}.

3.3 Analysis of Variance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1111.782	3	370.594	67.215	.000[b]
	Residual	88.218	16	5.514		
	Total	1200.000	19			

a. Dependent Variable: reverseLogistics

b. Predictors: (Constant), balaceOfTrade, environmentalHazard, Exportation

Source: SPSS version 20.

Table 4 Analysis of Variance

The decision rule states that at $F_{0.95}$ less than 0.05, we reject the null hypothesis and accept the alternative hypothesis. For $F_{0.95}$ greater than 0.05 we accept the null hypothesis and reject the alternative hypothesis. From table 4.4, we see that the sig. column gives us a value less than 0.05 which is 0.000 meaning that we reject the null hypothesis H_{02} and accept the alternative hypothesis H_{A2}.

Furthermore, if manually computed, we reject the null hypothesis if f_{calc}(that is f-calculated) is greater than f_{table}(that is the value of f gotten from the f-table) and accept the alternative hypothesis. If otherwise, we accept the null hypothesis and reject the alternative hypothesis.

From the table above, $f_{calc} = 67.215$, $f_{table} = F_{0.95(4,26)} = 2.74$, $67.215 > 2.74$. Therefore, we reject the null hypothesis H_{02} and accept the alternative hypothesis, H_{A2} which proves that there is a significant impact these variables on container shipping.

3.4 Formulation of Model and Interpretation

The regression model is given by: $Y_i = B_0+B_1X_1+B_2X_2+.....+b_kX_k+e_i$
For i=1, 2, 3,....., n
Where:
$x_1, x_2, ..., x_k$ represents the independent variables;
Y represents the dependent variable;
e is the disturbance term (error);
$B_0, B_1, B_2.....b_k$ are the regression weights. B_0 is a constant while $B_1, B_2, ... B_k$ are coefficients of the independent variables, $X_1, X_2, ... X_k$ respectively.
The model is formulated using the model summary table from where the e is gotten and the Coefficient table from where the B's are gotten.
RVL = Reverse Logistics
EXP = Exportation
EVH = Environmental Hazard
BOT = Balance of Trade
The model is stated thus:
$Y = 39.275 - 0.937X_1 - 1.012X_2 - 0.982\ X_3 + e_i$

$RVL = 39.275 - 0.937EXP - 1.012EVH - 0.982\ BOT + e_i$
Interpretation: The regression model above shows that Reverse Logistics RVL (Y) increases (decreases) by 0.937 for every one unit increase (decrease) of Exportation EXP(X_1), increases

(decreases) by 1.012 for every one unit increase (decrease) in Environmental Hazard (X_2), and so on. This means that for every one unit addition (reduction) in the use of a particular variable, there will a corresponding co-efficient value increase (decrease) on Y.

3.5 Test of Significance of the Model

The regression model obtained above was tested for its significance using ANOVA and co-efficient of determination, R^2.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.963[a]	.926	.913	2.34810	.926	67.215

Model Summary[b]

Model	Change Statistics			Durbin-Watson
	df1	df2	Sig. F Change	
1	3	16	.000	2.256

a. Predictors: (Constant), balaceOfTrade, environmentalHazard, Exportation

b. Dependent Variable: reverseLogistics

Source: SPSS v20 output

Table 5: Model Summary

From table 5, R^2 is given as 0.926= 92.6% ~ 93%. This means that the variables tested accounted for 93% effect on Reverse Logistics while the remaining 7% is unaccounted for and represented by the error term, e in the model. This is so because achieving a high level of efficiency in Reverse Logistics considering these variables is a must. Furthermore, table 4.5 gives us an f-significant value lower than 0.05 (which is the error permissible); 0.000, gotten from the sig. column, and so we conclude that the model is significant and that the analysis drawn from it is reliable for decision making.

4. Summary and Conclusion

4.1 Summary of Findings

The research reveals a great impact of reverse logistics on terminal efficiency, as the key variables which decide the effectiveness of reverse logistics were considered. The factors influencing the effectiveness includes: exportation, Balance of Trade and Environmental Hazard which were significantly related to reverse logistics in the inverse form. This implies that an increment in the reverse logistics would lead to reduced environmental hazards, exportation and balance of trade with respect to the overall logistics and supply chain network.

4.2 Conclusion

Results show that the null hypothesis which states that “there is no significant effect of reverse logistics on container shipping in Nigeria” is not valid or does not hold. This implies that the converse of this state is true. The alternate hypothesis holds as verified by the t- test that shows a significant relationship between the variables.

References

- De Brito, M. P. & Dekker, R. (2003), A frame work for Reverse Logistics. *ERIM Report Series Research in Management*, ERS- 2003- 045-LIS, pp1- 25.
- Rogers, D.S. & Tibben – Lembke, R. S. (2002), 'Going Backwards: Reverse logistics trends and Practices', *Reverse logistics Council*, Pittsburg PA.
- Stock, J.R. (1998), Development and Implementation of Reverse Logistics Programs, *Council of Logistics Management,* Oak Brook, IL.

MODAL SHIFT TO INLAND WATERWAYS: DEALING WITH BARRIERS IN TWO SWEDISH CASES

Sara Rogerson[1], Vendela Santén[1], Martin Svanberg[1], Jon Williamsson[2] and Johan Woxenius[2]
[1]SSPA Sweden AB, Göteborg, Sweden
[2]Department of Business Administration, School of Business, Economics and Law, University of Gothenburg, Göteborg, Sweden

Introduction

One way to reduce environmental impact from freight transport is to shift transport of goods from road to sea. In comparison, sea transport most often generates less emissions such as CO_2 (Medda and Trujillo, 2010) and hence, shifting from road to different types of sea transport has been advocated by both national and international authorities. The EU has over the last two decades promoted different types of initiatives such as the Marco-Polo, Ten-T and Motorways of the Sea to induce a shift from road to short sea shipping (SSS) (Baird, 2007, Garcia-Menendez and Feo-Valero, 2009). Inland waterway (IWW) shares similarities with SSS in terms of comparable sizes of vessels and competition with road transport, but also has an unutilised potential for a modal shift. In particular, road and rail infrastructure can be relieved from congestion, which is of importance in urban areas, where ports often are located (Browne*, et al.*, 2017).

While IWW transport is more common in Northwestern Europe, it is less common in Sweden. IWW transport in Northwestern Europe provides transport along rivers and canals and between ports and their hinterlands. In the Netherlands, with the largest share of inland waterway transportation in Europe, 18% of the goods volume is transported on IWW (CBS, 2016). In Sweden, the figures are much smaller, only 3% of the goods volumes make use of domestic sea transportation, in which 0,7 % is transported on IWW (Trafikanalys, 2016). In Sweden, from the 14th century until the early 1990s, rivers were used for floating logs to iron mills and paper and saw mills on the coast, but nowadays the majority of the small volume of IWW transport consists of transports of soil, stone, gravel and sand (Trafikanalys, 2017). As a result, container transport by IWW is rare.

Previous research on IWW transport has identified various types of barriers for a modal shift from road to sea: regulatory, financial, service and market related (described further later in the paper). In order for a modal shift to take place, actors need to take external prerequisites into account, but foremost, offer competitive services that can overcome the barriers. In Sweden, actors have to take major steps to attract a larger volume of goods that will enable the shift to IWW transportation. Barriers and key issues for implementation need to be understood from the perspective of how actors can overcome them. Therefore, the aim of this paper is to analyse how barriers for a modal shift can be overcome, by studying actors in the start-up phase of offering IWW transport services.

This study contains the following steps, 1) a literature review, 2) collecting data in two case studies, 3) collecting data from actors involved in Swedish IWW transportation, and 4) analysing collected data with regards to actor interactions to overcome barriers. Interviews were made several times and over 12-18 months for each case study and also, data was gathered from presentations and reports that the two entrepreneurs were producing. Moreover, data relevant to the two cases was collected from ports, logistics operators, goods owners and authorities, through two workshops and five interviews. Data was analysed, primarily to identify the barriers faced by the firms involved in the two case studies and their approaches to manage these barriers.

The following sections describe IWW and what hampers its growth in Sweden, and analyse ways forward in the empirical context of two case studies on the start-up phase of IWW transport services. The paper continues with the case study results and a concluding discussion.

Barriers and key issues for Inland waterway transportation

This section details earlier findings of relevance to IWW, based on studies of IWW in Sweden and Europe. Earlier studies have identified various barriers and key issues for modal shift from road to sea, among which four main categories can be identified: regulatory, financial, service quality and market characteristics. The barriers are summarised in Figure 1.

There are **regulatory** issues, specific to the Swedish setting, which create barriers. First of all there is uncertainty regarding regulation which by itself causes problem (Otterström and Torpfält, 2016). The background is that the regulation of IWW vessels is relatively new and has not been tested in Sweden. This creates uncertainty regarding for example cabotage (Garberg, 2016) or requirements on personnel (Otterström and Torpfält, 2016, Treiber and Bark, 2018). Moreover, regulations regarding piloting fees and fairway dues are set by authorities and are highlighted as influencing the costs to a large extent (Garberg, 2016). Regulatory issues also include the agreements with dockers/stevedores, which result in high costs for transhipment activities, and make it difficult for vessel personnel to perform transhipment (ibid). Regulatory issues also include investments in infrastructure of other modes (ibid) and regulations regarding competing modes, such as fees for railways.

Earlier studies reveal several key **financial** issues making it difficult to establish an IWW transport service. The various costs influence the competitiveness compared to other modes of transport, not least due to the large trucks (25,25 m and 64 tons - 74 tons on some main roads - allowed in Sweden) and well-developed rail freight system. The cost of pre/post-haulage (Konings, 2009, Wiegmans and Konings, 2015, Vierth*, et al.*, 2012), the additional handling costs (ibid.), port charges (Garberg, 2016, Olsson and Ronold, 2017), fairway dues (ibid), and piloting fees (Olsson and Ronold, 2017). Fee structures of other modes also affect the competitive situation (Vierth*, et al.*, 2012). There is also uncertainty regarding some of the costs, making it difficult for an entrepreneur calculating a business case. Additionally, there are investment costs and financial risk associated with starting a new business, for example investments in equipment in the ports (Olsson and Ronold, 2017). Lack of qualified personnel can also be an issue which drives up the cost of operations (Vierth*, et al.*, 2012).

Besides costs, several important issues related to **service quality** can be identified in earlier studies. Service quality issues are important when companies buying freight transport select transport service. Key issues for the selection of transport service are cost, transport time, reliability and transport quality, where the latter includes for example on-time deliveries and transport damages (Flodén, Bärthel and Sorkina, 2017). Previous studies discuss issues related to transport time, frequency and reliability. Long transport time (Konings, 2009, Meers*, et al.*, 2017, Vierth*, et al.*, 2012) is highlighted as difficult in the competition against road transport, particularly due to the time for loading and unloading barges (Konings, 2009). In ports, temporary quay stacking and additional handling is likely needed, and time schedules of vessels needs to be matched with crane availability (Konings, 2009). Various systems have to be integrated for IWW transport to function smoothly, such as aligning lock planning and quay handling (Caris*, et al.*, 2014). Frequency is also highlighted as important for shippers to select IWW transport (Konings, 2009, Meers*, et al.*, 2017, Otterström and Torpfält, 2016). The frequency offered to shippers is also related to the vessel size (Vierth*, et al.*, 2012). IWW transport is viewed as reliable (Konings, 2009), but earlier studies highlight issues such as prioritisation of transhipment in ports (Konings, 2009, Vierth*, et al.*, 2012) as possibly affecting the reliability. Also, resistance to change existing transport mode has been identified (Garberg, 2016) which means that a mental shift is thought to be required for customers to use IWW (Meers*, et al.*, 2017, Vierth*, et al.*, 2012).

IWW transport services are offered on markets with specific characteristics that act as barriers to new entrants. These **market characteristics** mainly relate to the volume of goods required, competition from other modes of transport, conditions of the waterways, pre-requisites of vessels, business models and environmental concerns. For an IWW transport to persevere there has to be enough volume of

goods, and concerns have been brought up that the potential volume is limited (Garberg, 2016), by the amount of goods that can carry the extra cost of handling. The competitive situation versus other modes of transport is also frequently discussed, that fee structure differ (Vierth et al., 2012) and that competition on price is difficult (Garberg, 2016). Conditions of the waterway create the boundaries for the vessels that can be used. Water levels (Vierth*, et al.*, 2012) and height of bridges (Konings, 2009) has been mentioned in other countries as difficulties. Also, prioritisation between traffic on land and waterways is an issue at certain bridges (Garberg, 2016). Vessels have to be adapted to the conditions of the waterways and the weather, including height of waves and possibility of ice on the Swedish lakes (Garberg, 2016, Olsson and Ronold, 2017). It is also a concern that specialised vessels, are not flexible regarding type of goods that can be transported (Vierth*, et al.*, 2012) and that IWW vessels cannot sail on alternative routes (ibid). It has also been identified that potential locations of inland ports may vanish, as land is used for other purposes (Garberg, 2016). Additionally, since IWW transport of containers is rare, financially successful business models are yet to be established (Otterström and Torpfält, 2016), and opinions are voiced that there are not enough business opportunities for containerised IWW transport in Sweden (Garberg, 2016). Finally, environmental advantages have been used by waterway transport as an opportunity but earlier studies also highlight a need to beware that other transport modes are improving faster and that emissions of SOx, NOx and particles are high for IWW transport (Caris*, et al.*, 2014, Fridell, 2011, Vierth*, et al.*, 2012).

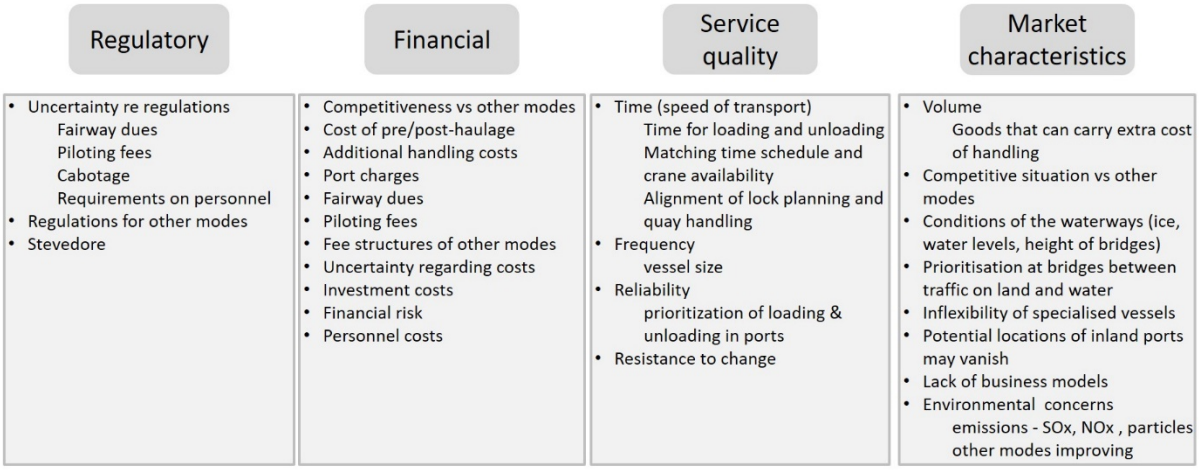


Figure 1: Barriers and key issues for implementation identified from literature

Case descriptions

To provide some background to the cases, the use of IWW in Sweden differs from Continental Europe in the sense that IWW connects the sea with two large lakes with ice conditions and rather high waves. Lake Vänern, the largest lake in the EU, is connected to the sea and Port of Gothenburg via the River Göta and Lake Mälaren via locks in Stockholm and Södertälje. With container transport on IWW being rare in Sweden, ports along the inland waterways do not operate services for container shipping and equipment, such as proper container cranes, are missing. Container transport may differ from other types of IWW transport (mainly bulk) in the type, volume and value of goods. Also, the distance to the quay is often close in industries traditionally using the waterways. Container transportation makes it possible though to consolidate goods of different types and from different goods owners.

Two entrepreneurs with ambitions to start offering IWW container services are described below. Figure 2 highlights the IWW as well as the locations of the start and end points, where both cases frequent Göteborg, while case Barge turns around in Trollhättan, and case Feeder has a longer journey and turns in Kristinehamn. The actors involved are similar in both cases: the focal company has the role of shipping lines, and interacts with vessel operators, companies sending and receiving goods

(shippers), road hauliers (performing the pre- or post-haul by truck), forwarders arranging the transport on behalf of shippers, seaport terminal, port authorities, inland port terminal, municipalities, the Swedish Transport Agency (draws up regulations and grants permits) and Swedish Maritime Administration (e.g. provides pilots).

Case Barge consists of starting up a container shuttle between Gothenburg and Trollhättan on the river Göta Älv, a distance of approximately 80 kilometres. Five locks are passed on the way. The idea is to transport relatively large flows of goods from shippers in both directions. Initially one shipper with large goods flows from Trollhättan to Gothenburg and another shipper with large goods flows in the opposite direction have shown interest in transferring their goods from truck to IWW transport. An IWW vessel will be brought in from within EU. The focal company in case Barge is still defining the business model. A proof of concept of the route was run in 2017 showcasing barge transport from Göteborg to Vänersborg (close to Trollhättan), unloading and loading onto truck. A partnership with a vessel owner has been established.

Case Feeder consists of starting up a container shuttle between Gothenburg and Kristinehamn on the river Göta Älv and lake Vänern. Six locks are passed on the way. Lake Vänern has stricter rules regarding vessels than Göta Älv due to higher waves. The vessel to use will be able to perform shipping on open sea (IMO vessel). The idea is to consolidate goods from and to many shippers in the region around Kristinehamn and offer a timetable with a minimum frequency of 2 departures per week from Kristinehamn.

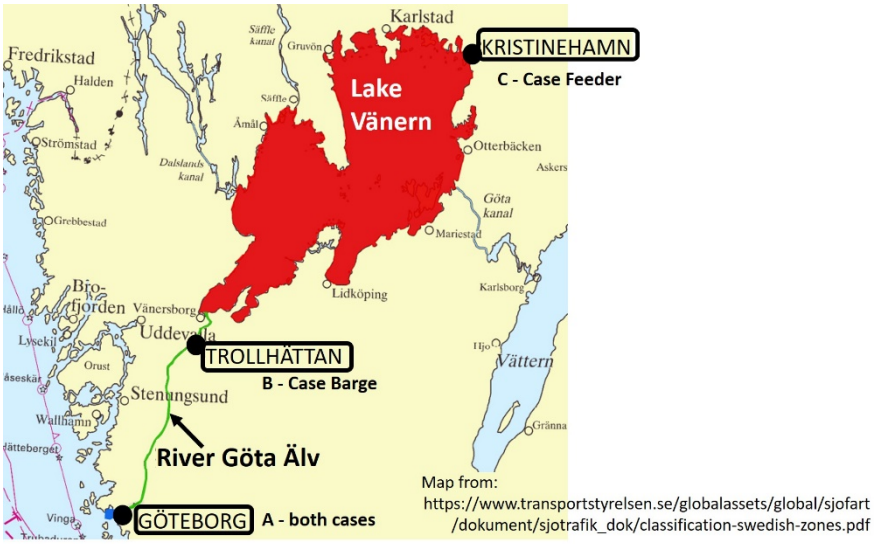


Figure 2: Showing start and end points for the two cases.

Results

As described above, previous studies have revealed barriers and key issues for increased use of IWW. Many of these barriers are evident in the studied cases. This section explains how some of the barriers and key issues can be managed, in particular through the involvement of actors with various motives, drawing on findings in the two Swedish cases. The strategies used by the entrepreneurs to overcome the barriers are summarised in Figure 3.

Some of the key **regulatory** issues for implementation relate to the fee structure for IWW, including fairway dues and piloting fees. Entrepreneurs starting up IWW transport need to interact with regulatory actors to understand the fee structures, e.g. where piloting is required, fees for piloting, rules regarding exemptions, and possibilities of exemption during start-up. Also, in Sweden, there is a

need to increase knowledge among regulatory actors regarding IWW transport, for example since the IWW directive is new and not yet applied to container transport. The entrepreneurs in the studied cases have tried to lobby with regulatory actors to increase their understanding of characteristics of container transport on IWW, to ensure that these particulars are taken into consideration for regulations of water transport in general. Initiatives to increase knowledge have been undertaken, such as seminars and the proof-of-concept. Also, the benefits of assigning responsibility for modal shift and use of inland waterway transport has been put forward.

Some of the key **financial** issues for implementation relate to the port, i.e. port charges. For the seaport terminal new goods flows from traffic on IWW result in differences in unloading, loading, handling, operational cost of equipment, storage, labour and possible investments needed. For example, the existing cranes in the sea port terminal are built for larger vessels and thus have lower productivity for smaller IWW vessels. The entrepreneur needs to be aware of these issues when communicating regarding port charges and the costs that the port terminal may need to cover. On the other hand, the port needs to be aware of the particular characteristics of the IWW set up, especially since it differs to their normal clients, but also the additional traffic of goods IWW can bring to the port. This may help the port realise that the normal fee structure needs adaptation. After clarifying these issues, negotiations between the entrepreneurs and the port terminal resulted in agreeing a fee structure adapted to port calls for IWW vessels (Case Feeder).

Another key **financial** issue for implementation concerns the inland ports. These rarely get container transports, and may therefore need to invest in facilities and equipment, such as cranes, or, to enable call at the port, adapt the quay for new vessel types. To manage risks during start-up a crane can be rented or bought second-hand. The entrepreneurs in the cases have interacted with the inland ports to explain how IWW transports can be seen as a new business opportunity. Containerized IWW wil, not only attract additional goods flows, but also create opportunities for added value services, such as stuffing, storage or a depot for empty containers. Offering stuffing and storage services would require interaction between the inland port and the shippers. Setting up a depot for empty containers would benefit shippers that are located closer to where containers need to be returned, and the associated container demurrage costs. It might also bring benefits to the local municipality, in terms of creating new jobs and making the region attractive to companies. Setting up a depot would require agreements between the depot and shipping lines that own the containers.

Two key issues for implementation related to the **service quality** are frequency and reliability. A frequency of service at least twice a week was needed according to discussions between the entrepreneurs and shippers, and a timetable established. To establish a timetable it is necessary to consider internal operations of and interactions with seaport and inland ports. The service should not call at the port too seldom. Also, the timetable needs to be adjusted to the schedule of the main line, both so that containers do not have to be stored long in the port, but also because this will affect the capacity in the seaport. Furthermore, arrival punctuality of the main line is not precise as weather conditions may cause delays, and the inland service needs to take this into account, so that the vessel is not scheduled to leave before the containers are loaded. Meanwhile, it is of interest to the port that the vessel spends as short time as possible in the port. The entrepreneurs in the study prepared timetables with information regarding closing that were provided to shippers. Regarding reliability, it is important for the port to be able to plan work and capacity utilisation. Reliability is also an important aspect when trying to convince shippers and forwarders to use IWW services. Hence, the entrepreneurs had to establish trust among actors that considered reliability as an essential feature of logistical services. Consequently, despite that a proof of concept had been performed, the necessity of arranging for back-up solutions that could be implemented with short notice was considered. This, in turn, requires agreements between the entrepreneur and hauliers.

A key barrier related to **market characteristics** is attracting the volumes that are necessary for a business to be viable. For start-up this meant establishing continuous flows with specific volumes, as well as securing the initial volumes necessary to start the businesses. Most shippers do not have enough volume to fill a vessel, and thus several shippers need to be interested and contacted by the entrepreneurs. In the studied cases many shippers showed great interest in the IWW solutions presented, but it took time and effort to get them to sign letters of intent. One strategy was to ask shippers to commit a smaller percentage of their volumes initially. Another strategy was to target shippers with very large volumes to quickly accumulate enough volume. Marketing arguments regarding environmental improvements compared to road transport were persuasive but the cost had to be competitive. Moreover, for the business to work for shipping lines, there has to be sufficient volumes in both directions, while, shippers often do not have shipments in both directions. Thus, the entrepreneurs targeted shippers with large flows in opposite directions to ensure capacity utilisation. The proof-of-concept was important to show the feasibility.

Another key issue for implementation related to **market characteristics** is the first/last mile of transport. First/last mile transport between inland port and shipper is needed since not all shippers are located by the riverside or the port. Shippers may want to only be in contact with one transport provider for the sea leg as well as the first/last mile. The entrepreneur can then offer transport on land for the first/last mile. To arrange this service entrepreneurs need to establish partnerships with hauliers. These hauliers need to ensure that capacity in terms of vehicles are available when needed. Also interaction with forwarders is needed. If forwarders are buying the sea transport they may arrange the last/first mile, thus requiring a different offer from the entrepreneurs. Furthermore, since shippers want to be able to compare the cost of the IWW service including first/last mile, with other modes, forwarder, haulier and shipping line need to agree to cost-sharing between main leg and first/last mile.

Regulatory	Financial	Service quality	Market characteristics
Barriers/key issues • *Fairway dues* • *Piloting fees* • *Uncertainty re regulations* Strategies LOBBYING PROOF OF CONCEPT EDUCATE RESPONSIBILITY Actors interacting Shipping lines – Regulatory actors	Barriers/key issues • *Port charges* • *Investment* • *Financial risk* Strategies NEGOTIATION EDUCATE TO CUSTOMIZE RENT/SECOND-HAND EQUIPMENT/ PARTNERSHIP Actors interacting Shipping lines – seaport terminal Shipping line – inland port terminals	Barriers/key issues • *Frequency* • *Reliability* Strategies TIMETABLE PROOF OF CONCEPT BACKUP Actors interacting Shipping lines – shippers Shipping lines – seaport terminal Shipping lines – inland port terminals	Barriers/key issues • *Volume* • *Transport first/last mile* Strategies SHIPPERS WITH LARGE FLOWS IN BOTH DIRECTIONS SMALL SHARE PROOF OF CONCEPT ESTABLISH PARTNERSHIPS BUSINESS MODEL Actors interacting Shipping lines – shippers Shipping lines – forwarders Shipping lines – hauliers

Figure 3: Strategies for managing barriers and key issues for implementation and actor interaction

Concluding discussion

Many of the barriers and key issues for implementation of modal shift to IWW described in earlier studies, were also found in the studied cases of entrepreneurs starting container shuttles. In the Swedish context certain barriers carry more or less weight compared to what would be the case in other countries. For example, the conditions of the Swedish waterways are generally good with regards to water levels, width and depth of the waterway, or height of bridges. Instead, the main issue appears to be that key stakeholders have limited experience of barge and container transport on IWW. This means that motivating and convincing actors comes high on the agenda for entrepreneurs. A key result of this paper is therefore the need for involvement of various actors to realise modal shift, identifying

which type of actors and for the specific topics that are related to those groups. While many barriers may explain the rarity of container transport on IWW in Sweden, this article describes how entrepreneurs may manage associated barriers.

To realise modal shift the entrepreneurs need to use various strategies to overcome the barriers and manage key issues for implementation in the best way. This has been done by proof of concept; negotiation with key stakeholders in the transport chain; using general technical solutions and contrasting the Swedish situation for IWW-based service providers with what is common practice elsewhere in Europe. The proof of concept-runs, through both locks and in ports, have decreased barriers both in number and in scale. The proof of concept showed stakeholders that there are viable solutions and provided much publicity. The entrepreneurs engaged in a "learning by doing" which is costly and requires patient investors as well as flexible and interested stakeholders in the transport chain. Negotiations with key stakeholders have been used to circumvent some of the financial barriers, i.e. the high costs associated with water transport (e.g. port charges were lowered). Other costs (e.g. pilot fees) were assessed as being remarkable, from an international standpoint, and expected to diminish over time. By using general technical solutions, such as renting, leasing or partnering, costs associated with hardware/equipment were decreased. This allows lower initial investments, but tends to result in a higher total cost over time, partially due to not being adapted to the specific situation. On the other hand, it provides flexibility and lowers exit costs in the case of bankruptcy.

By explicitly comparing the Swedish situation with transport on IWW in countries such as the Netherlands and Germany, the entrepreneurs have managed to create a debate about the sensibility the Swedish transport policies – that often favour road transports over train or water. Thus, the entrepreneurs have highlighted the regulators' lack of attention to issues related to IWW. This does not guarantee that the situation will improve but a likely scenario is that rules would harmonise with those that can be found in the parts of Europe that has a more flourishing IWW-sector. Such a development would enable the establishing of services providers in the IWW-sector and lead to several positive impacts on the Swedish transport system as a whole. First, it would enable the shifting of less time-sensitive container goods away from the currently strained road- and rail-networks. Second, it could lead to positive environmental impacts, especially if the self-propelled barges or the ships rely on cleaner fuels such as LNG. Third, the establishment of IWW-service providers in Sweden would also mean that a "new" industry will appear with the potential for new jobs, even though there might be some cannibalization of jobs in other parts of the transport sector. Fourth, an increased use of the shipping lanes would raise the importance of the quality of those lanes and make it more financially justifiable to maintain locks and channels, something that is currently debated at a national level.

As legislation, taxes and fees paid for waterway transport were identified as key barriers, and the interaction with regulatory actors and influencing policy decisions were identified as very important, this paper provides valuable insights for policy makers. Descriptions of the realisation of modal shift and specifically regulatory and financial barriers that policy makers can influence can provide input to their decision-making and help future implementation of container transport on IWW. For these barriers (such as fairway dues and piloting regulations) comparisons between different countries would be valuable. An understanding of the actual process towards realisation is also valuable to stakeholders of importance to realise a modal shift, such as shipping lines, inland port terminals, seaport terminals, logistics providers and shippers. This paper also describes the specific topics in which these actors should be involved and through their participation can facilitate modal shift to IWW.

The results presented in this paper provide three principal lessons that relate to, and have implications for, modal shift and innovation research. First, they show the necessity of flexible business model design (by the entrepreneur) to attract both customers and other stakeholders in the transport chain. Second, they stress the importance of influencing the policy discourse through examples. Third, it is

clear from the practical experiences that to realise modal shift the perception of IWW transport needs to change, which the entrepreneurs have tackled persistently through communicating, promoting, educating and lobbying. Further research could map strategies used in other countries to manage barriers for implementation of IWW services or compare container transport with other types of transport on IWW.

References

- Baird, A. J. (2007), 'The economics of Motorways of the Sea', *Maritime Policy & Management*, Vol. 34, pp.287 - 310.
- Browne, M., Woxenius, J., Dablanc, L., Cherrett, T. & E., M. (2017), 'Port cities and urban logistics', *The Logistics Research Network (LRN) conference*, Southampton, 6-8 September.
- Caris, A., Limbourg, S., Macharis, C., van Lier, T. & Cools, M. (2014), 'Integration of inland waterway transport in the intermodal supply chain: a taxonomy of research challenges', *Journal of Transport Geography*, Vol. 41, pp.126-136.
- CBS (2016), http://statline.cbs.nl/statweb/publication/?dm=slnl&pa=83101ned, Centraal Bureau voor de Statistiek, 2017-03-02
- Flodén, J., Bärthel, F. & Sorkina, E. (2017), 'Transport buyers choice of transport service – A literature review of empirical results', *Research in Transportation Business & Management*, Vol. 23, pp.35-45.
- Fridell, E. (2011), *Emissionsberäkningar för Vänersjöfart för BACAB (Emission assessment for Lake Vänern shipping for BACAB)*, IVL, Gothenburg.
- Garberg, B. (2016), *Regeringsuppdrag: Analys av utvecklingspotentialen för inlands- och kustsjöfart i Sverige (Government investigation - Analysis of the potential for inland and coastal shipping in Sweden)*, Swedish Maritime Administration, Norrköping.
- Garcia-Menendez, L. & Feo-Valero, M. (2009), 'European Common Transport Policy and short-sea shipping: Empirical evidence based on modal choice models', *Transport Reviews: A Transnational Transdisciplinary Journal*, Vol. 29, pp.239 - 259.
- Konings, J. W. (2009), *Intermodal barge transport: Network design, nodes and competitiveness*, thesis, TRAIL Research school, TU Delft, Delft.
- Medda, F. & Trujillo, L. (2010), 'Short-sea shipping: An analysis of its determinants', *Maritime Policy & Management*, Vol. 37, pp.285–303.
- Meers, D., Macharis, C., Vermeiren, T. & van Lier, T. (2017), 'Modal choice preferences in short-distance hinterland container transport', *Research in Transportation Business & Management*, Vol. 23, pp.46-53.
- Olsson, F. & Ronold, E. (2017), *Hinder och incitament för reguljär containertrafik via inlandssjöfart (Barriers and incentives for regular inland container shipping)*, thesis, Department of Business Administration, University of Gothenburg, Gothenburg.
- Otterström, V. & Torpfält, S. (2016), *Inlandssjöfart - från teoretisk möjlighet till potentiellt utförande (Inland shipping - from theoretical possibility to potential realisation)*, thesis, Department of Business Administration, University of Gothenburg, Gothenburg.
- Trafikanalys (2016), *Godstransporter i Sverige – en nulägesanalys*, Rapport 2016:7
- Trafikanalys (2017), Shipping goods 2016, Statistik 2017:19, Sveriges officiella statistik, Report available at https://www.trafa.se/sjofart/sjotrafik/
- Treiber, A. & Bark, P. (2018), *Förutsättningar för ökad inlandsvattensjöfart i sjöar, skärgårdar och kustområden (Conditions for increased inland shipping in lakes, archipelagoes and coastal areas)*, TFK, Stockholm.
- Wiegmans, B. & Konings, R. (2015), 'Intermodal inland waterway transport: Modelling conditions influencing its cost competitiveness', *The Asian Journal of Shipping and Logistics*, Vol. 31, pp.273-294.
- Vierth, I., Mellin, A., Hylén, B., Karlsson, J., Karlsson, R. & Johansson, M. (2012), *Kartläggning av godstransporterna i Sverige (Survey of freight transport in Sweden)*, VTI, Linköping.

A COMPARATIVE CASE STUDY ANALYSIS OF ACCESS TO WORK IN THE UK LOGISTICS INDUSTRY

Erica Ballantyne and Andrea Genovese
University of Sheffield, Management School, Sheffield, S10 1FL, UK

Introduction

The logistics industry has become a prominent source of employment in the UK, with approx. 1,568,000 people employed in transportation and storage (ONS, 2018a). As the sector continues to remain dominant in the UK, local authorities are taking a proactive approach towards improving the local economy and promoting employment opportunities by attracting investment from logistics businesses. Often such growth strategies involve developing former industrial (brownfield) sites into new office, business and retail parks. The logistics and distribution industry has played a prominent role in this regeneration process, especially with the consistent growth in e-commerce markets. Figures for UK retail sales indicate online sales as a total of all retailing continued to increase at 18.0% in May 2018 compared with May 2017, and online spending for food, department stores, and clothing and footwear stores continued to achieve new record proportions of online retailing at 5.8%, 17.4% and 17.6% respectively (ONS, 2018b). As online retailing in the UK continues to grow, so does the demand for more logistics facilities and fulfilment centres to process the growing number of online orders.

However, many of these new logistics facilities and business parks are located at the intersect of the major motorway network, invariably on the outskirts of town and city centres where they suffer from a distinct lack of public transport accessibility options (Lucas, 2006). This presents a problem around access to work for the many hundreds of low and semi-skilled workers employed by organisations located at these out-of-town sites, many of whom will be employed on the minimum wage, basic salaries, temporary or zero-hours contracts. These dynamics may pose huge obstacles to the future development of the industry, as they may result in poor workplace accessibility for employees that are often employed on very precarious conditions. Further, the limited accessibility may also lead to recruitment and employee retention issues for organisations, due to the perceived insecurity of jobs in the sector.

In today's service sector economy, the work in the logistics and distribution industry revolves around a 24hour – 7days per week operation, which is staffed over multiple shifts that require employees to commute between work and home during often unsociable hours. Thus for many employees, the nature of their work (warehousing and logistics related activities) is far from the traditional Monday to Friday, 9am to 5pm working patterns that the UK public transport system generally conforms to. To add to this, workers are resourced from far and wide, often residing in more urbanised areas (towns and cities) where housing is potentially more affordable but some considerable distance from their place of work (McQuaid and Chen, 2012), and are unlikely to be situated on a direct public transport link/route to these new logistics and distribution sites. Evidence suggests that there is clearly a 'mismatch' between the identified logistics park locations and the pre-established public transport network that could result in a number of potentially negative impacts, including: worker quality of life (especially those on minimum wages); relative ease of recruiting employees; sustainable transport commuting behaviour; and operational effectiveness.

This research adopts a case study approach to investigate the impact of current transport systems on access to work for employees in the UK logistics and distribution industry. Specifically, this paper considers the workforce at two major distribution centres (both e-commerce fulfilment centres) located on the outskirts of major conurbations in the North of England. In both cases, employees were surveyed (using a structured questionnaire), in order to evaluate their travel-to-work habits and related employment challenges. Based on the analysis of the responses to the questionnaires, key findings are drawn.

The remainder of this paper is organised as follows: the next section provides a concise literature review, mainly focused on the issues of transport poverty and its potential impact on the workforce in the logistics industry. Then, some methodological notes are illustrated, in order to describe the research approach and the data collection and analysis methods that were followed for conducting the study. Some preliminary results are shown, from which some implications are drawn. Finally, conclusions and directions for further research are provided.

Literature Review

The regeneration and conversion of former industrial out-of-town sites into distribution centres and warehouses raises the issue of access to labour. Indeed, with many hundreds of employees required to work in these establishments, the low skilled nature of many positions will mean that, in many cases, these workers will be employed on low wages, and thus as a demographic, they will mostly be reliant upon public transport to get them to and from work. Also, the nature of work in these establishments (i.e. warehousing) is often a 24-7 operation that is staffed over multiple shifts, meaning that employees will be required to get to and from work during unsociable hours. The nature of the public transport system is often following established schedules that conform to traditional Mon-Fri 9-5pm working patterns. To add to this, workers are resourced from far and wide, often living in more urbanised areas (towns & cities) that are some distance from their workplace and unlikely to have direct public transport links to these new parks. Thus there is clearly a mismatch between logistics parks locations and the pre-established public transport network that could be having negative impacts on workers' quality of life (especially those on minimum wage); relative ease of recruiting employees; and operational effectiveness.

With two-thirds of job-seekers not having access to a car and the cost of public transport rising, it is not surprising that these issues are becoming increasingly relevant in many parts of the UK, as the lack of access to transport alternatives is at risk of cutting off from work at least half a million people (Sustrans, 2015). According to research by O'Hara (2015), lack of affordable public transport is one of the main reasons for the unemployed turning down job offers, a situation that has significantly worsened in the last few years due to funding cuts to both local authority budgets and benefits induced by the current austerity regime.

Over the last two decades' carbon-emission reduction policies, rapidly fluctuating oil prices and stagnating real incomes have drawn increasing attention to the overall efficiency of the transport sector in Europe. Also, the evaluation of the social performances of transport systems has become an element of interest to many scholars and policy makers (see, for instance, Schwanen.et al., 2015). Specifically, it has been acknowledged that poorly-designed transport systems may have the potential to have a detrimental effect on people's quality of life and employment opportunities. In this context, Kenyon et al. (2002) defined the concept of *mobility-related social exclusion* in terms of *the processes that prevent people from participation in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks*.

In the UK context, there has been an ever-increasing trend in terms of car-ownership (Department for Transport, 2014). It is worth reporting that, in 2010, 22% of women and 17% of men lived in households that did not have car; in 1975, both these proportions were about twice as high. While this phenomenon has been described as generally positive, car-dependency has produced a significant alteration in terms of transport policy development. Specifically, there is evidence to claim that, coupled to public transport deregulation, it has reduced the viability of other modes and significantly contributed to poorer local environments, playing a significant role in the exclusion of already vulnerable sectors of the British population (Lucas, 2004; Dibben, 2005; Lucas, 2006).

In fact, in many parts of the UK it is now virtually impossible to perform simple day-to-day tasks by relying purely on public transport. Indeed, the proportion of households who find it difficult to access essential local services is much higher for those without cars than for those with cars (Fol et al, 2007).

For example, around 5-8% of car-owners report difficulties accessing supermarkets, post offices and GP surgeries, compared with 18-20% for those without a car. Access to hospitals is much more difficult for both groups, with 20% of those with a car and 40% of those without a car reporting difficulties (Department for Transport, 2014).

The impact is even more dramatic when looking at the interaction between the transport systems and the job market. As revealed by PTEG (2015), about three quarters of the jobseekers outside London do not own (and do not have access to) personal motorised transport (i.e., car, van or motorbike); therefore, they can face significant barriers in finding work as a result. In the UK, unemployment levels remain high following the recent economic recession, particularly amongst the Under 25's. From May to July 2015 there were reportedly 8.99 million people aged between 16 and 64 who were regarded economically inactive or unemployed; and in August 2015 the number of people claiming unemployment benefits in the UK rose by 1.2 thousand (Trading Economics, 2015). The PTEG (2015) study reports that the most significant barriers to employment opportunities include expensive public transport tickets; poorly connected employment sites; mismatches between working hours and available transport; and limited travel horizons. According to research by O'Hara (2015), lack of affordable public transport is one of the main reasons for unemployed people turning down job offers, a situation that has been significantly worsened in the last few years due to funding cuts to local authority budgets, allowances and benefits induced by the current UK austerity regime. These findings are consistent with the international academic literature stating the positive correlation between availability of public transport and employment rates in urban areas, with a special emphasis on deprived neighbourhoods (see, for instance, Ricciardi et al., 2015; Tyndall, 2015).

The logistics and distribution industry is traditionally labour intensive, requiring high numbers of low-skilled workers to be employed as warehouse operatives working on round-the-clock shift patterns to facilitate a 24hrs a day, seven days a week business operation. For logistics companies, selecting a location for a new distribution centre is generally focused on adopting a site that provides a balance between the lowest costs and greatest efficiency in order to meet operational and strategic objectives (Thai and Grewal, 2005). Thus, large warehouses and manufacturing sites are usually located some considerable distance outside urban areas for ease of access to motorway networks and or port terminal infrastructure, as opposed to proximity to public transport alternatives for the workforce. Coincidentally these locations are also where local authority town planners encourage large developments due to the availability of cheaper land and the ability to segregate the visually intrusive warehouses from popular residential areas and green spaces, thus avoiding nimbyism related objections.

Research approach

The research presented in this paper reports on the results of two questionnaire surveys conducted at the two case study distribution centres in the Yorkshire region (UK). Both the case study sites are large distribution centres operating 24 hours a day, seven days per week. Both the sites employ approximately 3000 staff, many of whom are working as warehouse operatives and are employed on varying shift patterns.

The questionnaire survey was prepared hard-copy for dissemination on-site, which was deemed the most appropriate mechanism for in-person data collection due to the nature of the survey, location of planned data collection, and the expected demographic of the targeted participants. For the second case site, an electronic version of the survey was also made available during the data collection period, the site shared the link to the survey on their employee social media and participants could also complete it on a tablet. In both cases, responses were collected over a period of two consecutive week days (including a night shift) which were selected to cover the majority of shift patterns at the site. Surveys were distributed amongst employees in the staff canteen for completion during their shift-breaks. Demographic profiles of the respondents are provided in the next section, along with some preliminary findings presented through some descriptive statistics.

Survey Findings

A total of 329 employees took part in the travel survey at Site 1; 160 employees took part in the similar exercise conducted at Site 2. Table 1 below reports the age profile of the respondents (note that six respondents did not provide their age). It can be noticed that, in both cases, an extremely young workforce was surveyed (as, at both sites, over 65% of the members of staff are under 35 years of age). At Site 1, the vast majority (68.00%) of the people surveyed are male, as shown in Table 2 (note that four people did not answer this question); a more balanced gender mix is shown at Site 2. Respectively, 64.73% and 74.65% of staff working at Site 1 and Sate 2 are on a permanent contract, while a good proportion of staff (28.42% and 23.94) are employed on temporary contracts. Staff work on both fixed and rotational shift patterns.

Age Group	Site 1		Case 2	
	%	Count	%	Count
18-25	28.17%	91	26.25%	42
26-35	39.63%	128	40.00%	64
36-50	21.67%	70	22.50%	36
51-65	9.91%	32	11.25%	18
65+	0.62%	2	0.00%	0
Question not answered	0.00%	*(6)*	0.00%	0
Total	100.00%	323	100.00%	160

Table 1: Age profile of the respondents

Gender	Site 1		Site 2	
	%	Count	%	Count
Male	68.00%	221	51.25%	82
Female	32.00%	104	48.75%	78
Other	0.00%	0	0.00%	0
Total	100.00%	325	100.00%	160

Table 2: Gender of the respondents

Of the respondents surveyed, 56.92% (185 out of 325) own a motor vehicle in Case 1; the percentage is even higher in Case 2 (67.30%, 107 out of 159). In the vast majority of the cases (see Table 3) this is a pre-owned vehicle; Table 4 provides additional data about vehicles owned by the workforce. For Site 1, it turns out that the average vehicle age is 8.51 years; and the median age of vehicles is 9 years; 7.88 and 8 years respectively for Site 2. As such, private vehicles are generally old and might not conform to the most recent environmental standards, thus impacting on the sustainability of staff commuting to and from the site. The majority (66.29% at Site 1; 66.36% at Site 2) of the surveyed workforce owning a car also state that this vehicle was mainly bought for commuting purposes.

Answer	Site 1		Site 2	
	%	Count	%	Count
Pre-owned	77.14%	135	77.57%	83
New	22.86%	40	22.43%	24
Total	100%	175	100%	107

Table 3: Demographic of vehicles owned by respondents

Owned Vehicles	Site 1	Site 2
Average age of owned vehicles	8.51	7.88
Median age of owned vehicles	9.00	8.00
Standard Deviation of age of owned vehicles	4.76	4.63

Table 4: Age of the owned vehicles

Was this vehicle bought for commuting purposes?	**Site 1**		**Site 2**	
	%	**Count**	**%**	**Count**
Yes	66.29%	116	66.36%	71
No	33.71%	59	33.64%	36
Total	100%	175	100%	107

Table 5: Vehicle ownership and commuting

Coherently to the results emerging from the previous questions, the complete overview of the commuting choices for the surveyed workforce reveal an overall dominance of car travel as the dominant mode of transport to work (Table 6). At the first site, 62.31% of the 329 surveyed staff travel to work by using their own motor vehicle, or through a self-organised car share scheme they've put in place with their colleagues. Public Transport is the second most preferred option, chosen by 32.83% of the respondents. 8 people (2.43%) travel to work regularly taking a taxi, while cycling and walking-only options are marginal (1.22%). In case of Site 2, the preference towards car travel is even more remarkable, with 81.36% of the surveyed workforce travelling by car, with just 8.07% of the staff using public transport options.

How do you travel to work?	**Site 1**		**Site 2**	
	%	**Count**	**%**	**Count**
Own motor vehicle (or car share)	62.31%	205	81.36%	131
Taxi	2.43%	8	2.48%	4
Public Transport (Bus/Tram/Train)	32.83%	108	8.07%	13
Cycling	1.22%	4	2.48%	4
Walking	1.22%	4	5.59%	9
Total	100%	329	100.00%	161

Table 6: Preferred mode of travel to work

Table 7 reports the average (23.14 minutes for Site 1; 20.52 minutes for Site 2) and median (20 minutes for both sites) journey times for car commutes, also showing the standard deviation (computed across all respondents who indicated they travel to work by car). This same pool of respondents was asked whether they could come to work by using public transport. In the case of Site 1, 47.64% of them stated that this would be possible, with 52.36% declaring that using public transport would not be an option for them, mainly due to the lack of feasible alternatives. The percentage of workers stating that public transport is not a viable option is even higher (62.63%) in the second case.

Travelling Times	**Site 1**	**Site 2**
Average car journey time	23.14	20.52
Median car journey time	20.00	20.00
Standard Deviation of car journey time	17.90	15.28

Table 7: Average car journey times

For those who stated that a public transport option is theoretically available, journey times however are much higher (90 and 67 minutes in terms of average, respectively, for Sites 1 and 2; 60 minutes in terms of median travel time for both cases) than the ones they currently face by car.

Journey Time	Site 1	Site 2
Average journey length of potential public transport journey	90.0	67.25
Median journey length of potential public transport journey	60.0	60.00
Standard Deviation journey length of potential public transport journey	48.4	41.50

Table 8: Average public transport journey times for employees who travel to work by car

This clearly explains the findings reported in Table 9, where a large majority of workers employed at both Sites travelling to work by car state that this option is easier or saves them time if compared to other options (multiple answers were allowed to this question). Twenty-five surveyed employees at Site 1 and 16 at Site 2 stated explicitly that they do not have any public transport option alternative.

Why do you travel to work by car?	Site 1		Site 2	
	%	Count	%	Count
It is easier	37.47%	145	38.14%	82
It saves me time	33.59%	130	33.95%	73
It is cheaper	16.28%	63	18.60%	40
I don't have any public transport alternative	6.46%	25	7.44%	16
Other (please specify)	6.20%	24	1.86%	4
Total	100%	387	100%	215

Table 9: Reasons for travelling to work by car

Conversely, when the 108 employees working at Site 1 who stated that they were travelling to work by public transport were asked the same question, 78 of them clearly stated that the main reason behind their opting to travel by public transport is the fact that they do not own a motor vehicle (with 20 also clarifying that they cannot afford to take a taxi to work). Clearly, their travel times (with over 37 minutes of average and 30 minutes of median time; see Table 11) are much higher than the ones of employees travelling by car, mainly due to the need to wait for buses to arrive and any time spent between connecting services.

Similar results were observed also at Site 2, even though the proportion of surveyed workers was much lower; the main reason for travelling to work by public transport was again the lack of access to a vehicle (indicated by 11 workers). In this case, journey times are strikingly higher than the ones reported by workers who travel by car (60 minutes of average travel time and 57 minutes as a median travel time).

Answer	Case 1		Case 2	
	%	Count	%	Count
It is easier	13.66%	22	5.00%	1
It saves me time	3.73%	6	5.00%	1
It is cheaper	17.39%	28	10.00%	2
I don't own a motor vehicle	48.45%	78	55.00%	11
I can't afford to take a taxi	12.42%	20	25.00%	5
Other (please specify)	4.35%	7	0.00%	0
Total	100%	161	100%	20

Table 10: Reasons for travelling to work by public transport

Journey Times	Site 1	Site 2
Average journey length of public transport journey	37.62	60.00
Median journey length of public transport journey	30.00	57.00
Standard Deviation journey length of public transport journey	26.69	29.79

Table 11 – Average public transport journey times

Discussion

Results of the survey clearly highlight some of the typical problems mentioned in the initial literature review about out-of-town logistics parks and distribution centres. Indeed, due to the location of the surveyed sites, the employed workforce needs to face a long commute in order to get to work. Most of the surveyed workforce travel to the site by using a car; in most of the cases, this vehicle was specifically bought for commuting purposes. This is coherent with findings from Dibben (2005) and Lucas (2006) regarding increased car-dependency. Particularly the high proportion of car commuters travelling in older vehicles (second-hand cars averaging 8/9 years old) is reflective of the low income demographic of the workforce employed at these sites who are often priced out of newer vehicles, and are unable to benefit from the environmental advantages that newer vehicles would bring (Lucas, 2006), such as improved fuel consumption and lower emissions.

The reliance on cars for commuting to both sites further highlights the fact that public transport does not seem to be designed to support the operations of out-of-town logistics facilities. Many staff that travel to work by car point out that using public transport would be impractical (due to a much longer commuting time); even staff travelling to work by public transport indicate that the main reason for taking the bus is the fact that they lack access to a vehicle, and that the current organisation of public transport schedules and routes does not serve these large sites and their 24/7 operations particularly well.

Conclusions & Limitations

By adopting a case study approach, this research has investigated the impact of current transport systems on access to work for employees in the UK logistics and distribution industry. Specifically, the workforce of two major distribution centres located on the outskirts of major conurbations in the Yorkshire (UK) region was surveyed (through a structured questionnaire), in order to evaluate their travel-to-work habits and related challenges. Based on the analysis of the responses to the questionnaire, some key preliminary findings have been highlighted. Specifically, coherently to the extant literature, these findings highlight the car-dependency of the workforce and the lack of support provided for round-the-clock shift-workers from the existing public transport options.

Next steps of this research will involve further analysis of the questionnaire data, along with an extensive review of the public transport network serving the case study distribution centre. This could lead to the formulation of a set of recommendations for site operators, involved local authorities and transport companies.

Whilst this research has just considered just two distribution centres, options are being considered at the moment for extending the analysis to similar industrial establishments, in order to generalise the findings and examine, to a wider extent, the impact of access to work within the logistics and warehousing sector on the local and national economy.

Acknowledgments

The authors would like to thank the Chartered Institute of Logistics and Transport (CILT UK) who have provided funding for this research. Further, thanks to the distribution centres that gave permission for us to conduct this survey on site and use the data for this research; and finally to all those that took part in the survey whose contribution is greatly appreciated.

References

- Department for Transport (2014). Vehicle Licensing Statistics. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/302409/vls2013.pdf [Accessed on 25 July 2015]
- Department for Transport (2014). National Travel Survey 2013. Available online at: https://www.gov.uk/government/statistics/national-travel-survey-2013
- Dibben, P. (2006). The "Socially Excluded" and Local Transport Decision-making: Voice and Responsiveness in a Marketised Environment. *Public Administration*, Vol.84, Iss.3, pp.655- 672.
- Fol, S., Dupuy, G., and Coutard, O. (2007). Transport Policy and the Car Divide in the UK, the US and France: Beyond the Environmental Debate. *International Journal of Urban and Regional Research*, Vol.31, Iss.4, pp.802-818.
- Kenyon, S., Lyons, G., and Rafferty, J., (2002). Transport and social exclusion: investigating the possibility of promoting inclusion through virtual mobility. *Journal of Transport Geography*, Vol. 10, Iss.3, pp.207–219.
- Lucas, K. (Ed.), (2004). Running on Empty: Transport, Social Exclusion and Environmental Justice. Policy Press, Bristol.
- Lucas K. (2006). Providing Transport for Social Inclusion within a Framework for Environmental Justice in the UK. *Transportation Research Part A-Policy and Practice*, Vol. 40, Iss.10, pp.801-809.
- McQuaid, R. W. & Chen, T. (2012) Commuting Times – The role of gender, children and part-time work. *Research in Transportation Economics,* Vol. 34, pp.66-73.
- O'Hara, M. (2015). *Austerity Bites: A Journey to the Sharp End of Cuts in the UK*. Policy Press.
- ONS (2018a). Employment by industry (Labour Force Survey). Available online at: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/employmentbyindustryemp13 [Accessed on 3 July 2018].
- ONS (2018b). Statistical bulletin - Retail sales, Great Britain: May 2018. Available online at: https://www.ons.gov.uk/businessindustryandtrade/retailindustry/bulletins/retailsales/may2018 [Accessed on 3 July 2018].
- PTEG (2015). Ticket to thrive. The role of public transport in tackling unemployment. Available online at: http://www.pteg.net/system/files/general-docs/PTEG%20%E2%80%93%20Ticket%20to%20Thrive%20Final%20Feb%2015.pdf [Accessed on 25 August 2015].
- Ricciardi, A. M., Xia, J. C., and Currie, G. (2015). Exploring public transport equity between separate disadvantaged cohorts: a case study in Perth, Australia. *Journal of Transport Geography*, Vol. 43, pp.111-122.
- Schwanen, T., Lucas, K., Akyelken, N., Solsona, D. C., Carrasco, J. A., and Neutens, T. (2015). Rethinking the links between social exclusion and transport disadvantage through the lens of social capital. T*ransportation Research Part A: Policy and Practice*, Vol.74, pp.123-135.
- Sustrans (2015). Locked Out. Transport Poverty in Britain. Available online at: http://www.sustrans.org.uk/sites/default/files/images/files/migrated-pdfs/Transport%20Poverty%20England%20FINAL%20web.pdf [Accessed on 19 July 2015].
- Thai, V.V. and Grewal, D. (2005). Selecting the location of distribution centre in logistics operations: A conceptual framework and case study. *Asia Pacific Journal of Marketing and Logistics*. Vol.17, Iss.3, pp.3-24.
- Tyndall, J. (2017). Waiting for the R train: Public transportation and employment. *Urban Studies*, Vol. 54, Iss.2, pp.520-537.
- The Poverty Site (2015). Ability to Travel Indicators. Available online at: http://www.poverty.org.uk/75/index.shtml [Accessed on 23 August 2015]
- Trading Economics (2015). United Kingdom Unemployment Rate. Available online at: http://www.tradingeconomics.com/united-kingdom/unemployment-rate [Accessed on 24 September 2015]

EXPLORING DEVIATION INFORMATION FOR PROACTIVE DECISIONS IN REAL-TIME TRANSPORT PLANNING

Per Wide
Chalmers University of Technology, Department of Technology Management and Economics, 412 96, Gothenburg, Sweden

Introduction

There is a desire for sharing real-time information between actors to deal with dynamic nature of operational decisions in transport chains, influenced by constantly changing conditions of activities (AEOLIX, 2017). More available information is important to be able to obtain higher resource utilization and overall efficiency. Inability to be flexible when unexpected changes occurs could affect logistics service providers possibility to deliver to customer in time, customer satisfaction, or generate sub-optimal transport solutions decreasing resource utilization. Real-time operational decisions are further under constrains of time (Schönberger and Kopfer, 2011), generating need for timely and correct available information. To deal with this decision support systems (DSS) have been proposed by literature, including detection of deviation; magnitude evaluation of change (re-plan needed or not); information for re-plan; re-plan decision (Séguin et al., 1997). Literature in supply and transport chains mainly emphasis on models for re-plan stage in DSS and less on the information of a deviation. However, this part is important as the available information can either make the decision makers act in a proactive or reactive way (Mukai et al., 2005). As seen in figure 1, this paper divides information for re-plan into deviation information, regarding information about a change, and support information, regarding information supporting the re-plan decision and this paper focuses on the former. Depending on the deviation information the re-plan decision in a transport chain will have conditions for either reactive or proactive re-plan decisions.

This paper will be focusing on operational deviations (Tang, 2006) in transport chain planning with low impact but high occurrence probability, in comparison with disruptions with high impact but low probability, making them the larges part of the trouble shooting in practical settings and where deviation information can be more applied. Transport chains are dealing with consignment, physical movement and handling connected to transport, as well as planning and control (Woxenius, 2012). These chains differ from logistics chains and supply chains focusing on items or articles respectively a product. This paper focuses on operational planning in transport chains that are exposed to dynamic changes. To cover a broader range of decisions for these activities a case study is executed on an actor acting the transport coordinator, terminal operator and shipper.

More advanced technologies, lead to possibility of having more near real-time information from other actors available. At the same time, logistics service providers are experience challenges to use information from tracking technology for operational control in decisions (Meyer et al., 2014). Further, complex setups between actors in a transport chain (Sternberg et al., 2013) make it hard to share real-time information. Literature has focused on algorithms or optimization models to solve the re-plan issue (Schönberger, 2011) and not on the detection of the change in practice. Even though, advanced technologies have been introduced there seem to be little understanding of deviation information that can better enhance condition for proactive re-planning. This paper therefore investigates deviation information in order to increase understanding on how deviation information influences possibilities for the planning decisions to be of proactive or reactive nature. This paper focuses deviation information in order to explore possibilities to move towards proactive re-plan decisions. Figure 1 presents the purpose of this paper and surrounding context.

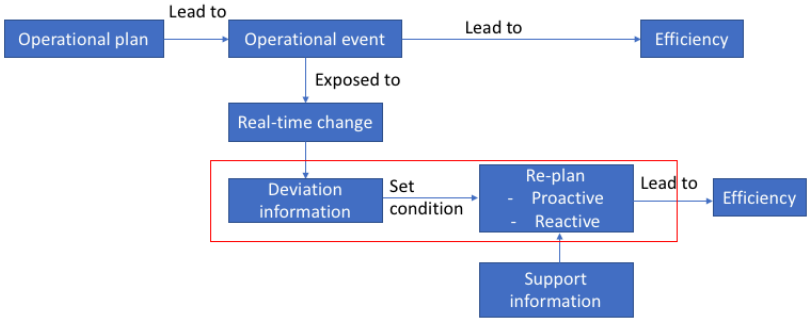


Figure 1: Model representing the context of the purpose of the paper, where the latter is marked with red square.

Frame of references

Proactive and reactive real-time freight transport planning

Many have raised different phases of dealing with real-time planning. Séguin et al. (1997) introduces a DSS with the steps of detecting changes, analysing data and making predictions, evaluate alternatives, select alternative and monitor environment. Similarly, Feldman et al. (2013) include detection, prediction, decision and act. Further the authors describe proactive in real-time planning as awareness of a change with undesired outcome already at timepoint t-Δ to be able to re-plan to a desired outcome at timepoint t. The time and relevance of information have also been pointed out of importance for proactive decisions (Mishra et al., 2017). Feldman et al. (2013) configure a proactive software for predicting discrepancies in shipment weights for air transports. Mukai et al. (2005) refer to proactive route planning when a transport vehicle can foresee next destination by providing high reward in order to get learning in the system. The authors add that optimization on not updated information and manual efforts lead to reactive planning approach and difficulties adopting to dynamic changes. From a more strategic and tactical viewpoint Zhalechian et al. (2018) see proactive as having pre-plans for a system to automatically adopt to changes in order to minimize performance consequences. Reactive is referred to as how well a system reacts after a change to minimize performance consequences. The difference of reactive and proactive decisions in this paper is based on the reasoning above and defined as followed. Reactive decisions are performed based on information received after the change has occurred. Proactive decisions get information about the change in advance (t-Δ) and can adopt directly. Importantly, the timing of detecting event is important, which is a problem in practice, or as previous research state "unexpected events are often not timely detected" (Meyer et al., 2014, p. 433). Similarly, importance of alertness in supply chains has been pointed out, as timely awareness of change (Xun et al., 2009). The underlying assumption is that a level of overall efficiency for the LSP is obtained at initial state and that this level deviates less with proactive decisions than reactive.

Dealing with real-time changes

To deal with real-time changes literature have focused on varies aspects. Roy (2001) goes through real-time decisions with regards to activities connected to LTL (less-than-truckload) or FTL (full-truckload), explaining different tools of EDI, decision support systems (DSS) and GPS for the decisions. DSS is commonly used to deal with real-time changes. The architecture of such system has been broadly discussed (Séguin et al., 1997) and solutions of the DSS with algorithms or heuristics (Schönberger, 2011). A novel study from Meyer et al. (2014) focused on how to use information from tracking technology and building up a support system for freight transport planners. Bock (2010) refers to real-time-oriented control system including one database mapping current situation with input from dynamic events and position and state of vehicle fleet.

Risk management deals with assessing the risks of a change or disruption, typically in regards to the probability that the change occurs combined with the impact it will have (Knemeyer et al., 2009). This is important when dealing with changes to find out probability or impact of risks or mitigation and avoidance strategies in operational activities but is not the focus of this paper. This paper aims only to focus on the deviation information. Zhalechian et al. (2018) defines resilience strategies for hub and spoke network as proactive and reactive. Regarding time point of view, this would be before the change actually happens in order to come up with strategies of mitigation or avoidance. However, it focuses little on information of a change or disruption on an operational level, rather on a tactical and strategic level (Tang, 2006). Indeed, flexibility is included but more from possibility of strategically making decisions to keep a supply or transport chain agile to adopt to changes. Angkiriwang et al. (2014) define reactive and proactive strategies for flexible production of stocks and buffers respectively postponement, agile contracts, routes and lead and setup times. However, also here the deviation information is not the focus. Further, reactive flexibility measures of recovery plans (Sahebjamnia et al., 2015) after change has occurred has been introduced.

Condition of deviation information

As previously noted, timing of deviation information is of importance (Meyer et al., 2014),(Xun et al., 2009). Further, no single information component will be able to cover all possible changes, leading to a need of combining information to identify what is going on (Fleischmann et al., 2004). This is also one of the main functions in a DSS (Séguin et al., 1997, Mishra et al., 2017). Taking the example of changes in travel time, many factors can influence (van der Spoel et al., 2017). Distinguishing between data and information can be of valid to understand what is being conditions for information. Following Davenport and Prusak (1998) data can be described as the discrete and objective facts about a change, in comparison to information being the message communicated. The authors further present that information can lead to knowledge and action. However, the two last parts will not be included in this paper as focus is on the deviation information not directly the response of a change. Combining or evaluating data to information can be managed by computer aided or semi-computer aided systems, differing in that computer aided is fully managed by a system and semi-computer aided is where a human is presented with information from a system. Mukai et al. (2005) adds that operational transport planning is often involving completely human evaluation, giving the case of human being source of information. Additionally, Meyer et al. (2014) included the problem of manually analysing the information as unfeasible.

To sum up, considering the timing of deviation information and combination of data four parts can be derived. Firstly, deviation information can be related to detection of a change, referred to as the change has occurred, or prediction of change, referred to indications before a change has occurred. Further, it has been seen that both these two can be achieved by either combining data manually or automatically.

Methodology

The study was constructed as a qualitative case study in order to capture and get in-depth understanding of the phenomenon of deviation information in real-time context of operational transport planning.

The chosen case company was based on two main features; (I) Different perspectives and transport modes represented by one case, as the case company is both shipper and plans the studied transport chain, which includes both road and rail transport. The road is assumed to be more flexible in comparison to the rigid schedule of rail transport, which could affect the conditions for deviation information. (II) The case company is using GPS on their own trailers, indicating possible pre-condition to obtain deviation information with conditions for proactive decisions.

Main data source for conducted study was five semi-structured interviews including three transport planners and two logistics business developers. The interviews were based on a question guide including different parts to cover the purpose of the research and second follow up interviews were made with the planners. Initially, the interviews focused on getting a broad overview of the operational planning executed in order to understand what decisions that were mainly in focus. Secondly, more detailed questions regarding deviation information in the planning were covered. The interviews with logistics business developers were aiming to get an understanding of the awareness of deviation information and proactive and reactive decisions from a higher and broader level of the planning. The input from the planners on these topics are including more detailed questions on what changes that occurs and how and what deviation information that is received. The interviews were made in person with the planners and via phone with business developers. During all interviews extensive notes were taken. As a second source of data on-site visits at the central DC were conducted three times by author, in order to do observations on planning and terminal activities. To assure research quality of the conducted case study, the qualitative dimensions of trustworthiness, including credibility, transferability, dependability and confirmability were followed (Halldórsson and Aastrup, 2003). For confirmability, multiple sources of data were used and the question guide was pilot tested on research colleagues to mitigate confusions for that respondents in understanding the questions. Furthermore, extensive notes were taken at all interview and observation sessions. Interpreted answers were shared with the respondents for credibility check. Transferability was treated by comparing case results with previous research. The use of question guide and use of highlighted parts from literature for performing and analysing the interviews are aiming to achieve dependability.

Case description

The case company is performing planning on freight flows of around 80 owned and 30 leased trailers and all haulier activities are outsourced. The trailers are going via train from south of Sweden to a Distribution Center (DC) in middle of Sweden, as of now referred to central DC. Trailers destination can either be the central DC or two other DC in middle of Sweden, for which road transport is used. All three DCs are of own regime. The planned freight flows in south of Sweden are combined routes of direct deliveries of trailers from train to stores and pick-up at suppliers for freight going north to the central DC. The train is doing one trip north and return south every day expect Saturdays. The planned deliveries in south of Sweden are direct deliveries of bigger shipments to stores. Activities for smaller deliveries of reloaded and delivered to stores are outsourced to third-party logistics partner and not covered in the planning of the case study. Further, some incoming freight are reloaded into trailers by the same third-party logistics partner and is also not covered in the case study. For delivery and pick up of trailers from and to the train at central DC, the planning revolves around delivery of trailers coming with the train heading to the two other DCs and collection of freight in trailers heading for the train from the same two DCs. The planning executed in the studied case revolves around the three main transport parts; delivering of trailers arriving with train to the two other DCs combined with pick-up of trailers from the other DCs that are going with the train, train transport both heading north and south and finally the delivery to stores and pick-up at suppliers in south of Sweden. Planning revolves around making an initial plan and thereafter performing firefighting re-planning to resolve issues occurring due to changes. The planning is mainly done in excel sheets, which are shared with terminal operators and hauliers. The next sections describe the three main transport chains parts being planned at the planning group at case company and how these parts are dealing with deviations.

Road delivery and pick up of trailers at two other DCs

Transport is performed via road through a contracted haulier company. The contracted haulier company has outsourced the transport to a sub-contracting haulier having six truck drivers operating between the three DCs. The truck drivers start early in the morning, one at the central DC and five at one of the other DCs in order to pick up trailers heading for the train going south during the day. Arriving at the main DC in time to collect the first trailers taken from the arriving train to deliver to another DC. Allocation of trailers needing transport are thereafter assigned after finished task.

However, some planners plan the whole day at once in comparison to others that only assign the next trailer to see how the status is of other drivers before choosing next task.

Deviation information is mainly revolving around input from drivers or from terminal operators. The communication is made via emails or phone calls, with the drivers a chat program going directly to the mobile devices of the drivers is used. In case of no response from planning group at case company the drivers may contact the contracted haulier, which spreads the information via phone or email. Timepoint for communication is either done at points of interest, as when trailer has been left or picked up. At this point the temperature is manually checked by planner via software connected to the GPS. Transport delays of congestion or breakdowns are communicated by drivers first when the change had occurred, i.e. when the driver is standing still in a queue. The driver may give an estimation of how long the queue is. This setup generates good overview at certain points during the transport but includes few updates for deviation between these points. During observation a new driver took a trailer at a DC and headed for the final destination of the train and not starting point at the main DC. This was first detected when terminal personal was waiting for the trailer and asked planner since it had not arrived. The planner could via GPS data manually get position of trailer and through the contracted haulier get hold of driver to rearrange route. The terminal reports what has been filled in what containers, according to first plan from planners, via excel sheets. No specific combination of data was executed, as it mainly revolved around getting deviation information from driver. One seen data combination was the combination of GPS data with route and experience of traffic situation, to estimate an arrival time to predict deviation. However, no other input than experience was used for traffic information.

Train transport

The train transport is executed by an external train operator at fixed time slots. The Swedish transport agency is responsible for the infrastructure and planning of trains in case of delays. The train is filled with trailers in south of Sweden by a third-party logistics partner. The case company receives information from the train operator about reasons for delays after the delay has occurred. Arriving train in middle of Sweden is unloaded by the case company. The planned arrival for this train is 05.10 in the morning, making information about delays to be announced during evening or night. This setup makes deviation information, detection or even prediction, of little interest for operational planning, as terminal personal and truck drivers will not be informed during these times to postpone start of working day. Instead, in case of train delay, the terminal operators need to find other tasks to perform. However, this is not so easy for truck driver waiting on the train to arrive as other tasks risks delaying delivery of these prioritised trailers. Earlier the case company had a jour function of one planner always being available in case something happened. During this time, they used alerts on temperature deviations from GPS software provider directly to the jour mobile phone. However, after taking away the jour the temperature alerts are done manually as mentioned above. The actual sequence of trailers is reported via email and manually compared by planner to identify deviations from plan.

Road direct delivery to stores and pick-up at suppliers

In comparison to the road transport from and to DCs, the planers make a route plan covering one day for a driver but the drivers have no fixed points on when to report status. The driver can even change the sequence between pick-up if preferred and possible, as some pick-up and deliveries are limiting with fixed time slots. Deviations can here alter how many shipments the driver is able to complete, which leads to that other drivers may need to take planned shipments from this driver. If demand is high and all available drivers all planned for full days, the options are to either provide more supply in form of getting more drivers or change in assignments. If on top of that changes occur altering the planned routes, it may occur at rare occasions that shipments are left for the next day. One haulier is used for the transport and similarly as previous the deviation information is communicated via phone calls from drivers or emails from haulier. Even though the drivers are good in communicating changes these are mainly done when something unexpected happens leading to reactive behaviour of re-plan

decisions. Importantly, changes at other involved actors, as supplier, are not reported by this actor but by drivers. For example, if the supplier only has 29 pallets ready for pick-up instead of planned 33, or the driver has to wait one hour for the remaining pallets, the driver calls the planning to inform. According to interviews this occurs also for suppliers with fixed pick up times. In line with the road transport related to DCs, there are little combination of data, as deviation information is mainly represented by detection after change has occurred.

Results and discussion

This section uses the dimensions of deviation information derived in frame of references to analyse and discuss interviews and observations data.

Deviation information in the case study was mainly received after a change had occurred rather than received before the change occurred. Few examples of prediction were found, only in connection to after a changed had occurred to predict next point of interest in transport chain. This makes the deviation information at case company revolve around detection rather than prediction. Deviation was identified when someone in the transport chain is reporting at fixed points or when something expected has not happened, leading to reactive planning with big gap between time of deviation and time for detection. The sub-contracting of activities between hauliers are generating difficulties for efficient information flows adding problems to minimize the gap between deviation and detection. The combination of data for deviation information was primarily executed manually, representing manual detection giving reactive planning possibilities. The combination of data was limited, probably as the case company received data for detection without need for combination and would probably be more of importance for prediction and proactive planning. The train was found not mainly limited by the inflexible infrastructure and schedule but the contextual settings of early arrival time in the morning in the case study show lower potential for detection or prediction information. Giving that flexible activities can give more potential for increased resource utilization compared to better deviation information. However, accurate prediction of magnitude for deviation, i.e. time, could support more options for alternative activities. The case company is not using system support to get from manual detection to automatic detection, even though technically feasible and previously used. The explanation considered no need for constant updates leading to extra work with more notifications. It could be argued that the automatic detection was one module in an otherwise manual system, which not made it suitable for the working settings. However, if the automatic detection had been linked to an automatic module for prediction this might had been more usable. Getting information for detection instead of prediction is generating a reactive re-plan approach, which is seen in the initial planning stage where slack is built in to the routes, comparable to a resilience strategy (Zhalechian et al., 2018), in order to be flexible and manage changes. The overtime of drivers is used as a reactive flexibility measure to deal with unexpected changes or planning for a short day for a driver generating possibilities to help out in other routes in case of changes. One can compare this slack as stocks and buffers in production planning (Angkiriwang et al., 2014) or as a recovery plan (Sahebjamnia et al., 2015).

The activity of planning has no certain rules on how to combine what shipments in a route or what trailers to priorities for transport between DCs. Further are schedules, except some given constraints of fixed time slots, proposals to drivers, who may decide on breaks at other timepoints. This space of freedom for drivers will generate problems to combine data when designing proactive deviation information for prediction. This adds new indications for intelligence needed for prediction systems, i.e. predictive arrival time need to include contextual aspects, adding to the factors identified by van der Spoel et al. (2017). This will be of importance to increase accuracy of prediction as detection is seen more reliable as deviation already happened. Further, to move towards prediction instead of detection, data for deviation information from other actors and data sources need to be considered, to cover contextual aspects and complex actor structures, as seen above. As setup to get this information prediction could be connected to more costs and efforts than detection. This raises the

importance of clearly linking prediction to efficiency, in better decisions and less slack in planning, in comparison to detection could influence practitioners to change this view.

Conclusions

This paper investigated deviation information in a case company to better understand how deviation information influences possibilities for the planning decisions to be of proactive or reactive nature. Based on literature four main types of deviation information were identified; proactive prediction or reactive detection, depending on timing of identification and both can be achieved via combination of data manually or automatically. The case study illustrates aspects, in comparison to previous literature, when proactive might have little potential or at least to high cost for results. It further points out important contextual issues affecting the possibilities for prediction or detection information to influence the operational planning. How the planning work is structured automatic detection or prediction could be of less interest, i.e. one automatic module deviating from manually structured work in planning was found not suitable. These contextual settings of activities and planning add theoretical implications that could be of importance when developing prediction systems for deviation information in DSS. Reactive planning structures with in-built slack need to be changed, in order to see value in proactive deviation information. Similar as Sternberg et al. (2013), a complex actor structure of hauliers has been seen to limit the possibility of getting proactive prediction information. Technological advancements can change costs for generating data from different sources indicate potential for achieving prediction. Proactive prediction can give potential in using other resources better, rather than having them waiting for arriving transport. However, differing from assumptions in literature, the possible influence was seen varying depending contextual settings as late daytime of arrival and activities possibilities to be flexible and meanwhile waiting do alternative tasks or not.
Limitations of single case study can be addressed by future research to broaden generalizability. The case study shows limitations of available deviation information that could be addressed to develop DSS relevant for practice. Further, the connection between proactive detection information and support information and measured efficiency can be combined for a broader understanding of the complete picture.

References

- AEOLIX 2017. AEOLIX Vision Document. http://aeolix.eu/wp-content/uploads/sites/11/2017/05/AOELIX-brochure-A5-no-marks.pdf
- ANGKIRIWANG, R., PUJAWAN, I. N. & SANTOSA, B. 2014. Managing uncertainty through supply chain flexibility: reactive vs. proactive approaches. *Production and Manufacturing Research,* 2**,** 50-70.
- BOCK, S. 2010. Real-time control of freight forwarder transportation networks by integrating multimodal transport chains. *European Journal of Operational Research,* 200**,** 733-746.
- DAVENPORT, T. H. & PRUSAK, L. 1998. *Working knowledge : how organizations manage what they know,* Boston MA, Harvard Business School.
- FELDMAN, Z., FOURNIER, F., FRANKLIN, R. & METZGER, A. 2013. Proactive event processing in action: a case study on the proactive management of transport processes (industry article). *Proceedings of the 7th ACM international conference on Distributed event-based systems.* Arlington, Texas, USA: ACM.
- FLEISCHMANN, B., GNUTZMANN, S. & SANDVOS, E. 2004. Dynamic Vehicle Routing Based on Online Traffic Information. *Transportation Science,* 38**,** 420-433.
- HALLDÓRSSON, Á. & AASTRUP, J. 2003. Quality criteria for qualitative inquiries in logistics. *European Journal of Operational Research,* 144**,** 321-332.
- KNEMEYER, A. M., ZINN, W. & EROGLU, C. 2009. Proactive planning for catastrophic events in supply chains. *Journal of Operations Management,* 27**,** 141-153.

- MEYER, G. G., BUIJS, P., SZIRBIK, N. B. & WORTMANN , J. C. H. 2014. Intelligent products for enhancing the utilization of tracking technology in transportation. *Internation Journal of Operations & Production Mangement,* 34**,** 422-446.
- MISHRA, M., SIDOTI, D., AVVARI, G. V., MANNARU, P., AYALA, D. F. M., PATTIPATI, K. R. & KLEINMAN, D. L. 2017. A Context-Driven Framework for Proactive Decision Support With Applications. *IEEE Access,* 5**,** 12475-12495.
- MUKAI, N., WATANABE, T. & JUN, F. Proactive route planning based on expected rewards for transport systems. 17th IEEE International Conference on Tools with Artificial Intelligence (ICTAI'05), 16-16 Nov. 2005 2005. 7 pp.-57.
- ROY, J. Recent trends in logistics and the need for real-time decision tools in the trucking industry. Proceedings of the 34th Annual Hawaii International Conference on System Sciences, 6-6 Jan. 2001 2001. 9 pp.
- SAHEBJAMNIA, N., TORABI, S. A. & MANSOURI, S. A. 2015. Integrated business continuity and disaster recovery planning: Towards organizational resilience. *European Journal of Operational Research,* 242**,** 261-273.
- SCHÖNBERGER, J. 2011. *Model-Based Control of Logistics Processes in Volatile Environments*, Springer-Verlag New York.
- SCHÖNBERGER, J. & KOPFER, H. 2011. Decision support systems and the coordination of supply consortium partners. *Computers in Industry,* 62**,** 587-596.
- SÉGUIN, R., POTVIN, J. Y., GENDREAU, M., CRAINIC, T. G. & MARCOTTE, P. 1997. Real-time decision problems: an operational research perspective. *Journal of the Operational Research Society,* 48**,** 162-174.
- STERNBERG, H., GERMANN, T. & KLAAS-WISSING, T. 2013. Who controls the fleet? Initial insights into road freight transport planning and control from an industrial network perspective. *International Journal of Logistics Research and Applications,* 16**,** 493-505.
- TANG, C. S. 2006. Perspectives in supply chain risk management. *International Journal of Production Economics,* 103**,** 451-488.
- VAN DER SPOEL, S., AMRIT, C. & VAN HILLEGERSBERG, J. 2017. Predictive analytics for truck arrival time estimation: a field study at a European distribution centre. *International Journal of Production Research,* 55**,** 5062-5078.
- WOXENIUS, J. 2012. Directness as a key performance indicator for freight transport chains. *Research in Transportation Economics,* 36**,** 63-72.
- XUN, L., J., G. T. & W., H. C. 2009. Supply chain agility: scale development. *The International Journal of Logistics Management,* 20**,** 408-424.
- ZHALECHIAN, M., TORABI, S. A. & MOHAMMADI, M. 2018. Hub-and-spoke network design under operational and disruption risks. *Transportation Research Part E: Logistics and Transportation Review,* 109**,** 20-43.

HARMONIOUS COLLABORATION OR COERCIVE INTEGRATION IN RETAILING: INVESTIGATING THEORY AND PRACTICE

Bernd Philipp[1] and David Grant[2, 3]
[1]ESCE Paris, and CRET-LOG, Aix en Provence, France
[2]University of Hull, UK
[3]Hanken School of Economics, Finland

Introduction, general objective and main purpose

This paper discusses an in-process research project investigating retail collaboration practices and their potential effects on supply chain activities. Given recent changes in the retail landscape the choice of an appropriate collaboration form has logistics consequences in terms of efficiency, fulfilment, service level, procurement strategies and operational synergies that have been overlooked so far in extant research. Further, there has been a recent and growing spate of merger and acquisition (M&A) activities in the combined online-offline retail setting visible, for example by consolidation of logistics service providers (LSPs), which merit discussion of two potential collaborative types: harmonious collaboration (HC) and coercive integration (CI). We consider our paper contributes and is novel within the logistics and supply chain management (LSCM) community as few studies exist on horizontal alliances.

Our paper is constructed as follows: first, we conduct a literature review resulting in a normative grid or typology of *a priori* pros and cons according to horizontal retail and mergers and acquisitions literature. Then, based upon secondary data, we provide a listing of four recent and real cases of relevant horizontal collaboration, classifying them in the light of literature as either HC or CI or in-between (i.e. uncertain) as a springboard to determine and anticipate any supply chain (management) effects and implications, including inter-alliance efficiency of operations, HR issues, culture issues etc. identified in the M&A literature. As a result of these two pieces of work, we then present a research agenda and conclude the paper.

Literature review

In order to construct a grid of *a priori* pros and cons on M&A and then select and examine the four recent M&A activities, we were obliged to start with a general academic literature, i.e. relevant for both horizontal and vertical alliances/M&A. We follow recommendations by Fink (1998), Mayring (2003) and Seuring & Müller (2008) for conducting both the literature review and subsequent content analysis. Both authors were involved in the data selection and analysis processes in order to reduce the risk when making decisions about how the paper is to be comprehended (Seuring & Müller, 2008).

For material collection, we used search terms of COLLABORATION; MERGER; ACQUISITION; COOPERATION; ALLIANCE; and HORIZONTAL in various combinations. Category selection, composed of structural dimensions and related analytic categories, was derived from our deductive approach. The academic literature review proposes six criteria as structural dimensions divided into two groups: four endogenous and two exogenous criteria. The structural dimensions (and their related analytic categories in brackets) are as follows: capability type (soft, modular, hard); resource's strategic importance level (high, low); extensive redundancy level of resources (high, low); synergy type (sequential, modular, reciprocal); uncertainty level (high, low) the new entity will face and the existence (yes, no) of potential rivals threatening the targeted collaboration.

Consequent material evaluation consisted in analyzing the identified secondary data sections against these criteria and their respective modalities. Following Mayring (2002), the successive steps of category selection and material evaluation were done in an iterative manner, revising and refining dimensions and underlying categories. Reliability was addressed by having all steps of the formal (content) analysis conducted by two researchers (Seuring & Müller, 2008).

As noted, we consider our research contributes and is novel within the LSCM community. For instance, few empirical studies exist on horizontal alliances (see Ensign, 1998; Bengtsson & Kock, 1999; Rindfleisch, 2000; O'Donnell et al., 2001; Hosken et al., 2012; Aguzzoni et al., 2016), although there is a long tradition, particularly in the retail sector of cooperative buying (for example, within the framework of informal buying groups) which constitutes the single most important modality (Zentes & Swoboda, 2000). Retail alliances have existed for years as predominantly national buying clubs, particularly in France (Clarke-Hill et al., 1998).

The lack of empirical work is also true as regards one element of our research interest, *i.e.* the combined online/ offline setting, as horizontal retail mergers and their effects are mostly limited to brick and mortar actors (Aguzzoni et al., 2016; Zhu et al., 2016; Saitone & Sexton, 2017) in extant contributions. This literature is also dominated by marketing effects such as product variety, depth of assortment, product quality, prices and consumers' total welfare rather than logistics consequences. Efficiency, fulfilment, service level, procurement strategies and operational synergies have been overlooked so far, although they appear indispensable for global success.

Summing up academic literature, table 1 develops a typology including characteristics, types and advantages (pros) and failure factors (cons) for alliances and acquisition in the upper part, whereas the lower part stresses on the decision-making criteria as regards HC versus CI: the synergy objective the 2 parties have, the type of capabilities the 2 parties bring in and more external factors, particularly uncertainty and market conditions.

HARMONIOUS COLLABORATION – HC (ALLIANCE)		***COERCIVE INTEGRATION – CI (ACQUISITION)***
Related notions and concepts, quasi-synonyms		
Intended collaboration/ cooperation strategies		Survival strategies; forced integration
Types		
Four types of strategic alliances: scale alliances; access alliances; complementary alliances; collusive alliances.		
Two main types of ownership in strategic alliances: Equity alliances (creation of a new entity that is owned separately by the partners involved, e.g. joint venture); non-equity alliances (typically looser, and does not involve the commitment implied by ownership; e.g. franchising).		
Two types of alliances: Y-alliances (local or national alliances formed to compensate for structural competitive disadvantages); X-alliances (cross-border extension of the operative alliance; globalization context).		

General advantages, reasons, motivations and business purposes		
Business purposes for alliances can be both operational and strategic; Necessity, asymmetry, reciprocity, and efficiency, stability and legitimacy; Survival and competitive advantage elements; "production of technology fusion" and market-related reasons; Positive projections and expectations into the future; potential to reduce financial risks.		Business extension; consolidation; operational synergies; building capabilities; speed; financial advantages (financial efficiency; tax efficiency; Asset stripping or unbundling); possibility to increase prices (local vs. national level; overlap region vs. non-overlap region) or to reduce quality level of the retailers' offer (cf. anti-trust issues).
General factors for failure (approximately 50% for both types)		
Miscalculations in terms of strategic and organizational fit; trust and co-evolution issues due to the lack of control on either side.		Excessive initial valuations; exaggerated expectations of strategic fit; underestimated problems of organizational and culture fit.
Relevant choice guidance: Synergy-related reasons (i.e. a priori synergy objective the two parties have)		
Sequential synergies: (one company completes tasks and passes the results to a partner to do its part) are aimed at: prefer equity alliance (one company invests in an equity stake in the other).		
Modular synergies: (managing resources, independently and pooling results for greater profits) are aimed at: prefer non-equity alliance.		
		Reciprocal synergies: (both firms execute tasks through close knowledge sharing) are aimed at: prefer acquisition.
Relevant choice guidance: Capabilities-related reasons (resources and competences) (i.e. type of capabilities the two parties bring in the collaboration)		
		Strategic importance of resource: necessity of control
Type of capabilities (resources or competences) to be combined: soft, prefer equity alliance		***Type of capabilities (resources or competences) to be combined:*** hard
		Save potential of extensive **redundant** resources (elimination of redundancies across company functions after the acquisition).
High modularity of capabilities: prefer alliance route		
Relevant choice guidance: Uncertainty reasons and market conditions (i.e. exogenous factors the two parties only have limited control over)		
High uncertainty (of markets and/ or technologies) the new entity will face:		

prefer alliance route (non-equity or equity alliance).		
		Company will have **rivals** for potential partners (these rivals might also want to collaborate with the targeted partner and thus destroy the company's collaboration plans): prefer acquisition.

(Sources: Oliver 1990; Murray & Mahon 1993; Vyas et al. 1995; Reijnders & Verhallen 1996; Clarke-Hill et al. 1998; Elmuti & Kathawala 2001; Dyer et al. 2004; Hosken et al. 2012; Aguzzoni et al. 2016)

Table 1: Choice between alliance and acquisition

We observed that general advantages, reasons, motivations and business purposes of HC are quite similar to that of CI, resulting in a poor discrimination degree for decision-making. The same observation is true with regards to failure factures, especially when considering that failure represents about 50% for both types, HC and CI. Indeed, most relevant advice for decision-making as regards HC vs. CI can be derived from the following criteria: the synergy objective the two parties have, the type of capabilities the two parties bring in, and more external factors particularly uncertainty and market conditions. Hence, we stressed these criteria when conducting our literature review, resulting in the above normative grid of *a priori* pros and cons. They are summed up in the table above and developed in detail as follows.

The literature does provide choice guidance between HC and CI depending on the synergy type the two parties aim for. HC (equity alliance: one company invests in an equity stake in the other) should be preferred when sequential synergies are targeted, i.e. when one company completes tasks and passes the results to a partner to do its part. Modular synergies (*i.e.* managing resources independently and pooling results for greater profits) as objectives for collaboration also call for HC (non-equity alliance). On the other hand, if reciprocal synergies (both firms execute tasks through close knowledge sharing) are aimed at, literature recommends CI (acquisition). The type of capabilities – both resources and competences - the two parties bring in is another decision basis for HC versus CI treated by literature. HC (equity alliance) should be preferred when soft capabilities are combined or exchanged. The same recommendation (alliance route) is given in case of high modularity of capabilities.

Further, the literature recommends CI when resources represent a strategic importance, making it necessary to control them. CI also applies in case of hard capabilities involved. Last but not least, CI represents the advantage of a huge save potential in case of extensive redundant resources. Academic literature also provides choice guidance between HC and CI depending on more external factors, particularly uncertainty and market conditions. High uncertainty (of markets and/or technologies) the new entity will face is considered as a driver for HC (alliance route: non-equity or equity alliance), whereas CI (acquisition) should be preferred if the company will have rivals for potential partners; these rivals might also want to collaborate with the targeted partner and thus destroy the company's collaboration plans.

Capabilities and potential synergies are related, as business synergy refers to the extent to which supply chain partners combine complementary and related resources to achieve spillover benefits (Cao & Zhang, 2012). Ansoff (1988) advocates that synergy can produce a combined return on resources that is larger than the sum of individual parts, resulting from the better use of resources within the supply chain, covering both physical and immaterial assets (Itami & Roehl, 1987). Lasker et al. (2001) stipulate that synergies between supply chain partners are more than a sole exchange of resources. By mixing the individual firms' capabilities, the cooperation might build something new and valuable together. Supply chain partners can also achieve synergy of joint IT infrastructure and processes (Larsson & Finkelstein, 1999; Zhu, 2004; Tanriverdi, 2006).

We next observed what has happened in four M&A cases practice to determine whether these cases related to pros and cons of actual horizontal online/ offline horizontal retail collaboration as observed in secondary data match with theoretical typologies proposed by M&A literature (HC versus CI, or in-between). More precisely, do actual supply chain consequences (*e.g.* inter-alliance efficiency of operations, fulfilment, service level, procurement strategies and operational synergies) reflect pros and cons of the theoretical typology proposed by M&A literature?

Actual case examples from 2015 onwards

The four case examples chosen in combined online-offline retail are shown in table 2 below. They stem from academic/ non-academic (media, trade) literature considered as secondary data. This selection of recent (*i.e.* 2015+) horizontal collaboration activities are classified in light of the literature as either HC or CI or in-between (*i.e.* uncertain).

FOUR CASE EXAMPLES (secondary data)				
Brick-and-mortar retailer	**E-retailer**	**Product category**	**Source & secondary data**	**HC, CI or Uncertain**
Walmart (USA)	Bonobos (USA)	Online: menswear line	https://www.retaildive.com/news/why-the-walmart-bonobos-deal-shows- the-way-to-retails-showroom-future/504685/	uncertain
Whole Foods Market (USA)	Amazon (USA)	Food (online grocery)	http://abc7ny.com/shopping/amazon-is-buying-whole-foods-in-a-$137b-deal/2107171/ https://www.freightwaves.com/news/amazon-can-leverage-whole-foods-distribution-network	CI rather than HC.
Monoprix (Carrefour group; F)	Ocado (UK)	Food (online grocery)	https://www.lsa-conso.fr/casino- signe-avec-ocado-pour-lui-confier-l-e-commerce-alimentaire-de-monoprix,273717 https://www.lsa-conso.fr/pourquoi-monoprix-a-signe-avec-ocado-pour-son-e-commerce,274407 https://www.lemonde.fr/economie/article/2017/11/29/casino-s-allie-avec- l-anglais-ocado-pour-faire-le-grand-saut-dans-le-commerce-alimentaire-en-ligne_5222094_3234.html	uncertain
Auchan Retail (F)	Alibaba Group (China)	Food (online grocery)	https://www.lsa-conso.fr/auchan-et-alibaba-deviennent-partenaires-en-chine-pour-unir-le-commerce-digital-et-physique,272767	uncertain

Table 2: Case examples of horizontal retail collaboration identified via Internet search

Our findings are unfortunately but necessarily brief for an eight page conference paper but suggest aspects of a research agenda to follow. As noted, previous research has not sufficiently investigated different pro and con factors of horizontal collaboration in retail, particularly in an online-offline and M&A context. Hence, further research should empirically investigate these different factors in this industry sector as follows:

- Research should test our *a priori* pros and cons to determine their veracity and appropriateness;
- Research should longitudinally consider various retail M&A activity to determine whether HC or CI, or a combination is taking place and which one predominates;

- Research should investigate these factors across the online and offline retail groups; and
- Research should investigate root causes regarding little difference in the literature regarding general advantages, reasons, motivations and business purposes between HC and CI to verify whether these two postulated concepts are indeed unique and distinct.

Conclusion, contribution and limitations

This paper's contribution is a literature review deriving *a priori* factors affecting retail horizontal collaboration practices, concerning two potential collaborative types: harmonious collaboration (HC) and coercive integration (CI), through the lens of the mergers & acquisitions literature. A further contribution is the presentation of four actual case studies, together with a proposed research agenda to further investigate the issues found. A limitation of this paper is that there is no empirical study to support or refute our conceptual notions. However, the proposed research agenda will provide the authors and other academics with the opportunity to do just that in future.

References

- *Aguzzoni, L., Argentesi E., Ciari L., Duso T. & Tognoni M. (2016), "Ex post merger evaluation in the UK retail market for books", The Journal of Industrial Economics, Vol. 64, Iss. 1, pp. 170-200.*
- *Ansoff, H.I. (1988), The New Corporate Strategy. Wiley, New York, NY.*
- *Bengtsson, M. & Kock, S. (1999), "Cooperation and competition in relationships between competitors in business networks", Journal of Business and Industrial Marketing, Vol. 14, Iss. 3, pp. 178-93.*
- *Cao, D.M. & Zhang, Q. (2012), Supply Chain Collaboration: Roles of interorganizational systems, trust, and collaborative culture. Springer edition, (electronic Kindle format).*
- *Clarke-Hill, C.M., Robinson, T.M. & Bailey, J. (1998), "Skills and competence transfers in European retail alliances: a comparison between alliances and joint ventures", European Business Review, Vol. 8, Iss. 6, pp. 300-10.*
- *Dyer, J.H., Kale, P. & Singh, H.(2004), "When to ally and when to acquire", Harvard Business Review, Vol. 82, Iss. 7/8, pp. 109–115.*
- *Elmuti, D. & Kathawala, Y. (2001), "An overview of strategic alliances", Management Decision, Vol. 39, Iss. 3, pp. 205-17.*
- *Ensign, P.C. (1998), "Interrelationships and horizontal strategy to achieve synergy and competitive advantage in the diversified firm", Management Decision, Vol. 36, Iss. 10, pp. 657-68.*
- *Fink A. (1998), Conducting research literature reviews: from paper to the internet. Thousand Oaks CA: Sage.*
- *Hosken, D., Olson, L.M. & Smith, L.K. (2012), Do Retail Mergers Affect Competition? Evidence from Grocery Retailing. Federal Trade Commission Bureau of Economics working paper no. 313, December.*
- *Itami, H. & Roehl, T.W. (1987), "Mobilizing invisible assets", Harvard University Press, Cambridge (USA).*
- *Larsson, R. & Finkelstein, S. (1999), "Integrating Strategic, Organizational, and Human Resource Perspectives on Mergers and Acquisitions: a Case Study of Synergy Realization", Journal of Organization Science, Vol. 10, Iss. 1, pp. 1-26.*
- *Lasker, R.D., Weiss, E.S. & Miller, R. (2001), "Partnership synergy: a practical framework for studying and strengthening the collaborative advantage", The Milbank Quarterly, Vol. 79, Iss. 2, pp. 179-205.*
- *Mayring, P. (2002), Einführung in die qualitative Sozialforschung – eine Anleitung zum qualitativen Denken. [Introduction to qualitative social research], Weinheim, Germany: Beltz Verlag.*

- *Murray, E.A. & Mahon, J.F. (1993), "Strategic alliances: gateway to the new Europe?", Long Range Planning, Vol. 26, Iss. 4, pp. 102-11.*
- *O'Donnell, A., Gilmore, A., Cummins, D. & Carson, D. (2001), "The network construct in entrepreneurship research: a review and critique", Management Decision, Vol. 39, Iss. 9, pp. 749-60.*
- *Oliver, C. (1990), "Determinants of interorganizational relationships: integration and future directions", Academy of Management Review, Vol. 15, Iss. 2, pp. 241-65.*
- *Reijnders, W.J.M. & Verhallen, T.M.M. (1996), "Strategic alliances among small retailing firms: empirical evidence for the Netherlands", Journal of Small Business Management, Vol. 34, Iss. 1, pp. 36-46.*
- *Rindfleisch, A. (2000), "Organizational trust and interfirm cooperation: an examination of horizontal versus vertical alliances", Marketing Letters, Vol. 11, Iss. 1, pp. 81-95.*
- *Saitone, T.L. & Sexton, R.J. (2017), "Concentration and Consolidation in the U.S. Food Supply Chain: The Latest Evidence and Implications for Consumers, Farmers, and Policymakers", Economic Review, special issue.*
- *Seuring, S. & Müller, M. (2008), "From a literature review to a conceptual framework for sustainable supply chain management", Journal of Cleaner Production, Vol. 16, pp. 1699–1710.*
- *Tanriverdi, H. (2006), "Performance Effects of Information Technology Synergies in Multibusiness Firms", MIS Quarterly (JSTOR), Vol. 30, Iss. 1 (March), pp. 57-77.*
- *Valentin, E.K. (2001), "Swot Analysis from a Resource-Based View", Journal of Marketing Theory and Practice, Vol. 9, Iss. 2 (Spring), pp. 54-69.*
- *Vyas, N.M., Shelburn, W.L. & Rogers, D.C. (1995), "An analysis of strategic alliances: forms, functions and framework", Journal of Business & Industrial Marketing, Vol. 10 No. 3, pp. 47-60.ships: integration and future directions", Academy of Management Review, Vol. 15, Iss. 2, pp. 241-65.*
- *Zentes, J. & Swoboda, B. (2000), "Allied groups on the road to complex networks", Technology Society, Vol. 22, pp. 133-50.*
- *Zhu, K. (2004), "The complementarity of Information Technology Infrastructure and e-commerce capability: a resource-based assessment of their business value", Journal of Management Information Systems, Vol. 21, Iss. 1, pp. 167-202.*
- *Zhu, J. et al. (2016), "Effects of upstream and downstream mergers on supply chain profitability", European Journal of Operational Research, Vol. 249, Iss. 1, pp. 131–143.*

CAUSES OF DRUG SUPPLY SHORTAGES WITHIN STATE HOSPITAL PHARMACIES IN DEVELOPING COUNTRIES: CASE OF NAMIBIA WINDHOEK

Dofilia S. Kaloia, Ishmael Mubwandarikwa and Logan Fransman
The Namibian-German Institute of Logistics, Namibia University of Science and Technology (NUST), Windhoek, Namibia

Introduction

Safeguarding the supply of drugs and satisfying the needs of patients when it comes to quantity, quality, cost and accessibility is at a strategic priority of any health care system priorities (Abdollahiasl et al., 2014). Pharmaceutical supply chains are subject to a lot of threats leading not only to deteriorating treasured resources but also the disruption of available drugs resulting in the growing problem of shortages**.**

Drug shortage is a condition in which the supply of all clinically alternative versions of a controlled drug is insufficient to meet the current or estimated demand at the user levels, which are patients (Gu, Wertheimer, Brown & Shaya, 2011). The term drug shortage was seldom encountered at least ten years ago, in recent years the degree and impact of drug shortage increased to critical levels. The author further stated that the list of drugs in shortage is rapidly increasing with the passing of the years. In addition, in 2010, there were 211 newly reported drug shortages, tripling the amount in 2006 with almost 75% being sterile injectable (Gu, et al., 2011). In many healthcare practice settings, the shortage is prevalent and affecting nearly all the classes, with the most critical ones such as surgical and being affected the most (Ventola, 2011). Based on a particular case in the USA, the FDA reported that the number of drug supply shortage tripled from 61 types of drugs to 178 between 2005 and 2010, with over 200 reported in 2012 alone. It was still reported by the federal drug administration in the United States of America that from 2014, 754 drug products types remained on shortages (Caulder, Mehta, Bookstave, and Sims & Stevenson, 2015. The roots of drug shortages are multifaceted and varied, the problem can either be due to the supply or demand. This situation affects almost every stakeholder in the healthcare system, which is why collaboration is required to handle or reduce shortages. It is also possible to affect the amount of work, important decisions and financial impact if not be anticipated on time (Pauwels, et al.2015). Namibia, a country situated in the southern part of Africa, consists of a population estimated to be 2.304 million inhabitants from the 14 regions (Namibia Statistical Agency, 2011). Drug shortage continues to be a burden on health care system in this part of the world (Mclaughlin et. Al., 2013). The general problem is that pharmacies, and the health authorities responsible for the supply of drugs to patients in Namibia, are unable to make an informed decision in order to deal with drug supply shortages in hospitals because there has been little research on the causes of drug supply shortages within state hospitals in the country. Shortage of drugs in state hospitals. Hospital and other health facilities (Tjitemisa, 2014). Although previously many Authors have provided an insight into the size and the impact of the problem on the health care system worldwide, this problem was never addressed in Namibia.

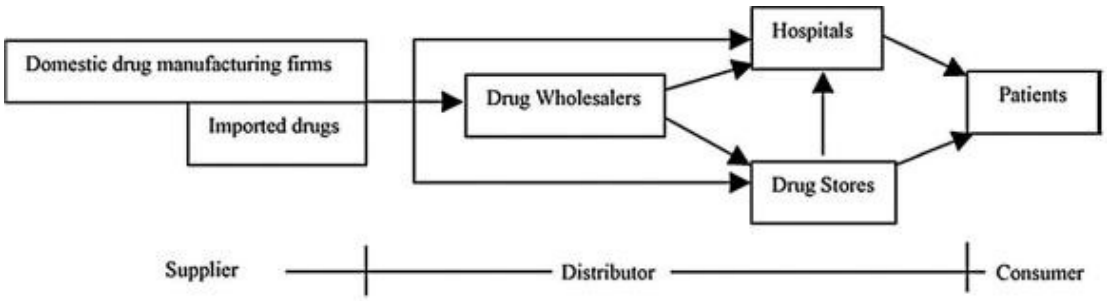
Literature review

The origin of drug shortages is complex and diverse and the problem can be situated at both the supply and demand side. Keeping inventory of drugs while providing suitable patient care remains a daily challenge for pharmacists within state hospitals in light of national drug shortages in the country. According to a report by New Era (2017), in Windhoek the capital of Namibia there is a shortage of various critical medicines in state hospitals, particularly the ones used for children treatment. On the other hand, the Oshakati state hospital was reported to have been facing a situation whereby specialised medication that is needed for patients who are on cancer treatment were also on shortages. This section summarizes and presents an overview of the general

healthcare supply chain, the factors leading to drug supply shortages, and possible measures to deal with the situation.

Health care system supply chain overview

As an important point of departure for this study,, it is vital to understand the of a health care system supply chain**.** The pharmaceutical industry is a scheme of techniques, processes and organizations that are part of the finding, development and creation of drugs and medications. The Pharmaceutical Supply Chain represents the path through which essential pharmaceutical products including drugs are distributed to the end-users with the seven rights achieved (Mehralian, 2012). The application of modern logistics and supply chain management practices in the healthcare sector has trailed behind other industries, this can be due to various reasons. Generally, supply chain deals with resources needed to deliver products to consumers. When it comes to health care, the management of the supply chain becomes more complex. To complete the process in this care system, physical goods and information about medical products and services usually go through a number of independent stakeholders, including manufacturers, insurance companies, hospitals, providers, group purchasing organizations, and several regulatory agencies (Belliveau, 2016). Below is a diagram showing a typical pharmaceutical supply chain.



Source: Yu *et al.* (2010)

Diagram 1: A typical pharmaceutical supply chain

After an overview having an overview of a healthcare supply chain, we are now going to look at factors in the supply chain perspective leading to drug supply shortages in hospitals.

Factors leading to drug supply shortages in hospitals

Healthcare services are known as knowledge-intensive services rendered by knowledge workers (Gu, Wertheimer, Brown & Shaya, 2011). After looking at the general supply chain of the health system, it is important to understand that providing such a service requires using some kind of goods which are referred to as pharmaceutical products. Just like any other company, hospitals are also striving to make sure that they satisfy their customers, which in this case are referred to as patients. A shortage of products exits in variousindustries, but when it comes to the health industry, this situation is very critical and needs serious attention. Following are the factors that some authors have identified as leading causes of drug supply shortages in hospitals.

The study made use of a quantitative design to identify the different supply chain factors leading to drug supply shortages in state hospitals in Windhoek, Namibia. A model was developed from past literature showing a relationship linking possible supply chain related causes of drug shortages.

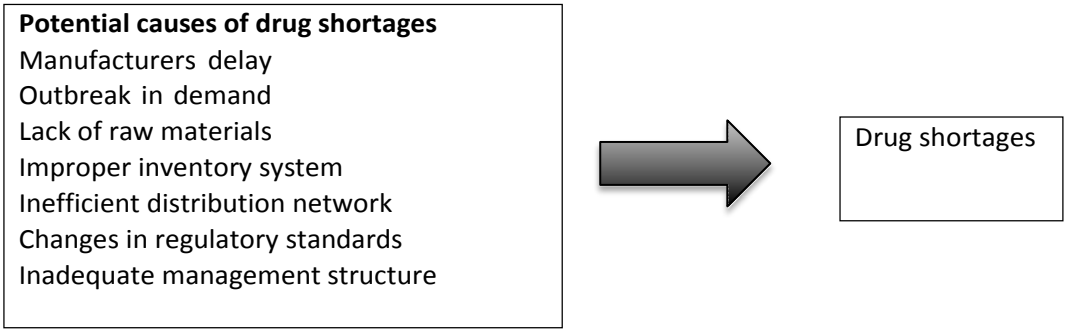


Figure 1. Conceptual framework

Lack of Raw Material

Raw materials are essential for the production of all products. Gu et al. (2011) stated that unavailability of raw materials is a leading factor to shortages of drug supply. He further stated that sub-optimal quality of raw materials may have a profound impact on drug shortages and various factors can contribute to the raw material shortage. Supporting the same point, Joel 2010, also alluded that, reasons for drug shortages are complex and despite appearances to the contrary, are generally linked to the laws of supply and demand and raw material shortages is one of the reasons. Ventola (2011) also agreed that shortages of raw materials are a major cause of drug shortage in hospitals, and interruptions in the supply of basic materials are normally accountable for drug shortages. These shortages are especially problematic when a primary or sole supplier of the product suspends or ceases production, disturbing other manufacturers. Even when there is more than one manufacturer of a drug, there might be only a single producer of a specific raw material that is vital in the production of a specific drug.

Outbreak in demand

The demand for products including drugs is increasing at an alarming pace. According to Gu et al. (2011), an outbreak in demand can also lead to the shortage of drug supply, most especially when there is an outbreak of a new disease. The issues of supply and demand can also be a leading factor in the shortage of drugs. Ventola (2011) addressed that, sometimes the demand of a drug can rise above normal prospects or the size of fabrication, this mainly happens when a new medication has been introduced or an old one needs to be improved. An example was given by the author of 2006 where a shortage of pediatric flu vaccine occurred in the USA and the centres for disease control and Prevention (CDC) changed its guidelines to include children 6 to 59 months of age. This change in recommendations put pressure on the suppliers of the only product that the Federal Disease association had approved for use in children 6 to 23 months of age. Unexpected demand for a drug can lead to a shortage when domestic and international supply cannot keep pace. These changes can be further exacerbated when the manufacturing process for a drug is lengthy or the raw materials required to produce it is limited.

Disruption in supply

The Ministry of social services (2016) identified that shortages can also occur when a supplier of a multi-sourced drug (i.e., more than one manufacturer) experiences a supply disruption or makes a business decision to discontinue the drug. This reduction in supply capacity may drive up demand and deplete the product inventories of the remaining suppliers.

Other leading factors

Apart from the lack of raw materials, the increase in unexpected demand, there are also other natural and operational factors amounting to the causes of drug supply shortage. The increased consolidation of generic production at a few sites, and changes in regulatory standards requiring

upgrading of manufacturing plants are all possible reasons for shortages of injectable generic medicines (Gray & Manasses, 2012). Gu et al. (2011) have again identified natural disasters and labor disruptions being factors that lead to drug supply shortage, Natural disasters may result in a shortage by affecting the raw materials needed by the sole producer of a drug and impose unexpected impairment to manufacturing facilities and Labor disruptions attribute to drug shortages by diminishing the productivity of the manufacturing sector. There are other various factors contributing to drug supply shortage, ranging from not only the inefficient distribution network, inadequate management and external factors but also the inefficiency of meeting customer service expectation and incurring unnecessary logistics cost. The challenges amounting to this shortage problem include unclear organizational and management structures and procedures, inadequate inventory-control management systems, and inadequate dispatch and distribution systems.

Strategies to deal with drug supply shortage

It is very difficult to address a drug shortage effectively due to the complexity of the supply chain and the difficulty of demand prediction as there are often no obvious and early indications for a shortage (Kohler, 2013). However, in recent years some researchers have attempted to address strategies that can be used to address the worsening situation of drug shortages. The drug shortage situation requires an organizational strategy that includes a focus on client safety. According to the Yang, et. al. (2016), to help curb the situation of drug supply shortage, it is important to involve the entire care team in some way to help identify, strategies to promote client safety and continuity of treatment potential treatment options, most appropriate care provider to manage and minimize wastages of drugs, organization collaboration and management of the of issue, making a follow-up of evolving issues from the wastage minimization strategy. Some reports also stated some strategies for dealing with shortages of drug supply. In the report of The Ministry of Health and Long Term-Care (2012) , it was identified that, when there is a potential risk of drug shortage supply, strategies of the following nature were identified; developing an inventory of available across care settings based on the availability of supply and how critical the need or demand is, conducting a review on current drug prescription practices, based on the available evidence of clinical efficacy, In addition, reducing the wastage of drugs and making use of alternatives medication were also suggested. Kaakeh et. al. (2011), have identified, that, to deal with the persistent shortage of drug supply some implementing steps have to be followed:

1. Monitoring. This step follows the concept of identifying the drugs that are needed but are in shortage so that they can be monitored.
2. Seeking alternatives. When the drugs in shortage have been listed, then pharmacists or nurses have to look for alternative medications to curb for the shortage.
3. Communicating. Communication is very important in all areas of work, in the same notion; pharmacists and nurses have to communicate the situation with all staff involved as well as patients. This helps patients understand that the shortage may not be the fault pharmacy. Good communication helps in bringing a good solution to the crisis. Barlas (2013) alluded that as a solution to the crisis, many hospitals pharmacies make the use of compounded drugs when the usual source of drugs becomes weak.

Methodology

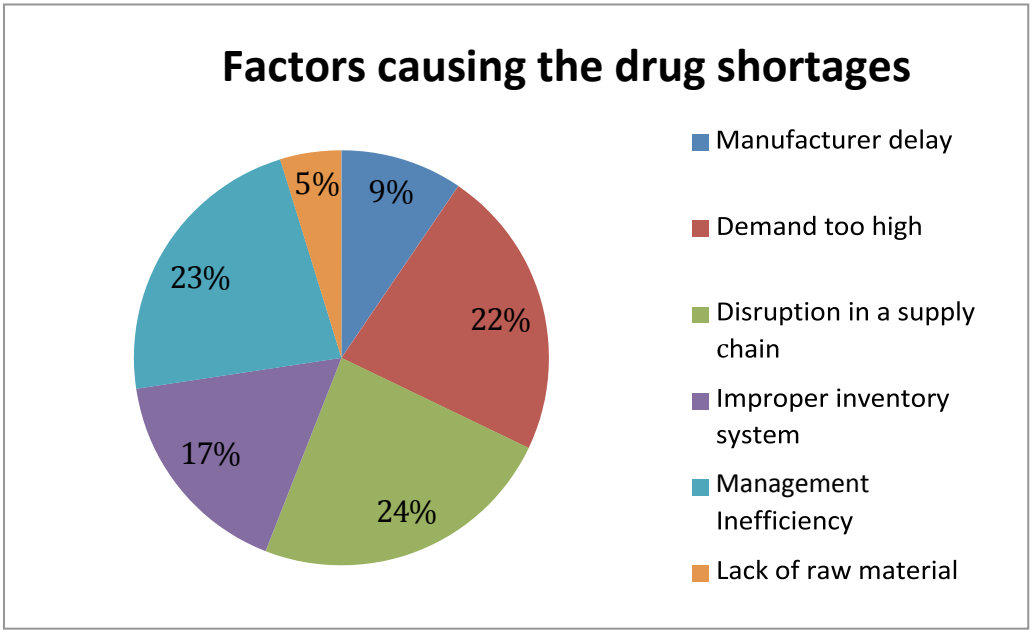
This research endeavours to describe the causes of drug supply shortages at state-owned hospital pharmacies, looking at a specific case in Namibia. The study used a descriptive design that is recommended by Yin (2009) as an approach suitable for an initial method for scientific enquiry, in an environment where a dearth of information exists. Descriptive analysis requires information to demonstrate relationships to describe a particular situation, and thus fits the aims of this study where pharmaceutical drug supplies are related to supply chain specific topics i.e. demand,

inventory management, distribution and the supplier and manufacturing performance. A descriptive survey was used and administered through a non-probability sampling technique that selected participants that were available at the time of the survey. The research was limited to a group of selected respondents by considering their experience and the relevant wards dealing with the hospital pharmacy. A sample of 22 out of a population of 350 health employees (Nurses, Pharmacists and the Chief Pharmacists) at the Windhoek State Hospital completed the survey.

Findings

Factors causing drug supply shortage

This study explored the causes behind drug shortages in state hospitals looking at the perspective of pharmacies and wards Windhoek Namibia.



According to the findings the most commonly mentioned reasons causing drug supply shortages are the disruption in the supply chain (24%), management inefficiency (23%), and demand too high (22%) as well as having an improper inventory system in place (17%). The study further found out that manufacturers delays (9%) and Lack of raw materials (5%) are the least critical factors causing drug supply shortages. The study revealed that the shortage of drug supply is not an assumption within state hospitals in Namibia it is indeed a fact. As about 52% of the respondents had to deal with a situation of drug supply in their wards for at least 2 to 3 times a month. Just as mentioned by Mclaughlin, Thomson and Poselnick (2013), that drug supply shortage is a reality and continues to be a burden in hospitals around the world. In agreement with, Ventola 2011, who stated that disruptions in the supply chain are a cause to drug supply shortage in the hospitals, in support with the framework the study also revealed the same reality with 24% of the respondents stating that disruption in the supply chain being the main cause. Moreover, the study has also found out that management inefficiency in hospitals, as well as an increase in demand and improper inventory systems, are causes of drug supply shortages. The number and types of drugs on shortage have been increasing worldwide, Caulder, Mehta, Bookstave and Sims (2015) indicated that at least from 61 to 178 types were on shortage between 2005 and 2010. The findings revealed that of the types of drugs on shortage the most affected ones are the category of pain drugs and emergency operation drugs, according to figure 4. Although not mentioned in the literature review, the study has found an interesting factor that the expiry date of drugs can be a leading factor to drug supply shortage. Some drugs have a short lifespan and by the time they

reach the wards, some have already expired or about to be expired, these drugs are not fit to be given to patients they end up being dispensed of thrown away, which adds to the list of damaged inventory and increasing shortages. Like many related studies in literature, respondents in this study also indicated disruptions in the supply chain, lack of raw materials, management inefficiencies, increasing demand, improper inventory system, manufacturers delay, being causes of drug supply shortage in state hospitals. Lack of integration and collaboration between the procurement function and distribution function as the expiry date of drugs are factors causing drug supply shortages.

Conclusion

Pharmaceutical supply chains is a field of growing interest in the 21st century. Maintaining the supply of medications and securing the needs of end customers in terms of quantity, quality, and more accessibility of drugs are at the top of any health care system priorities (Abdollahiasl et al., 2014). The purpose of this paper was to explore the causes of drug supply shortages and determining strategies to address and handle the shortage crisis. On the basis of the summary of findings, several conclusions are drawn. Like many related studies in literature, respondents in this study also indicated disruptions in the supply chain, lack of raw materials, management inefficiencies, increasing demand, improper inventory system, manufacturers delay, being causes of drug supply shortage in state hospitals. Lack of integration and collaboration between the procurement function and distribution function as well as the expiry date of drugs are factors causing drug supply shortages. This study further concluded that providing alternative medication, having contingencies planning in terms of alternative suppliers, the collaboration of functions and integration are strategies to deal with or handle drug supply shortage.

References

- *Abdollahiasl, A., Nikfar, S., Kebriaeezadeh, A., Dinarvand, R., Abdollahi, M., Jaberidoost, M., & Cheraghali, A. M. (2014). A system dynamics model for national drug policy: Daru Journal of Pharmaceutical Sciences, 22 (1) doi: 10.1186/2008-2231-22-34*
- *Barlas, S . (2013). FDA Strategies to prevent and respond to drug shortages: Finding a better way to predict and prevent company closure. The pharmacist and therapeutics journal 38 (5): 261-263. https://www.ncbi.nlm.nih.gov*
- *Belliveau, J. (2016). Exploring the role of supply chain management in healthcare. Retrieved from http://revcycleintelligence.com*
- *Caudler, R. C., Mehta, B., Bookstaver, B., Sims, D. L., & Stevenson, B. (2015). Impact of Drug Shortages on Health System Pharmacies in the Southeastern United States. Journal of managed care pharmacy, 50(4), 279-286. doi 10.1310/hpj5004-279.*
- *Gu, A., Wertheimer, A. I., Brown, B., & Shaya, T. F. (2011). Drug shortages in the US causes, impacts and strategies. Innovation in pharmacy, 2 (60), pp.2-6. Retrieved from http://pubs.lib.umn.edu.*
- *Iyengar, S., Hedman, L., Forte, G., & Hill, S. (2016). Medicine shortages: a commentary on causes and mitigation strategies. BMC Medicine, 14, 124. doi.10.1186/s12916-016-0674-7*
- *Kaakeh, R., Sweet, B. V., Reilly, C., Bush, C., DeLoach, S., Higgins, B., ... Stevenson, J. (2011). Impact of drug shortages on U.S. health systems. American Journal of Health-System Pharmacy, 68(19), 1811-1819. DOI: 10.2146/ajhp110210*
- *Jahre, M., Dumoulin, L., Greenhalgh, L. B., Hudspeth, C., Limlim, P., & Spindler, A. (2012). Improving health in developing countries: reducing complexity of drug supplychains. Journal of Humanitarian Logistics and Supply Chain Management, 2(1), 54-84.*
- *Minior, T., Douglas, M., Edgil, D., Srivastava, M., Crowley, J., Firth, J., & Lee, L. (2017). The Critical Role of Supply Chains in Preventing Human Immuno deficiency Virus Drug Resistance in Low-and Middle-Income Settings. The Journal of infectious diseases, 216(9), S812-S815.*
- *New Era. (2017, October 18).Another wave of medicine shortages hits state hospitals. Retrieved from : www.newera.com.na.*

- *McLaughlin, M., Kotis, D., Thomson, K., Harrison, M., Fennessy, G., Postelnick, M., & Scheetz, M. H. (2013). Effects on patient care caused by drug shortages: a survey. Journal of managed care pharmacy, 19(9), 783-788. doi 10.18553/jmcp.2013.19.9.783*
- *Mehralian, G. H. (2012). "Intellectual capital and corporate performance in Iranian pharmaceutical industry", Journal of Intellectual Capital, 13 (1), pp. 138-140*
- *Namibia Statistics Agency. (2011). Namibia 2011 population and housing Census Main Report (p. 7). Windhoek.*
- *Pauwels, K., Simoens, S. , Casteels, M., & Huys, I. (2015). Insights into European drug shortages: a survey of hospital pharmacists: PLoS One 10 (3). doi:10.1371*
- *Shah, N. (2004). Pharmaceutical supply chains: key issues and strategies for optimisation. Computers & Chemical Engineering, 28, 929-941.*
- *Tjitemisa, K. (2014, June 4). A shortage of essential drugs used in surgery at both public and private pharmacies has sparked panic at leading hospitals in the country. The Namibian. Retrieved from http://www.namibian.com.na*
- *Ventola, L. S. (2011). The Drug Shortage Crisis in the United States. Causes, Impact, and Management Strategies .Supply Chain Management: An International Journal. 36(11), pp. 189-190.*
- *Yang, C., Wu, L., Cai, W.,Zhu, W., Shen, Q., Li, Z., & Fang, Y. (2016). Current Situation, determinants, and Solutions to drug shortages in Shaanxi Province, China: A Qualitative Study. PLoS ONE 11(10) doi:10.1371.*
- *Yin, R. K. (2009). Case study research: design and methods (4th ed.). Los Angeles, Calif: Sage Publications*

COLLABORATION IN CIRCULAR SUPPLY CHAINS

Jelena Vlajic[1] and Hsin-I Hsiao[2]
[1]Queen's Management School, Queen's University Belfast, Belfast, Northern Ireland
[2]National Taiwan Ocean University, Taiwan

Introduction

Collaboration is a well-studied topic in the supply chain literature. Most of the studies consider collaboration with regard to the supply chain structure, e.g. see Simatupang and Sridharan (2002), information sharing technologies and practice, e.g. see Attaran and Attaran (2007); Jayaraman, Ross and Agarwal (2008) and relationships between supply chain members, e.g. see Bensaou (1999), Hoyt and Huq (2000), Whipple and Russell (2007), Bordonaba-Juste *et al.*, (2009). More recently, there have appeared an increasing number of papers that considers collaboration in the context of sustainability and environmental management, e.g. (Zsidisin and Siferd, 2001; Grekova *et al.*, 2016; Chen *et al.*, 2017), as well as a limited number of studies in the context of the circular economy, e.g. see literature review of Batista *et al.*, (2018) and Govindan and Hasanagic (2018).

As companies create business relationships with multiple business partners, they participate in multiple supply chains (Soosay and Hyland, 2015). Naturally, there is a variety of collaboration levels between a company and its suppliers and customers or other businesses (Ralston, Richey and Grawe, 2017), and collaboration occurs between independent, geographically dispersed companies. This is especially true in circular supply chains, which consists not only of forward and reverse flows, but also flows to alternative supply chains (Vlajic, Mijailovic and Bogdanova, 2018), where useful waste and by-products are exchanged (Batista *et al.*, 2018). However, characteristics of these flows, as well as nature of collaborative relationships between companies is not given sufficient attention in the supply chain management literature. Moreover, although collaboration is one of the key pillars of the circular economy and circular supply chains (De Angelis, Howard and Miemczyk, 2017), as far as it is known to the authors of this study, only a few studies of industrial eco-parks and industrial symbiosis considered collaboration as a central issue, see Herczeg, Akkerman and Hauschild (2018).

This paper is organized as follows: in the literature review, we first present concept of the circular supply chains, and after that a literature review on collaboration. The literature review section concludes with suggestions from the literature on collaboration in circular supply chains. These suggestions are explored in a case study of the fresh food processor, and some initial findings are presented. The paper ends with the conclusion and future research directions.

Literature review

Circular supply chains

The circular economy refers to "an industrial economy that is restorative by intention" and "aims to rely on renewable energy; minimises, tracks, and hopefully eliminates the use of toxic chemicals; and eradicates waste through careful design", (Webster, 2015, p. 52). The circular economy can be seen on three levels of initiatives: corporate-level (*micro* level), symbiosis associations (*meso* level) and city, province or state level (*macro* level) (Su *et al.*, 2013). Micro level initiatives correspond to initiatives in circular supply chains (Nasir *et al.*, 2017). (Vlajic, Mijailovic and Bogdanova, 2018, p.523) define a *circular supply chain* as "a connected network of organisations involved in the design and management of value-adding processes and value recovery of a product, component or material". Both, value-adding and value recovery activities aim to fulfil economic, social or environmental benefits for the companies involved, as well as for a society (Lieder and Rashid, 2016). (Batista *et al.*, 2018) suggest that any study of circular supply chains considers the coordinated forward as well as the reverse flows.

Value-adding activities occur within the forward logistics flows, usually in a supply chain within the same sector. These activities are subject of resource reduction. (Carter and Ellram, 1998, p. 86) define resource reduction as "the minimization of waste which results in more efficient forward and reverse distribution process". Typical practices in resource reduction consider the design of eco-efficient products and production processes, the use of economy-of-scale and the increments of efficiency in production and logistics processes (Chopra and Meindl, 2016), as well as green or environmental purchasing (Zsidisin and Siferd, 2001; Eltayeb, Zailani and Ramayah, 2011).

Value recovery activities occur typically in reverse flows, and these flows take form of open or closed loops (Vlajic, Mijailovic and Bogdanova, 2018). Moreover, Weetman (2017) further classify that open loops as those that sink in within the same sector (within sector loops) or to another sector (cross-sector loops), suggesting existence of both, vertical and horizontal flows. Typical practices in value recovery are related to reuse, remanufacturing, recycling, i.e. to recovery of products, components and material, respectively. As value recovery also considers the use of by-products and useful waste, as they can be sold to other customers in alternative chains, (Batista *et al.*, 2018) proposed that circular, open loop supply chains are part of the forward logistics flows.

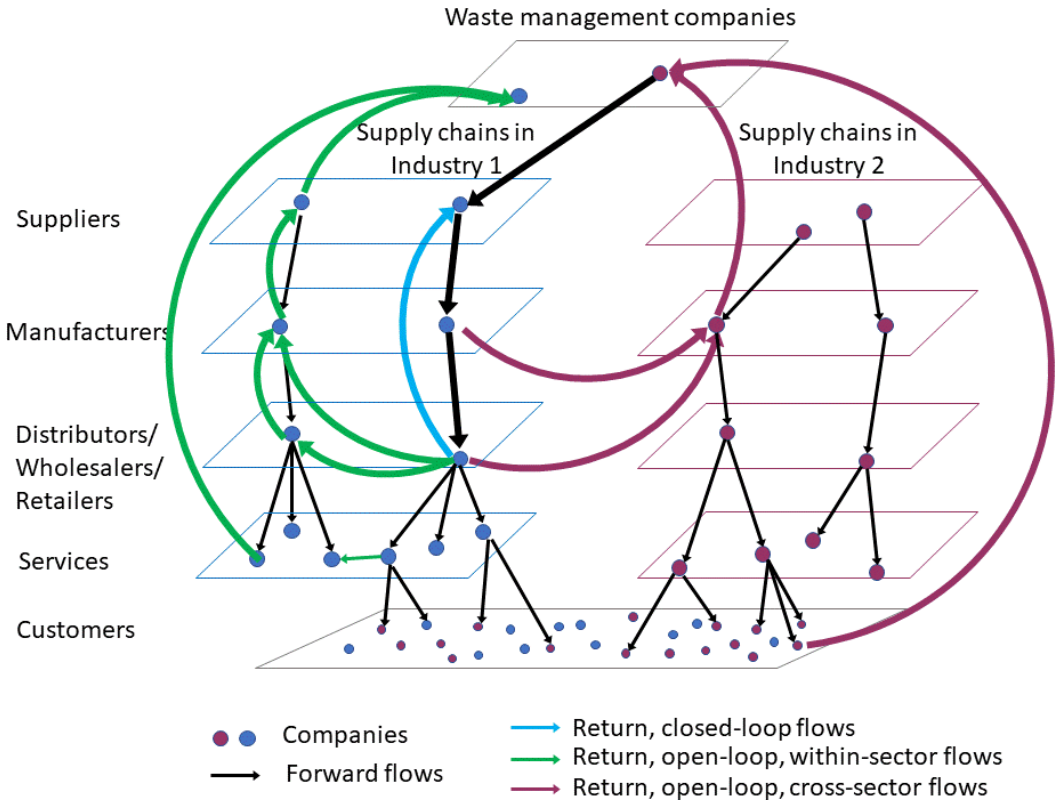


Figure 1: Flows in circular supply chains

These flows in circular supply chains are product of various types of collaborative relationships in circular supply chains. However, except a few studies focused on industrial eco-parks (Herczeg, Akkerman and Hauschild, 2018), in the available literature on circular economy and circular supply chains (Su *et al.*, 2013; Genovese *et al.*, 2017; Nasir *et al.*, 2017; Batista *et al.*, 2018; Govindan and Hasanagic, 2018), there are no studies that investigate what kinds of collaboration results in successful circular flows.

Thus, to form propositions on collaboration in circular supply chains, we explore more general literature on collaboration in supply chains.

Collaboration in supply chains

Collaboration is an amorphous meta concept that has multiple interpretations in supply chain theory and practice (Barratt, 2004). In this paper we focus on two angles: a structural view and a relationship view.

- ***Structural view***

In relation to the supply chain structure, collaboration is considered as internal (intra-organizational) or external (inter-organizational) (Kache and Seuring, 2014). This classification also can be further classified to vertical, horizontal or lateral collaboration (Simatupang and Sridharan, 2002).

Internal collaboration occurs between different functions of a company. The most often used practice of internal collaboration is the formation of cross-functional teams, often enabled by integrated information systems (Vickery *et al.*, 2003). Though internal collaboration benefits the creation of internal integration and performance improvement, there is a risk of organizational silo (Barratt, 2004). Barratt also states that internal integration needs to be linked with external collaboration, upstream and downstream of the supply chain to gain the most benefits, which is confirmed in the body of literature (Kache and Seuring, 2014).

External collaboration occurs between the company and its business partners. Depending on the position of the business partners in the supply chain, external collaboration is seen as vertical or horizontal. *Vertical collaboration* occurs along the supply chain, i.e. between a company and its suppliers and customers, while *horizontal collaboration* occurs between a company and its competitors or other organization in the same sector. Forms of vertical, external collaboration *downstream*, with customers (in downstream part of the chain) is Customer Relationship Management (CRM), Collaborative demand planning, Collaborative planning, forecasting and replenishment, Demand replenishment and shared distribution, while *upstream* examples of external collaboration are Supplier Relationship Management (supplier development, VMI, CRP), Supplier planning and production scheduling, collaborative design and new product introduction and collaborative transportation (Barratt, 2004). While there is a large body of research on vertical collaboration, horizontal collaboration received only limited attention, mostly in studies on distributor integration (Simchi-Levi, Kaminsky and Simchi-Levi, 2008), horizontal integration in transport (Cruijssen, Dullaert and Fleuren, 2007), and transhipment, i.e. collaboration in the cases of emergency deliveries between retailers (Evers, 1997; Herer, Tzur and Yücesan, 2002). Simatupang and Sridharan (2002) introduced also *lateral* collaboration, as mix of horizontal and vertical collaboration. This kind of collaboration is promising, as work to enhance both, vertical and horizontal collaboration can result in competitive and sustainable solutions (Reniers, Dullaert and Visser, 2010).

While vertical and internal collaboration received a lot of intention in the supply chain and logistics literature (Chen *et al.*, 2017), research on horizontal collaboration as well as research on lateral collaboration is still in its infancy (Soysal *et al.*, 2018).

- ***Relationship view***

External collaboration is often analysed in the supply chain management literature by considering relationships between companies in the same supply chain, i.e. their closeness. Closeness ranges from the arms-length transactions to close relationships between supply chain partners.

'*Arms-length*' relationship is the earliest type of collaboration, as well as the simplest one (Hoyt and Huq, 2000) and the most common (Simchi-Levi, Kaminsky and Simchi-Levi, 2008). This type of a relationship is characterised by repeated transactions over time with the same buyer or supplier (Whipple, Lynch and Nyaga, 2010) while there is little or no investment in assets and minimal information exchange (Hoyt and Huq, 2000). In the literature on outsourcing, one type of arms-length relationship is out-tasking, typically employed for non-strategic relationships. Out-tasking means that the responsibility for the performance of a designated task (for example, handling returned inventory or product disposal) is assigned to an outside business partner (Sanders *et al.*, 2007).

There are different opinions what kind of relationship is on the other end of the spectrum of collaborative relationships: joint venture (Lambert, Emmelhainz and Gardner, 1999), vertical integration (Barratt, 2004), strategic partnerships (Simchi-Levi, Kaminsky and Simchi-Levi, 2008), full/comprehensive outsourcing of complete function to the third-party provider (Sanders *et al.*, 2007), collaborative process management (Whipple and Russell, 2007) or collaborative relationships (Whipple, Lynch and Nyaga, 2010).

Between these end positions on collaboration, literature suggest various levels and types of partnerships (Lambert, Emmelhainz and Gardner, 1999; Cruijssen, Dullaert and Fleuren, 2007; Simchi-Levi, Kaminsky and Simchi-Levi, 2008), outsourcing (Sanders *et al.*, 2007), or information sharing (Attaran and Attaran, 2007).

Collaboration in circular supply chains: research issues

Collaboration in supply chains is seen as one of major accelerators of circular economy and circular supply chains (Weetman, 2017). In this context, industrial eco-parks and industrial ecology are seen as a good example of collaboration between companies to achieve sustainability goals (Reniers, Dullaert and Visser, 2010). This is especially a case when they are part of regional industrial area, as companies in proximity of each other can easier establish trust and coordination (Sterr and Ott, 2004). However, the majority of companies belongs to different supply chains and they are often *dispersed geographically*, or they are in the same region but not in the same industrial area.

Next, most of the research in the area of supply chain management and collaboration is done in the context of large companies (Bordonaba-Juste *et al.*, 2009). However, according to Rhodes (2015), 99% of companies in the UK belong to small and medium companies (SMEs). These companies have less resources, are unable to make investments into modern information systems and technologies (Bordonaba-Juste *et al.*, 2009). Moreover, specific collaborative relationships, such as outsourcing are not desirable, as outsourcing as collaborative strategy is especially risky for SMEs (Sanders et al., 2007).

As circular flows consist of forward flows extended by the closed or open, cascading loops (Batista *et al.*, 2018), there are implications for the creation of both vertical and horizontal collaborative relationships that would enable these flows. Thus, the first goal of this study is to investigate what kind of structural collaborative relationships exists in circular flows. Next, while (Weetman, 2017) states that major companies can use their scale and vertical integration to help drive circularity into the mainstream, there are no insights whether the vertical integration would be suitable for SMEs. The second goal of this study is to investigate closeness of relationships in circular flows, i.e. collaboration that enables resource reduction and value recovery.

Methodology

To answer the question: "What kind of relationships and collaboration practices enable creation of circular flows?", we conducted an exploratory case study. An exploratory case study is useful for defining propositions of a subsequent study (Seuring, 2008), and a single case can provide an opportunity to observe and analyse a phenomenon and is a starting point of multiple case studies (Yin, 1994). The case study enables us to conduct a close observation of operations and to map value adding and value recovery processes in the first stage. In the second stage, we make a connection between the value adding and value recovery processes in terms of relationships between the focal company and its business partners.

As a first case, we selected a processing company in food industry. The food industry is chosen due to estimated huge potential for circular economy gains - Ellen MacArthur Foundation estimates that consumption of primary material in EU can be reduced 32% by 2030 and 53% by 2050 in food industry (Ellen MacArthur Foundation, 2015). Processing companies might have operational capacity to conduct both, value-adding and value recovery processes, and they typically have multiple suppliers and buyers. Thus, they are good candidates for 1) exploration of both, internal and external collaboration types, and 2) exploration of both, vertical and horizontal collaboration, as use or sale of these by-products is subject of both, vertical and horizontal collaboration. Moreover, there is a variety of relationships and collaboration types when a company has multiple business partners.

Findings

The selected food processor belongs to medium size company, and the main processes in the company are split to three parts: 1) crops and vegetable production, 2) vegetable washing, packing and processing, and 3) waste recovery and energy production in Anaerobic Digester (AD). Types of products and corresponding flows, as well as business partners are presented in Table 1.

Preliminary analysis of the case shows that the company has both vertical and horizontal flows with multiple business partners in the food sector and in other sectors, as well as established paths for internal flows and that the company uses both, resource reduction and value recovery processes.
Based on Table 1 and Table 2, we can draw preliminary conclusions:

- *Flows and collaboration related to resource reduction*

Resource reduction takes place internally, as well in collaboration with key suppliers and key customers. However, collaboration practices for resource reduction differ: Internally, the processor vertically integrated its functional parts: crops and vegetable production, vegetable processing and recycling and energy recovery via AD. Integration of the functional parts results in increased efficient processes, as well as in energy production that is used for company requirements and export to the electrical network. Externally, though the food processor uses arms-length transactions, it cultivates relationship with the suppliers by developing trust, sharing knowledge and steering suppliers towards joint objectives. This is also a result of geographical and temporal circumstances: most of the producers are in the same region, their farms are typically family businesses passed down from one generation to another and there is a history of doing business together. Interestingly, via non- contractual, informal relationship, the processor receives waste from poultry farms for free, which is used as feed for AD. Considering upstream relationships with key customers, there is also closer arms- length relationship: large retailers have supplier development programmes which are used to help the food processor in improving the quality and preservation of the products, use of packaging as well as delivery service. Packed food products are sold via large retailers, and the loop closes via food recycling organized by the local waste management company or food redistribution of food recycling organized by the retailer itself. Another observation is related to the horizontal, cross-sector collaboration: the food processor has a weekly service from the AD manufacturer that helps optimization of the AD, and consequently the highest yield of electrical energy.

- *Flows and collaboration related to reuse processes*

The reuse process is observed both, internally and externally. Internally, the main by-product of washing root vegetables (waste water) is reused in the fields, while externally, food processor collaborates with local farmer to obtain surplus of barley, which is used as feed for AD. This is considered as reuse for another purpose, as barley can contribute to the value adding process. Downstream, small quantities of surplus products and first products in batches are regularly sent to the food bank. This is a voluntary act, non-contractual relationship and collaboration. All other unsold products are sold to alternative customers, such as retailers, wholesalers, canteens, food services. These are non-contractual relationships as well, as the quantities, the quality of products and the type of product available are uncertain. However, again geographical and temporal circumstances play a role in transactions: the food processor has a list of potential customers, who are contacted when needed.

- *Flows and collaboration related to recycling process*

Recycling processes are observed in both internal and external flows. All low quality and waste products that result from processing activities are transported to the AD, together with by-products and special material obtained for other growers and farmers. Thus, recycling is enabled by the vertical internal integration, as well as vertical non-contractual collaboration with suppliers.

Flows	Types of products Business partners	Key products (fresh vegetables and prepared vegetables)	Surplus, second rated products, higher quality returns	Crops	Waste, by-products (plants) and low quality products	By-products: Waste water
Inter.	Focal company	Resource reduction: process efficiency, max of yield, product preservation			▪ Recycling (on the field, AD) ▪ Energy recovery (AD facility) ▪ Resource reduction (Energy)	Use for another purpose (Fields watering)
Vertical	Key suppliers (growers and farmers)	Resource reduction: process efficiency, max of yield, product preservation		Use another purpose: (barley,AD)	▪ Recycling and energy recovery (AD facility) – feed: Waste (poultry farms)	
	Key customers (large retailers)	Resource reduction: max of yield, product preservation				
	Alternative customers (food services, retailers, wholesalers)		Reuse (discounted sale)			
Horiz.	Alternative customers (other food processors)		Reuse (discounted sale)			
	Organizations in other sectors (e.g. equipment manufacturers)				Energy recovery (AD facility: optimal digestibility)	
Other	Organizations in the sector (e.g. food banks, NGOs)		Reuse (donations)			

Table 1: Value-adding and value recovery activities and flows in circular supply chain of a fresh food processor

Forward flow: Value adding		*Reverse flows: Value recovery*	
Resource reduction	*Reuse for another purpose*	*Resource reduction*	*Reuse for another purpose*
Vertical collaboration - external: - upstream (**joint objectives**: crop rotation – with producers, waste reduction) - downstream ("**supplier development**" by the retailers: productivity, waste reduction) Vertical collaboration – internal **integration:** Production (crops), processing (vegetables, waste) and waste recovery + energy production (AD facility) Horizontal collaboration – external: - Other sector (**arms-length transactions**: Equipment producer + service) Horizontal collaboration – external: - Within the sector: non-contractual transactions	Vertical collaboration - internal: **integration** of - waste recovery/ energy production - crops production - waste management	Vertical collaboration - external: - downstream (**arms-length transactions**) - non-contractual transactions	Vertical collaboration - internal: **integration** of - production - waste management

Table 2: Collaboration types in circular supply chain of a fresh food processor

Conclusion

The focus of this study is the collaboration in circular supply chains. As the literature review shows, despite 1) the significant contributions on collaboration in supply chain management literature and 2) collaboration being one of the major pillars of circular economy, research on collaboration in circular supply chains is in its infancy. Though the first studies focus on industrial eco-parks and collaborative efforts, research on geographically dispersed locations of supply chain members requires attention. To fill in the gap in research on types of collaboration in circular supply chains, we explore circular flows and collaboration that enables these flows on the example of a food processor.

Our preliminary findings show that circular flows are 1) enabled by both, vertical and horizontal collaboration, within and cross-sector, 2) most of the collaborative efforts are invested in resource reduction and 3) value recovery is mostly done in vertical collaboration. These findings will be tested and deepened through the study of cases of other food companies that differ in size. Particularly, the influence of external factors (e.g. regulations, climate, culture, etc.) will be explored on the food companies in other geographical locations, such as Taiwan.

References

- De Angelis, R., Howard, M. and Miemczyk, J. (2017) 'Supply Chain Management and the Circular Economy: towards the Circular Supply Chain', *Production Planning & Control*. Taylor & Francis, 7287(January), pp. 1–13. Attaran, M. and Attaran, S. (2007) 'Collaborative supply chain management', *Business Process Management Journal*, 13(3), pp. 390–404.
- Barratt, M. (2004) 'Understanding the meaning of collaboration in the supply chain', *Supply Chain Management: An International Journal*, 9(1), pp. 30–42.
- Batista, L., Bourlakis, M., Smart, P. and Maull, R. (2018) 'In Search of a Circular Supply Chain Archetype – A Content-Analysis Based Literature Review', *Production Planning & Control*. Taylor & Francis, 29(6), pp. 438– 451.
- Bensaou, M. (1999) 'Portfolios of Buyer-Supplier Relationships. (cover story)', *Sloan Management Review*, 40(4), pp. 35–44.
- Bordonaba-Juste, V., Cambra-Fierro, J. J., Bordonaba-Juste, V. and Cambra-Fierro, J. J. (2009) 'Managing supply chain in the context of SMEs: a collaborative and customized partnership with the suppliers as the key for success', *Supply Chain Management: An International Journal*, 14(5), pp. 393–402.
- Carter, C. R. and Ellram, L. M. (1998) 'Reverse logistics: a review of the literature and framework for future investigation', *Journal of Business Logistics*, 19(1), pp. 85–102.
- Chen, L., Zhao, X., Tang, O., Price, L., Zhang, S. and Zhu, W. (2017) 'Supply chain collaboration for sustainability: A literature review and future research agenda', *International Journal of Production Economics*. Elsevier Ltd, 194(April 2016), pp. 73–87.
- Chopra, S. and Meindl, P. (2016) *Supply Chain Management: Strategy, Planning, and Operation*. VI. Essex: Pearson Education.
- Cruijssen, F., Dullaert, W. and Fleuren, H. (2007) 'Horizontal Cooperation in Transport and Logistics: A Literature Review', *Transportation Journal*, 46(3), pp. 22–39.
- Eltayeb, T. K., Zailani, S. and Ramayah, T. (2011) 'Green supply chain initiatives among certified companies in Malaysia and environmental sustainability: Investigating the outcomes', *Resources, Conservation and Recycling*. Elsevier B.V., 55(5), pp. 495–506..
- Evers, P. T. (1997) 'Hidden benefits of emergency transshipments', *Journal of Business Logistics*, 18(2). Genovese, A., Acquaye, A. A., Figueroa, A. and Koh, L. S. . (2017) 'Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications', *Omega*. Elsevier, 66, pp. 344–357. Govindan, K. and Hasanagic, M. (2018) 'A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective', *International Journal of Production Research*. Taylor & Francis, 7543, pp. 1–34.
- Grekova, K., Calantone, R. J., Bremmers, H. J., Trienekens, J. H. and Omta, S. W. F. (2016) 'How

environmental collaboration with suppliers and customers influences firm performance: Evidence from Dutch food and beverage processors', *Journal of Cleaner Production*, 112, pp. 1861–1871.

- Herczeg, G., Akkerman, R. and Hauschild, M. Z. (2018) 'Supply chain collaboration in industrial symbiosis networks', *Journal of Cleaner Production*, 171, pp. 1058–1067.
- Herer, Y. T., Tzur, M. and Yücesan, E. (2002) 'Transshipments: An emerging inventory recourse to achieve supply chain leagility', *International Journal of Production Economics*, 80(3), pp. 201–212.

- Hoyt, J. and Huq, F. (2000) 'From arms-length to collaborative relationships in the supply chain: An
- evolutionary process', *International Journal of Physical Distribution & Logistics Management*, 30(9), pp. 750– 764.
- Jayaraman, V., Ross, A. and Agarwal, A. (2008) 'Role of information technology and collaboration in reverse logistics supply chains', *International Journal of Logistics Research and Applications*, 11, pp. 409–425..
- Kache, F. and Seuring, S. (2014) 'Linking collaboration and integration to risk and performance in supply chains via a review of literature reviews', *Supply Chain Management*, 19, pp. 664–682.
- Lambert, D. M., Emmelhainz, M. A and Gardner, J. T. (1999) 'Building succesful logistics partnerships', *Journal of Business Logistics*, 20(1), pp. 165–181.
- Lieder, M. and Rashid, A. (2016) 'Towards circular economy implementation: A comprehensive review in context of manufacturing industry', *Journal of Cleaner Production*. Elsevier Ltd, 115, pp. 36–51..
- Nasir, M. H. A., Genovese, A., Acquaye, A. A., Koh, S. C. L. and Yamoah, F. (2017) 'Comparing linear and circular supply chains: A case study from the construction industry', *International Journal of Production Economics*.
- Elsevier, 183, pp. 443–457.
- Ralston, P. M., Richey, R. G. and Grawe, S. J. (2017) 'The past and future of supply chain collaboration: a literature synthesis and call for research', *The International Journal of Logistics Management*, 28(2), pp. 508– 530.
- Reniers, G., Dullaert, W. and Visser, L. (2010) 'Empirically based development of a framework for advancing and stimulating collaboration in the chemical industry (ASC): Creating sustainable chemical industrial parks', *Journal of Cleaner Production*. Elsevier Ltd, 18(16–17), pp. 1587–1597.
- Rhodes, C. (2015) *Breafind Paper. Business Statistics*.
- Sanders, N. R., Locke, A., Moore, C. B. and Autry, C. W. (2007) 'A multidimensional framework for understanding outsourcing arrangements', *Journal of Supply Chain Management*, 43(4), pp. 3–15..
- Seuring, S. A. (2008) 'Assessing the rigor of case study research in supply chain management', *Supply Chain Management: An International Journal*, 13(2), pp. 128–137..
- Simatupang, T. M. and Sridharan, R. (2002) 'The Collaborative Supply Chain', *Journal of Logistics Management*, 13(1), pp. 15–30.
- Simchi-Levi, D., Kaminsky, P. and Simchi-Levi, E. (2008) *Designing and Managing the Supply Chain. Concepts, Strategies and Case Studies*. III. New York: McGraw-Hill.
- Soosay, C. A. and Hyland, P. (2015) 'A decade of supply chain collaboration and directions for future research',
- *Supply Chain Management: An International Journal*, 20(6), pp. 613–630.
- Soysal, M., Bloemhof-Ruwaard, J. M., Haijema, R. and van der Vorst, J. G. A. J. (2018) 'Modeling a green
- inventory routing problem for perishable products with horizontal collaboration', *Computers and Operations Research*. Elsevier B.V., 89, pp. 168–182.
- Sterr, T. and Ott, T. (2004) 'The industrial region as a promising unit for eco-industrial development -
- Reflections, practical experience and establishment of innovative instruments to support industrial ecology',
- *Journal of Cleaner Production*, 12(8–10), pp. 947–965.
- Su, B., Heshmati, A., Geng, Y. and Yu, X. (2013) 'A review of the circular economy in China: Moving from rhetoric to implementation', *Journal of Cleaner Production*. Elsevier Ltd, 42, pp. 215–227.
- Vickery, S. K., Jayaram, J., Droge, C. and Calantone, R. (2003) 'The effects of an integrative supply chain
- strategy on customer service and financial performance: An analysis of direct versus indirect relationships',
- *Journal of Operations Management*, 21(5), pp. 523–539.
- Vlajic, J. V., Mijailovic, R. and Bogdanova, M. (2018) 'Creating loops with value recovery:

empirical study of fresh food supply chains', *Production Planning & Control*. Taylor & Francis, forthcomin(May), pp. 1–17.

- Webster, K. (2015) *The Circular Economy. A welth of flows*. Ellen MacArthur Foundation.
- Weetman, C. (2017) *A Circular Economy Handbook for Business and Supply Chains. Repair, Remake, Redesign, Rethink*. Kogan Page.
- Whipple, J. M., Lynch, D. F. and Nyaga, G. N. (2010) 'A buyer's perspective on collaborative versus transactional relationships', *Industrial Marketing Management*. Elsevier Inc., 39(3), pp. 507–518.
- Whipple, J. M. and Russell, D. (2007) 'Building supply chain collaboration: a typology of collaborative approaches', *The International Journal of Logistics Management*, 18(2), pp. 174–196.
- Yin, R. K. (1994) *Case study research. Design and Methods*. Second. London: SAGE publications.
- Zsidisin, G. A. and Siferd, S. P. (2001) 'Environmental purchasing: A framework for theory development',
- *European Journal of Purchasing and Supply Management*, 7(1), pp. 61–73.

ANALYZING SUPPLY CHAIN RESILIENCE USING TEMPORAL FAULT TREE ANALYSIS

Ernest E. Edifor[1], David Lascelles[1] and Graham Dixon[2]
[1]Manchester Metropolitan University, Manchester, UK
[2]Esprit Warehousing Ltd, UK

Introduction

Supply chain disruptions are inevitable because the world of business is dynamic and susceptible to environmental, political, economic, technological changes etc. As supply chains evolve to adapt to the changing world of business, they get complex and hence more efforts needed to analyse it to reduce the risks of disruptions. The question then is how can new or existing businesses reduce the risks associated with their supply chains? Over the past few decades, various solutions have been proposed to tackle this question. A promising solution suggests the use of a quantitative probabilistic safety assessment technique called Fault Tree Analysis (FTA).

FTA is backward-deductive technique used heavily in the engineering field to analyse the reliability of systems by determining how various component failures of the system can propagate to cause a total system failure. However, traditional FTA is unable to capture the dynamic behaviour (or sequential dependencies) inherent in real-world systems. This limitation can lead to inaccuracies in the results produced by FTA when used on some real-world scenarios.

In this paper, a recent improvement to FTA called Temporal Fault Tree (TFT) is used to analyse a supply chain with the aim of improving its resilience. First, there is a brief description and application of the logical gates in TFT. Using analytical approaches, these gates are used to model and analyse (logically and probabilistically) the risk drivers of a hypothetical supply chain network. Finally, a discussion of the results is made to provide some insight into how the supply chain can be improved to make it more resilient. The main contribution of this paper is the development of TFT-based techniques to analyse real-world supply chain risk drivers more accurately to improve supply chain resilience.

Literature review

The business environment is continuously increasing in complexity, specifically with factors of risk becoming heavily interrelated (Manuj and Mentzer, 2008). Subsequently, appropriate resilience to risk is becoming more challenging as the task of detecting the catalyst of failure is more time consuming and problematic (Craighead et al., 2007; Simchi-Levi et al.,2015). Not only do internal risk factors have a potentially significant harmful effect on any company, the resulting systemic knock-on effects impact the wider supply chain, causing the interrelated links between the elements of the business environment to change in a way that may be even harder to understand (World Economic Forum, 2018). This in turn has significant implications for investment priorities, resource allocation and placement within the context of a risk mitigation strategy (Chopra and Sodhi, 2004; Tang, 2006). This has led to an increased focus on supply chain resilience and the development of conceptual frameworks to facilitate a better understanding of its antecedents and dynamics (Pettit et al., 2010; Ponis and Koronis, 2012).

One fundamental theme emerging from the literature on supply chain resilience is the need for optimisation of the resilience of a supply chain strategy or configuration (Machado et al., 2009). Many models are available to optimise supply chain design in the context of risk. Several are heuristics based (e.g. Baumgartner and Thonemann, 2010; Pan and Nagi, 2010). Such linear approaches fail to capture the dynamic nature and complex network of relationships in a supply chain. A promising alternative is the utilisation of Fault Tree analysis to simulate the cause and consequences of a disruption in a supply chain (Ziegenbein and Baumgart, 2006).

FTA (Vesely et al., 2002), developed over 6 decades ago, is a Probabilistic Safety Assessment (PSA) technique. It is a top-down approach of determining how the basic component failures of a system can propagate to cause an entire system failure. Traditionally, FTA uses the Boolean gates AND and OR to model relationships between two or more events. The AND gate is fired when all the events have occurred and the OR gate is fired when at least one of the events have occurred. A fault tree diagram is a graphical representation of the events (faults) of a system and the relationship between them. Once a fault tree of a system is constructed, two main types of analysis – logical and probabilistic – can be performed. Logical (or qualitative) analysis involves the determination of the necessary and sufficient combinations of events that can cause the top-event (i.e. undesired system state). Probabilistic (or quantitative) analysis involves the calculation of the failure probabilities of the events (including the top-event). A detailed description of FTA is presented in (Vesely et al., 2002).

Classical FTA is unable to capture dynamic real-world events that have sequential dependencies which leads to inaccuracies in the logical and probabilistic analysis (Dugan, Bavuso and Boyd, 1992; Gulati and Dugan, 1997). Many attempts have been made to address this problem. A notable improvement of FTA is Dynamic Fault Tree (DFT) analysis (Dugan et al., 1992) that, proposes novel gates to capture sequential dependencies. However, DFTs are crafted mainly for probabilistic analysis. A more recent improvement which is herein refer to as Temporal Fault Tree (TFT) analysis (Walker, 2009) improves FTA by providing new dynamic logical gates that enable comprehensive logical (Walker, 2009) and probabilistic analysis (Edifor, 2014). The usefulness of this dual analytical capability for supply chain risk assessment is discussed in this paper.

Problem description

Ziegenbein and Baumgart (2006) provide a promising quantitative technique using FTA to assess the probability of occurrence of a supply chain disruption. In their discussion, they classify supply chain risk drivers according to the Supply Chain Operation Reference (SCOR) categories of plan, source, make, deliver and environment, which are then analysed using the traditional FTA method (Figure 1).

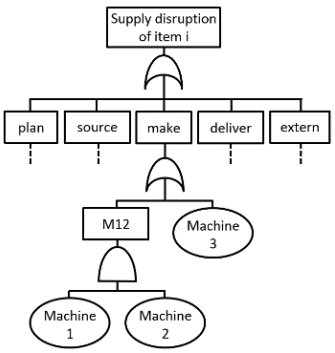


Figure 1: Fault tree adapted from Ziegenbein and Baumgart (2006)

From the diagram, it is evident that the Make category fails when both Machine 1 and Machine 2 fail or when Machine 3 alone fails. In the case where both Machine 1 and Machine 2 would need to fail in order to trigger the failure of the Make category this assessment is logically accurate. However, if Machine 1 is a primary device and Machine 2 is a controller that detects the failure of Machine 1 and activates a standby device, then the assessment that both Machines 1 and 2 would need to fail in order to trigger the failure of the Make category is inaccurate. This is because the controller activate the standby machine immediately the primary machine fails so the Make category does not fail when the controller fails subsequently. However, if the controller fails before the primary machine fails, the make category fails because when the primary machine fails, the controller has failed and is unable to activate the standby machine. This sort of machine configuration is not uncommon in real-world systems. The aim of this paper is thus to analyse such real-world events more accurately. In this paper,

the assumption is made that all events are non-repairable; i.e. once an event has occurred, it remains in the failed state.

Assessment of supply chain risk

In addition to the traditional Boolean gates AND and OR, TFT uses three dynamic gates in its analysis. These are Priority-AND (PAND), Priority-OR (POR), Simultaneous-AND (SAND) and sometimes, parameterised-SAND (pSAND) as seen in Figure 2.

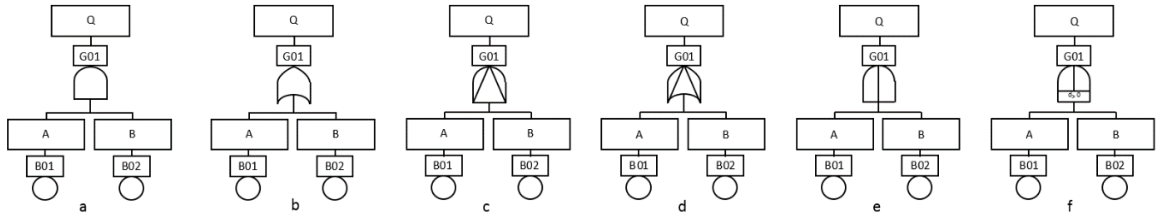


Figure 2: Logical gates (AND, OR, PAND, POR, SAND, pSAND)

Figure 2a represents an AND gate; the output event *Q* is triggered when all input events *A, B* occur. For example, if a business has two production plants, *P1* and *P2*, from which all their products are made, the failure of *P1* AND *P2* will lead to the business failing to fulfil its targeted production level. Figure 2b is the OR gate; the output event *Q* is triggered when at least one of the input events *A, B* have occurred. For example, if a business uses a haulier, *H*, to deliver goods to its retailers, *R* via two motorways, *M1 and M2,* then the business will fail to deliver goods to *R* when *H* fails OR (*M1* AND *M2* fail). Failure of *H* could be due to industrial action, liquidation etc., failure of *M1* and *M2* could be due to motorway disruption etc.

The PAND gate is used to represent scenarios where an input event occurs strictly before another input event to trigger an output event. As shown in Figure 2c, the output event *Q* occurs when event *A* occurs strictly before the subsequent event *B*. For example, assume a business has two main suppliers *S1*, *S2,* which supply 85% and 15% of a commodity respectively. If there is a shortfall in supplies from *S1*, an administrative officer *AO* puts in a request to *S2* to provide additional volume to make up the shortfall. In this case, a possible cause of failure in deliveries would be *AO* failing before *S1* – i.e. *AO* PAND *S1*. When *S1* fails and *OA* has failed prior to this event, the system fails because *S2* would not be triggered to deliver additional supplies.

The POR gate, represented in Figure 2d, is triggered when an event *A* occurs strictly before a subsequent event *B* but the subsequent event *B* need not occur for the gate to be triggered. Unlike the PAND gate where the output event is not triggered until all input events have occurred, in the POR gate, the output event is triggered when the first (leftmost) input event occurs. From the previous example for the PAND gate, if the maximum shortfall *S2* can supply if *S1* fails is 80%, then, for a shortage in supply to occur, *S1* must fail before *S2* or if only *S1* fails. In this case, the failure triggering expression can be expressed as *S1* POR *S2*.

The SAND gate, in Figure 2e, models the situation where two or more events occur at exactly the same time; *A* and *B* need to occur at exactly the same time to trigger *Q*. In the real world, it is difficult to find a practical example of the SAND gate because it is statistically nearly impossible for two or more events to occur at the exact same time (Merle et al., 2010). This has led to the creation of another gate called parameterised-SAND (pSAND) (Edifor et al., 2013). The pSAND gate represents the scenario where an event is triggered when two or more events occur within a specific period. pSAND is represented in Figure 2f; *Q* happens when *A* and *B* occur within a specific time frame. The time frame is represented by a "*d*" in the diagram; e.g. *d>0.1* means the duration between the events is 0.1 (days, hours, minutes,

seconds etc.) Suppose a fruit juice business uses two products apple and mango to produce three juices – apple, mango and apple and mango juice. Both products are distinctly sourced from two suppliers *S1* and *S2* respectively. Assume both products are required to produce the apple and mango juice, the failure of *S1* and *S2* to supply within 2 days will lead to no production. After 2 days, arrangements are made for supply from other companies. With this scenario, there will be no production of apple and mango juice when both *S1* and *S2* fail within 2 days – i.e. *S1* pSAND *S2*.

A logical expression can be derived from the fault tree by using the following symbols '.', '+', '<', '|', '&' and '$\&_d$' for AND, OR, PAND, POR, SAND and pSAND respectively. Meaning, *A* AND *B* can be represented as *A*.*B*, *A* POR *B* as *A*|*B* and *A* pSAND *B* as *A* $\&_d$ *B,* where "d" is the duration between *A* and *B*. Before constructing a fault tree, a top-event (i.e. system failure) must be identified. This could be supply disruption of an item, failure in order fulfilment etc. Once the top event has been identified, the direct sub-system failures that triggers the top-event must be identified. The sub-system failures can be decomposed by identifying their failures, propagate downwards until all the ending nodes in the fault tree are basic failures (known as basic events). Events that are not basic events or top-events are usually the intermediate events. The basic rules for constructing a fault tree are provided in (Vesely et al., 2002).

Each set of logical combinations of events that can cause the top-event is called a cut sequence. Through the use of the Boolean laws and the Temporal Truth Table (Walker, 2009), the logical expression can be reduced to its smallest, simplest form resulting in a combination of what is termed minimal cut sequences (MCSQ). The MCSQ is a combination of the basic events that are necessary and sufficient to trigger the occurrence of the top-event. In order to be necessary, each basic event in the MCSQ is needed to trigger the top-event. To be sufficient, each MCSQ, without the inclusion of other events, should trigger the top-event. The result of the logical analysis highlights the single points of failure of the system, which is extremely useful in resource allocation within a risk mitigation strategy. Logical analysis also enables development of more robust supply chain configurations.

The probabilistic analysis involves the evaluation of the probability of the top-event occurring and the contribution of various events to occurrence of the top-event. Various failure data (corresponding to the failure distribution) will therefore need to be assigned to each individual event. Some analytical and simulation techniques (Edifor, 2014) have been developed for these evaluations; the former is restricted to exponential distribution while the latter is not limited to any failure distribution. The sensitivity analysis and risks for each basic or intermediate event can be calculated as part of the probabilistic analysis. These calculations provide analysts with information regarding critical aspects of the system that may require more resource allocation, attention or backups.

Case Study

An analysis of a hypothetical case study is considered to practically demonstrate the technique proposed in this paper. Kelso is a chemical plant that produces various chemicals for hospitals, universities and related sectors. It has two main chemical suppliers (Supplier-A and Supplier-B) and a haulier (Haulier-A) that transports the supplies from the suppliers to the company's only plant. Kelso's contract is such that, 75% of its chemicals are supplied by Supplier-A and 25% by Supplier-B. When both suppliers are unable to deliver their contracted volumes, Kelso's administrator, who is based in the plant, requests the shortfall from Supplier-C with a lead-time of 2 days via a second Haulier (Haulier-B). Haulier-C delivers Kelso's packaging from a Supplier-D. The supply contracts and supply configuration is such that if Administration fails its duties (e.g. due to employee sickness, industrial action, etc) before Supply-A fails to supply goods there would be no supply of goods from Supply-C. In addition, there would be failure in the supply of goods if Supply-A and Supply-B fail within 2 days. Finally, a failure of Supply-A and Supply-B before Supply-C or just the failure of Supply-A and Supply-B would lead to a failure in supplies.

A fault tree depicting the above scenario is presented in Figure 3 (note that the top-event is failure in order fulfilment). MotSX is motorway disruption to Supplier-X; VehSX is a vehicle failure (of a haulier) to Supplier-X; SupX is Supplier-X; Adm is the administrator.

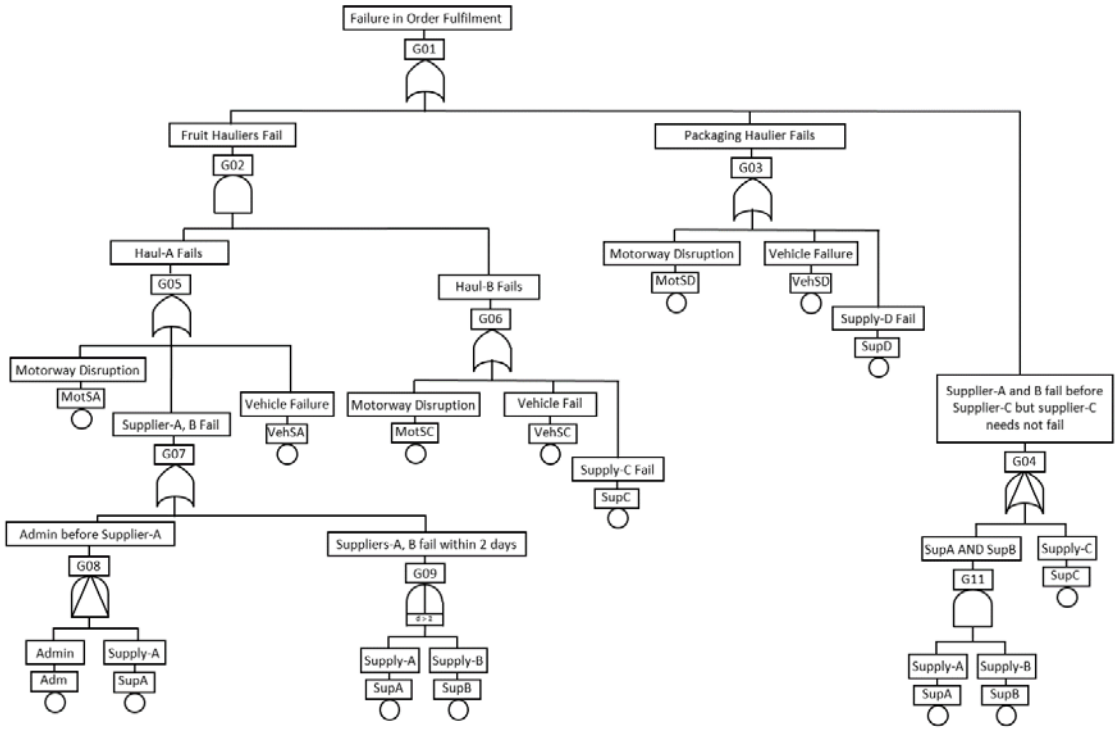


Figure 3: Fault tree of Kelso

For the above fault tree, the top-event (failure in order fulfilment), can be expressed as

$$\text{Top} = \big(\text{MotSA} + \text{VehSA} + (\text{Adm} < \text{SupA} + \text{SupA\&SupB})\big).(\text{MotSC} + \text{VehSC} + \text{SupC}) + (\text{MotSD} + \text{VehSD} + \text{SupD}) + \big((\text{SupA}.\text{SupB})\big|\text{SupC}\big)$$

Using the Euripides algorithm (Walker, 2009), the minimal cut sequences (MCSQs) from the above expression are:

$$\begin{aligned}\text{Top} = {} & \text{SupD} + \text{VehSD} + \text{MotSD} + (\text{SupA}.\text{SupB}) + (\text{MotSA}.\text{SupC}) + (\text{MotSA}.\text{MotSC}) \\ & + (\text{MotSA}.\text{VehSC}) + (\text{SupC}.\text{VehSA}) + (\text{MotSC}.\text{VehSA}) + (\text{VehSA}.\text{VehSC}) \\ & + \big((\text{Adm} < \text{SupA}).\text{SupC}\big) + \big((\text{Adm} < \text{SupA}).\text{MotSC}\big) + \big((\text{Adm} < \text{SupA}).\text{VehSC}\big)\end{aligned}$$

The MCSQs above are the combinations basic events that distinctively lead to the top-event occurring; it can be considered as the most effective configuration of Kelso's supply network. Immediately, it is clear that the single points of failure are Supplier-D (SupD), Haulier-C's vehicle to Supplier-D (VehSD) and the motorway VehSD uses (MotSD). However, the expression does not provide any indication of which events are critical and contribute most to the occurrence of the top event, that is, failure in order fulfilment. To determine the contribution of each event to the occurrence of the top event, each event need to be assigned failure rates. Again, for the sake of demonstration, the failure data (restricted to exponential distribution) in Table 1 are assumed.

Event	*Failure rate per hour*
VehSA, VehSB, VehSC, VehSD	2.354E-8
MotSA, MotSB, MotSC, MotSD	3.251E-4
SupA, SupD	4.114E-8
SupB, SupC	2.332E-7
Adm	2.324E-5

Table 1: Failure data of events

Based on the availability of these failure data, the dynamics of the top event can be evaluated using formulae provided in (Edifor, 2014). Figure 4 is a graph showing the probabilities that Kelso will fail to fulfil its order from within the first hour to 10000 hours (approximately 417 days); these probabilities are 3.252E-04 and 9.971E-01 respectively. From the graph, it is clear that the likelihood of failing to fulfil orders within 417 days is almost certain whiles there is less likelihood of failure within the first hour.

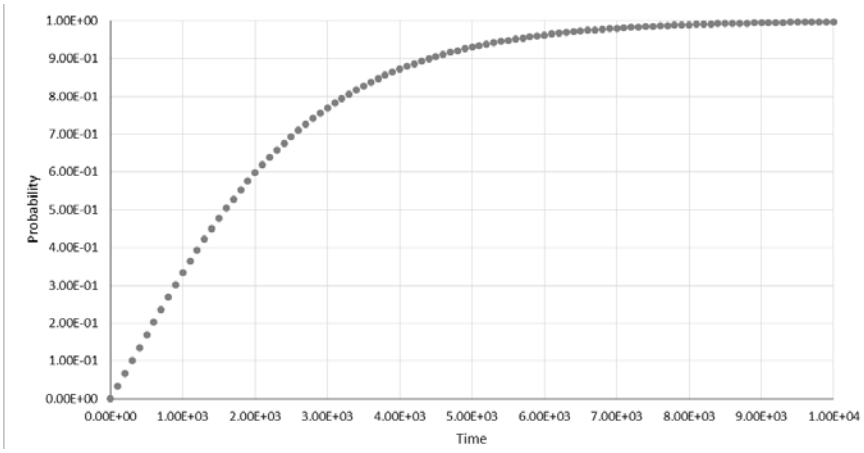


Figure 4: Failure in order fulfilment from 1 hour to 10000 hours

At each point of the graph, the MCSQs and events contributing to the top-event occurrence can be evaluated. Table 2 is a summary of the top ten MCSQs (left) and events (right) contributing to the top event occurrence at 10000 hours; FV importance is the Fussell-Vesely Importance (Henley and Kumamoto, 1981) that shows the contribution of each event to the occurrence of the top-event.

Order	*MCSQs*	*Probability of failure*
1	MotSD	0.9612
2	MotSA.MotSC	0.9240
3	MotSA.SupC	0.0022
4	SupD	0.0004
5	VehSD	0.0002
6	MotSA.VehSC	0.0002
7	MotSC . VehSA	0.00022
8	SupA.SupB	9.581E-07
9	SupC . VehSA	5.482E-07
10	VehSA . VehSC	5.540E-08

Order	*Event*	*FV Importance*
1	MotSD	0.9641
2	MotSA	0.9269
3	MotSC	0.9268
4	SupC	0.0022
5	SupD	0.0004
6	VehSD	0.0002
7	VehSA	0.0002
8	VehSC	0.0002
9	SupB	9.608E-07
10	SupA	9.608E-07

Table 2: Top ten contributing MCSQs (left) and events (right)

Discussion

Motorway disruption to Supply-D is the most critical point of the supply chain; it features as a single point of failure (Table 2 – left) and as the biggest contributor to the top event (Table 2 – right). From the top ten list, Supply-A is the least contributor to the top event. This suggests that more resources should be channelled into making the supply of packaging more reliable because it is more likely to lead to failure in order fulfilment. An interesting point to deduce from the result is that, though VehSD is a single point of failure, its failure does not contribute much to the top-event as the failure of MotSA which is not a single point of failure. This could be because according to the failure data in Table 1, the former is relatively less likely to occur. The techniques that underpin TFT analysis make visible the interrelationships that exist between events and the probability of their occurrence. Such information is usually obscured in the complexity of many large real-world supply chain operations.

There are several benefits of using a dynamic technique, such as TFT, to model and analyse supply chain risk. As is obvious from Kelso's example (though hypothetical), it can be used to (1) improve the supply chain network configuration (2) identify single points of failure in the supply chain network (3) pin-point critical aspects of the supply chain (4) identify combinations of supply chain network events that contribute most to the failure of the supply chain. Given some data on the severity of these events, the risks associated with each event can also be evaluated. FTA is flexible; whenever changes are applied to the supply chain network, the corresponding fault tree can be adjusted accordingly and re-evaluated to show how the changes impact the entire system.

Conclusion

Supply chains are critical to business success therefore their resilience should be a priority for any business. However, analysing the resilience of a supply chain can be a daunting task. FTA, a technique popular in engineering has been used in analysing the supply chains, however, these analysis fail to capture some dynamic real-world scenarios.

In this paper, TFT analysis (a modification of traditional FTA), has been used to model and analyse a small supply chain network as a proof of concept. The potential benefits of this technique have been demonstrated and it is evident that TFTs can contribute to the improvement of supply chain network resilience.

References

- Baumgartener, K., Andre F., & Thonemann, U. W. (2010), 'Supply Chain Design Considering Economies of Scale and Transport Frequencies'. *EJOR*, Vol 218 (3), pp.789-800.
- Chopra, S. and Sodhi, M. S. (2004), 'Managing Risk to Avoid Supply-Chain Breakdown', *MIT Sloan Management Review*, 46 (1), pp. 53-62.
- Craighead, C. W., Blackhurst, J., Rungtusanatham, M. J. and Handfield, R.B. (2007), 'The Severity of Supply Chain Disruptions: Design Characteristics and Mitigation Capabilities', *Decision Sciences*, 38 (1), pp. 131-156.
- Dugan, J. B., Bavuso, S. J., & Boyd, M. A. (1992), 'Dynamic Fault-Tree Models for Fault-Tolerant Computer Systems', *IEEE Transactions on Reliability*, 41(3), pp.363-377.
- Edifor, E. E. (2014), 'Quantitative Analysis of Dynamic Safety-Critical Systems Using Temporal Fault Trees', *PhD Thesis*, University of Hull.
- Edifor, E., Walker, M., & Gordon, N. (2013), 'Quantification of Simultaneous-AND Gates in Temporal Fault Trees', *Advances in Intelligent Systems and Computing*, Vol 224.
- Gulati, R., & Dugan, J. (1997), 'A Modular Approach for Analyzing Static and Dynamic Fault Trees', *In Reliability and Maintainability Symposium*, pp. 57-63.
- Henley, E. J., & Kumamoto, H. (1981), 'Reliability Engineering and Risk Assessment', Prince-Hall, Inc, New Jersey.

- Machado, V. H., Azevedo, S. G., Barroso, A. P., Tenera, A. and Machado, C. M. (2009), 'Strategies to Mitigate Supply Chain Disturbances', *In Proceedings of POMS2009*, 20th annual conference of production and operations management society: Orlando.
- Manuj I, & Mentzer,J.T (2008), 'Global Supply Chain Risk Management Strategies', *International Journal of Physical Distribution & Logistics Management*, Vol. 38 (3), pp.192-223.
- Merle, G., Roussel, J., Lesage, J., & Bobbio, A. (2010), 'Probabilistic Algebraic Analysis of Fault Frees with Priority Dynamic Gates and Repeated Events', *IEEE Transaction on Reliability*, 59 (1), pp.250-261.
- Pan, F. & Nagi, R. (2010), 'Robust Supply Chain Design Under Uncertain Demand in Agile Manufacturing', *Computers and Operations Research*, Vol 37 (4) pp. 668-683
- Pettit, T., Fiksel, J. & Croxton, K. (2010), 'Ensuring Supply Chain Resilience: Development of a Conceptual Framework', *Journal of Business Logistics*, Vol 31 (1) pp. 1-21
- Ponis S.T. & Koronis E. (2012), 'Supply Chain Resilience: Definition of Concept and its Formative Elements', *Journal of Applied Business Research*, Vol 28(5), pp 9-21
- Simchi-Levi, D., Schmidt, W., Wei, Y., Zhang, P. Y., Combs, K., Ge, Y., Gusikhin, O., Sanders, M. and Zhang, D. (2015), 'Identifying Risks and Mitigating Disruptions in the Automotive Supply Chain', *Institute for Operations Research and the Management Sciences* Vol 45 (5) pp.375-390.
- Tang, C. (2006), 'Robust Strategies for Mitigating Supply Chain Disruptions', *International Journal of Logistics*, Vol 9 (1) pp. 33-45
- Vesely W., Stamatelatos M., Dugan J., Fragola J., Minarick J., & Railsback J. (2002), 'Fault Tree Handbook with Aerospace Applications', Washington DC: NASA Office of Safety and Mission Assurance.
- Walker, M. (2009), 'Pandora: A Logic for the Qualitative Analysis of Temporal Fault Trees', *PhD Thesis*, University of Hull
- World Economic Forum (2018), 'The Global Risks Report 2018', accessed on 7th May 2018, from https://www.weforum.org/reports/the-global-risks-report-2018
- Yin, R. (2009), 'Case Studies: Design and Methods', 4th ed, Thousand Oaks: Sage Publications
- Ziegenbein, A., & Baumgart, J. (2006), 'Supply Chain Risk Assessment-A Quantitative Approach', accessed on May 12, 2016, from http://www.fucam.ac.be/redirect.php3?id=46721

OPTIMISING THE TOTAL LOGISTICS COST OF COMMODITY PROCUREMENT IN GLOBAL SUPPLY CHAIN MANAGEMENT

Ahmed Aljizani[1], Alessandro Creazza[1], Steve Trotter[1] and David Menachof[2]
[1]University of Hull, Business School, UK
[2]Florida Atlantic University, College of Business, USA

Introduction

Managing global supply chains in today's continuously changing business environment is a challenging task. Recent business conditions are characterised by volatility and uncertainty in demand and prices. Such an environment puts more pressure on practitioners and complicates the process of decision making. The market uncertainty makes it difficult to achieve organisational objectives of meeting customer needs at a lower cost. The fluctuation of freight rates has a huge impact on organisational financial performance and the ability to stay in the market.

Dry bulk shipping is the most significant type of seaborne trade in terms of volume of cargoes traded (Yin, Luo et al. 2017). Clarkson's database stated that the volume of dry bulk in 2013 exceeds 5.5 billion tons (excludes container cargos), representing 53% of global seaborne trade volume (Clarkson PLC 2015). However, the dry bulk shipping market is relatively characterised with volatility. Figure shows the evolution of the US Gulf - Japan 50,000t Grain (HSS) Grain Supramax Voyage Rates from January 2007 to December 2017. The troughs and peaks in the figure demonstrate the violent fluctuation of the freight rates with the lowest value 20 and highest 131 US Dollar. One major factor affecting the behaviour of the dry bulk market is the fluctuation of the world economy (Yin, Luo et al. 2017). In addition, the inherent nature of shipping industry, such as shipbuilding cycles and speculative investments in ships also influences the fluctuation of the freight rate (Dai, Hu et al. 2015). Therefore, dry bulk shipping has continuously been considered as one of the most volatile industries (Alizadeh, Huang et al. 2015, Adland, Cariou et al. 2016).



Figure 1: The evolution of freight rates

Companies usually deal with such volatility in prices by financial hedging (Roncoroni and Brik 2017). In other words, they purchase insurance against changes in prices to minimise the effect of these fluctuations on their profits. However, these hedging strategies usually do not consider the day-to- day procurement which has to take into account the current prices as well as the future trends (Berling

and Martínez-de-Albéniz 2011). Thus, it is critical to have a robust procurement process that combines elements of classical inventory theory and financial price modelling. Traditional inventory theory considers finding optimal inventory levels that reflect the balance between ordering cost and holding cost, while financial price modelling deals with price process behaviour and how to predict its future values. Volatility of freight rates necessitates that the price behaviour is taken into account. This requires modelling the freight rates process, and, based on understanding whether a rate increases or decreases, the procurement decision should be made in conjunction with the inventory cost consideration.

In this paper, we study how freight rates volatility influences the optimal logistics cost in global supply chains. The logistics cost includes the purchasing cost of commodities and inventory holding cost of these commodities. Traditionally, the transportation cost is ignored or considered to be constant as a part of purchasing cost. However, we will address the inventory problem considering transportation cost as a separate cost and taking in account the freight rates volatility. We determine the optimal cost using an extended EOQ model, relaxing the assumption of transportation cost certainty. The freight rate is modelled as a stochastic process, which leads to a time-varying procurement policy as a function of the current price and amount of inventory on hand. The model is applied in a global supply chain in which the buyer needs to purchase commodities in international markets. In this supply chain, in order to minimise the total cost it is essential to minimise the purchasing cost through selecting the right quantity and the right time to buy with respect to commodity price and freight rates behaviour.

In summary, our study aims to offer insights that extend existing models and methods regularly used in the field of inventory management. The paper contributes to the current body of knowledge on inventory management in three respects. First, real data is used to empirically estimate freight rate model parameters and test the EOQ model with respect to its original form and assumptions. Second, using the EOQ model as a starting point, we relax the assumption of constant transportation cost and allow the coefficient of freight rate uncertainty to be dynamic and stochastic. In doing so, the model presents several managerial implications that may help companies to better understand the influence of freight rates volatility and consequently adopt more successful inventory strategies. Third, our paper delivers techniques and tools that may be useful for future research in dealing with freight rates volatility in the field of supply chain management. The remainder of the paper is organized as follows: section two shows the relevant literature; section three is about understanding the classical EOQ model; section four develops the dynamic EOQ model; in section five, a numerical example is illustrated; and section six discusses the results and finding. The paper concludes with section seven, which offers suggestions for future research.

Background literature

Different researchers have addressed the issue of incorporating the transportation cost into EOQ. (Swenseth and Godfrey 2002) presented a model in which two freight rate functions have been incorporated into a total logistics cost function to determine their impact on purchasing decisions. Results indicated that there would be a significant improvement in cost if the appropriate freight rates were applied. (Gurtu, Jaber et al. 2015) analysed the impact of changes in fuel prices and the imposition of a carbon tax on emissions on the transport of shipment lot sizes and supply chain costs. The EOQ models have been modified to include increasing transport costs and a carbon tax to demonstrate its impact on various inventory policies. They concluded that the order cost and lot size are affected by changes in the fuel price, emissions tax, fuel consumption, and distances travelled. (Zhao, Wang et al. 2004) presented a modified EOQ model considering the transportation costs to minimise the total cost for a supplier-retailer logistic system, and results indicated that the modified model is more efficient. (Madadi, Kurz et al. 2010) addressed specific inventory management decisions with transportation cost consideration in a multi-level environment consisting of supplier-warehouse-retailers and numerical study shows that the proposed model is robust and generates reasonable cost savings.

(Zhao, Seibert et al. 2010) studied the integration of inventory and transportation decisions in a logistics system, and calculations showed that the proposed strategy could significantly reduce the overall system costs. (Baboli, Neghab et al. 2006) studied an optimal ordering policy in a two-level supply chain, considering transportation costs in inventory replenishment decisions and found that the model leads to savings in comparison to the traditional model in which the transportation costs are not considered. (Birbil, Bülbül et al. 2012) analysed the impact of the transportation costs along with discounts in EOQ-type models and concluded that the problems can be efficiently solved.

Traditionally, in many published works of inventory theory, the differential calculus approach is used to optimise a cost or profit function. However, other approaches are also used to obtain optimal inventory values. Andriolo et al. (2014) conduct a literature review to explore and discuss the evolution of the EOQ model during the past hundred years. With the objective of better incorporating aspects of real industrial problems and constraints, several researchers add new incremental conditions attempting to reflect real case problems as well as to change the emphasis on different model conditions and constraints. Cárdenas-Barrón (2001) presents two alternatives – specifically, tabular and graphical – to the differentiation approach. The tabular and graphical approaches are covered in many production, inventory and operations management textbooks (Gascon 1995, Zipkin 2000, Snyder 2007, Muckstadt and Sapra 2010). On the other hand, marginal cost analysis is used widely in the econometrics environment. The use of marginal cost analysis in inventory theory can be found in the works of Hadley and Whitin (1963), and more recently in the works of (Maddah and Jaber 2008, Teunter and Dekker 2008, García-Laguna, San-José et al. 2010).

Despite the many articles that address the inventory management under uncertainty conditions, no one, to the best of our knowledge, has studied the EOQ model with stochastic transportation cost in global supply chains. Considering freight rates volatility, this paper develops a model in which the transportation cost is variable as maritime freight rates fluctuate in the global shipping market.

The model

The total logistics cost consists of three major components: holding cost, ordering cost, and shipping cost. The ordering cost is considered fixed regardless of the size of the shipment. The holding cost is the average of inventory in each cycle, $Q/2$, multiplied by the inventory cost h. Shipping cost is volatile and depends on the fluctuation of prices in the shipping market. Freight rate follows an Ornstein-Uhlenbeck process (Benth, Koekebakker et al. 2014).

The Ornstein-Uhlenbeck process is modelled as follows:

$$d\vartheta = \beta(\mu - \vartheta_t)d_t + \sigma dw_t \qquad (1)$$

Where θ is the logarithm of commodity price, $nt, i.e. ln(nt) = \theta$; $\beta$is the mean reversion coefficient; μ is the long-term mean price; σ is the volatility of the process; and w_t is the standard Wiener process. If the logarithm price, ϑ_t, is greater than μ, the price shows a downward trend and an upward trend if the logarithm price, ϑ_t, is less than μ. The mean reversion coefficient, β, has a huge influence on the movement direction of the price, upward or downward.

Given the logarithm of commodity price at time $t = 0$, θ_0, the logarithm of commodity price at time t , θt, is normally distributed with mean

$$\mathrm{E}\{\theta \mathrm{t}|\theta 0\} = e^{-\beta t}\theta 0 + \mu(1 - e^{-\beta t}), \qquad (2)$$

and variance

$$Var\,(\theta \mathrm{t}|\theta 0) = \left(1 - e^{-2\beta t}\right)\frac{\sigma^2}{2\beta} \qquad (3)$$

Thus, the commodity price, πt, is log-normally distributed with mean

$$\mathrm{E}(\pi t|\theta 0) = exp\left\{e^{-\beta t}\theta 0 + \mu\left(1 - e^{-\beta t}\right) + \left(1 - e^{-2\beta t}\right)\frac{\sigma^2}{4\beta}\right\} \qquad (4)$$

Because we are dealing with the long-term average cost in this model, as the time t → ∞, the term $e^{-\beta t}$ and $e^{-2\beta t}$ approach zero. As a result,

$$\mathrm{E}(\pi\infty|\theta 0) = exp\left(\mu + \frac{\sigma^2}{4\beta}\right) \qquad (5)$$

After defining the process of the freight rate (F), the shipping cost per shipment under freight rate uncertainty is derived. Q is the order quantity (shipment size) which is sent from supplier to buyer. The shipping cost is also a function of the order quantity Q. Given that the average price of the freight rate per shipment is $exp\left(\mu + \frac{\sigma^2}{4\beta}\right)$, the shipping cost is given by:

$$F = (Q)e^{\left(\mu + \frac{\sigma^2}{4\beta}\right)} \qquad (6)$$

Having defined the cost components, the total logistics cost can be expressed as follows:

Total Logistics Cost = Shipping Cost + Holding Cost + Ordering Cost

$$\mathrm{TC} = (Q)e^{\left(\mu + \frac{\sigma^2}{4\beta}\right)} + \frac{Qh}{2} + \frac{D}{Q}\mathrm{K} \qquad (7)$$

The objective is to determine the optimal order quantity, Q*, the optimal number of shipments and the optimal inventory cycle. We differentiate the equation (7) with respect to Q and set it equal to zero. As a result, we get:

$$\frac{dTC}{dQ} = e^{\left(\mu + \frac{\sigma^2}{4\beta}\right)} + \frac{h}{2} - \frac{DK}{Q^{-2}} = 0 \qquad (8)$$

By rearranging and solving for Q, we get:

$$Q* = \sqrt{\frac{DK}{e^{\left(\mu + \frac{\sigma^2}{4\beta}\right)} + h/2}} \qquad (9)$$

<u>Numerical Experiment</u>

In this section, we provide a numerical study with two main objectives. First, we analyse the effect of price volatility on the decision variables. Second, we compare the performance of the dynamic inventory model against classic inventory models that do not consider the price fluctuations.

The following numbers are based on interviews with procurement managers in different companies who deal with commodities in global supply chains in order to depict a realistic application example. The supply chain variables we consider are the following:

Demand Rate, D= 100,000 metric tonnes/year
Setup Cost, K= $50/order
Average Commodity Price, c = $195/metric tonne
Holding Cost, h = $16/metric tonne/year

To run the model we also need to estimate the values of the mean reverting process parameters:

The long-term mean price μ
The mean reversion coefficient β
The volatility of the process σ

To estimate these values we use the time series of US Gulf - Japan 50,000t Grain (HSS) Grain Supramax Voyage Rates from December 2016 to December 2017.

The price process parameters values β, the mean reversion coefficient; μ the long-term mean price; σ, the volatility of the process are estimated by using the regression functions. Values of μ, β and σ are shown in table 1.

Month	Price $	Price Change $	Previous Price $
2016-Dec	37.90		
2017-Jan	35.88	-2.03	37.90
2017-Feb	34.44	-1.44	35.88
2017-Mar	37.40	2.96	34.44
2017-Apr	37.75	0.35	37.40
2017-May	36.88	-0.88	37.75
2017-Jun	35.70	-1.18	36.88
2017-Jul	36.25	0.55	35.70
2017-Aug	37.88	1.63	36.25
2017-Sep	41.15	3.28	37.88
2017-Oct	42.25	1.10	41.15
2017-Nov	44.25	2.00	42.25
2017-Dec	46.30	2.05	44.25
Slope	0.13919	**β**	-0.14
Intercept	-4.6091	**μ**	33.11
STE	1.805292	**σ**	0.05

Table 1: Estimation of Freight Rates Process Parameters

We focus on the effect of the volatility on the inventory policy. We need to keep in mind that by changing σ not only the volatility changes, but also the mean of the full price process. We run the analysis with different values of σ to understand the impact of the volatility in the optimal order quantity and total annual cost. The economic order quantity and total annual cost paths for different values of σ are shown in figure 2.

From figure 2 it can be observed that high volatility decreases the optimal quantity and increases the annual total logistics cost. The decrease in the optimal quantity could be explained by the risk associated with the increase in price volatility. Of course, with more frequent fluctuations in prices there is a good opportunity to purchase at lower prices than the current one. Managers in periods of high volatility try to make the purchasing decision at the minimum possible price but at the same time they try to avoid an out-of-stock situation. If possible, they will go for the backordering option when prices are high and fulfil the orders when the prices go down. In periods of high volatility, holding and backordering cost is higher than purchasing cost. This suggests that optimal policy is driven more by price speculation rather than customer service level.

We also observe that as volatility goes down, the change in optimal costs decreases. Hence, the manager thinks of building inventory or safety stocks when prices are low. This approach suggests that the optimal inventory level varies with freight rates. Even if safety stock level is applied it will change with the purchasing price unless it is determined by different service conditions. A changing safety stock level results in the expected order cycle length being not exactly Q/D. It is presumed that safety stock is high during the period in which commodity price is low as a result of the low holding cost. To get the benefit of lower prices, procurement managers tend to make large orders when the price is low enough. However, it is important to note that overestimation of financial gains of ordering huge quantities which is calculated over a short period of time might cause a significant increase in inventory cost. On the other hand, if prices increase the manager will try to delay the order, waiting for prices to come to a more encouraging level to make the purchasing decision. In general, the change in optimal quantity and total cost is minimal in the case of low volatility.

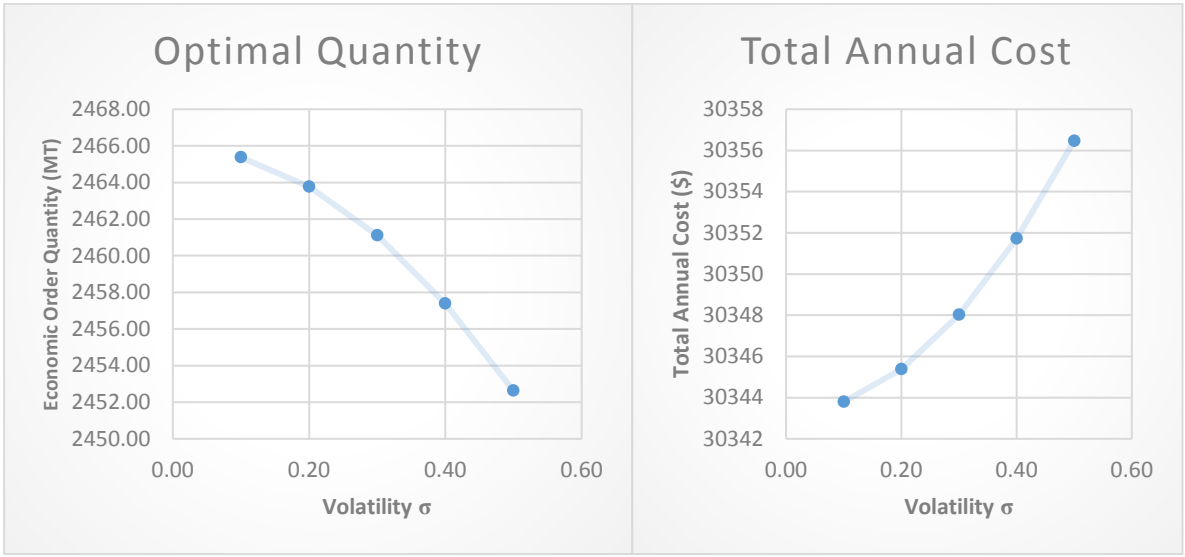


Figure 2: Optimal quantity and total annual cost

This might be because the managers consider the price is relatively stable so they tend to minimize the holding cost by keeping a low inventory level. This is true because as the volatility is low, the change in price will not have a huge impact on the total price. This is because optimal quantity is also relatively unaffected, so if the price change is low, it is not beneficial to make very frequent changes to the ordered optimal quantity. In contrast, when the volatility is high managers need to adjust the optimal quantities in response to the changes in freight rates. In this case, managers will focus more on reducing the impact of price volatility than minimizing the inventory cost. This explains the large differences in optimal quantities when there is a big change in freight rates. With higher volatility, the probability of having low prices in the near future increases. This fact affects the manager's behaviour in periods of high volatility and eventually impacts the total logistics cost. There is an opportunity to make significant cost savings or increased profit margins, but this comes with the risk of excess inventory or stock out losses. Therefore, decisions are required to be made to take advantage of the low prices.

Conclusion

In this paper, we considered the procurement and inventory management of commodities in global supply chains under freight rates volatility. To deal with price volatility, we developed a model for inventory management under stochastic transportation cost. We presented a novel approach to obtaining the optimal policy applying a dynamic inventory model. Instead of the traditional method of optimal base-stock level, we focused on the optimal total logistics cost based on whether the supply chain manager should or should not make an order decision. In doing this, we extend the traditional

EOQ model by incorporating freight rates as a stochastic process to take into account the volatility of the price. Furthermore, we provided a new procedure to calculate the optimal logistics cost that included solving several differential equations. We established a time-varying procurement policy that is a function of the up-to-date freight rates and current inventory cost. To supplement our theoretical results, we conducted a study on how the price process parameters influence the inventory policy. We further developed recursive expressions to model the price process and compute the total logistics cost. Our analytical results were illustrated by a simulating based on running the model using actual corn market price data. An insightful observation from this study is that with lower volatility, the decision is derived by the expected change in the price, but with high volatility the importance of price speculation increases more and more until it becomes the force directing the procurement decision.
As with all research, our study suffers from some limitations that need to be considered when interpreting our results. First, we continue to assume the demand to be constant. We followed this because the annual demand of commodities is almost stable (Canuto 2014). The continuous fluctuation of prices makes it more important to give higher attention to prices than demand which is not much less volatile oin commodities markets (Abbott 2014, Canuto 2014).

However, despite these limitations our research lays the foundation for future research in commodity procurement and inventory management. The assumption of constant demand could be relaxed to take into account the dependency of demand on price changes. Such extensions, however, would increase the complexity of the model and therefore it would be necessary to understand and model the demand process first as well as estimating the time between consecutive orders. The model considers the issue from a buyer's perspective in commodity supply chains. Further research could investigate how the model can be applied by different supply chain partners, such as commodity farmers, commodity shippers and vessel owners, commodity processors, and customers, and evaluate the implications of its applications for these additional supply chain partners.

References

- *Abbott, P. (2014). Biofuels, binding constraints, and agricultural commodity price volatility. The economics of food price volatility, University of Chicago Press: 91-131.*
- *Adland, R., et al. (2016). "The influence of charterers and owners on bulk shipping freight rates." Transportation Research Part E: Logistics and Transportation Review **86**: 69-82.*
- *Alizadeh, A. H., et al. (2015). "A regime switching approach for hedging tanker shipping freight rates." Energy Economics **49**: 44-59.*
- *Baboli, A., et al. (2006). Economic order quantity in a centralized two-level supply chain with transportation cost. Service Systems and Service Management, 2006 International Conference on, IEEE.*
- *Benth, F. E., et al. (2014). "Stochastic dynamical modelling of spot freight rates." IMA Journal of Management Mathematics **26**(3): 273-297.*
- *Berling, P. and V. Martínez-de-Albéniz (2011). "Optimal inventory policies when purchase price and demand are stochastic." Operations Research **59**(1): 109-124.*
- *Birbil, Ş. İ., et al. (2012). "A general framework for economic order quantity models with discounts and transportation costs." European Journal of Operational Research.*
- *Dai, L., et al. (2015). "The dynamics between newbuilding ship price volatility and freight volatility in dry bulk shipping market." International Journal of Shipping and Transport Logistics **7**(4): 393-406.*
- *García-Laguna, J., et al. (2010). "The integrality of the lot size in the basic EOQ and EPQ models: applications to other production-inventory models." Applied Mathematics and Computation **216**(5): 1660-1672.*
- *Gascon, A. (1995). "On the finite horizon EOQ model with cost changes." Operations Research **43**(4): 716-717.*

- *Gurtu, A., et al. (2015). "Impact of fuel price and emissions on inventory policies." Applied Mathematical Modelling **39**(3): 1202-1216.*
- *Madadi, A., et al. (2010). "Multi-level inventory management decisions with transportation cost consideration." Transportation Research Part E: Logistics and Transportation Review **46**(5): 719-734.*
- *Maddah, B. and M. Y. Jaber (2008). "Economic order quantity for items with imperfect quality: revisited." International Journal of Production Economics **112**(2): 808-815.*
- *Muckstadt, J. A. and A. Sapra (2010). EOQ Model. Principles of Inventory Management, Springer**:** 17-45.*
- *Roncoroni, A. and R. I. Brik (2017). "Hedging size risk: Theory and application to the US gas market." Energy Economics **64**: 415-437.*
- *Snyder, A. (2007). The Principles of Inventory Management, Createspace.*
- *Swenseth, S. R. and M. R. Godfrey (2002). "Incorporating transportation costs into inventory replenishment decisions." International Journal of Production Economics **77**(2): 113-130.*
- *Teunter, R. and R. Dekker (2008). "An easy derivation of the order level optimality condition for inventory systems with backordering." International Journal of Production Economics **114**(1): 201-204.*
- *Yin, J., et al. (2017). "Dynamics and interactions between spot and forward freights in the dry bulk shipping market." Maritime Policy & Management **44**(2): 271-288.*
- *Zhao, H., et al. (2010). "The relationship of personality to entrepreneurial intentions and performance: A meta-analytic review." Journal of management **36**(2): 381-404.*
- *Zhao, Q.-H., et al. (2004). "Model and algorithm of an inventory problem with the consideration of transportation cost." Computers & Industrial Engineering **46**(2): 389-397.*
- *Zipkin, P. H. (2000). Foundations of inventory management.*

UTILIZATION OF RAILWAY FOR BULK PETROLEUM PRODUCT TRANSFERS IN SRI LANKA

Janak Dharmaprema and Varuna Gunasekara
Ceylon Petroleum Storage Terminals Limited, Colombo, Sri Lanka

Introduction

A Sri Lankan railway was introduced by the British during the colonial times to facilitate their business objectives. The main focus was on the plantation industry and transportation of related goods. Sri Lankan petroleum industry was operated by 03 multi-national companies (Namely Caltex, Mobil and Shell) until the nationalization in 1961. They had identified the cost effectiveness of rail transport and had located the petroleum infrastructure beside the railway lines and Colombo port. Oil facilities were installed at the Chinabay, Trincomalee as per the strategically needs of the British during the World War II, which included tanker unloading and rail transport. Later facilities were developed to cater the fuel requirement of the Katunayake international airport via rail.

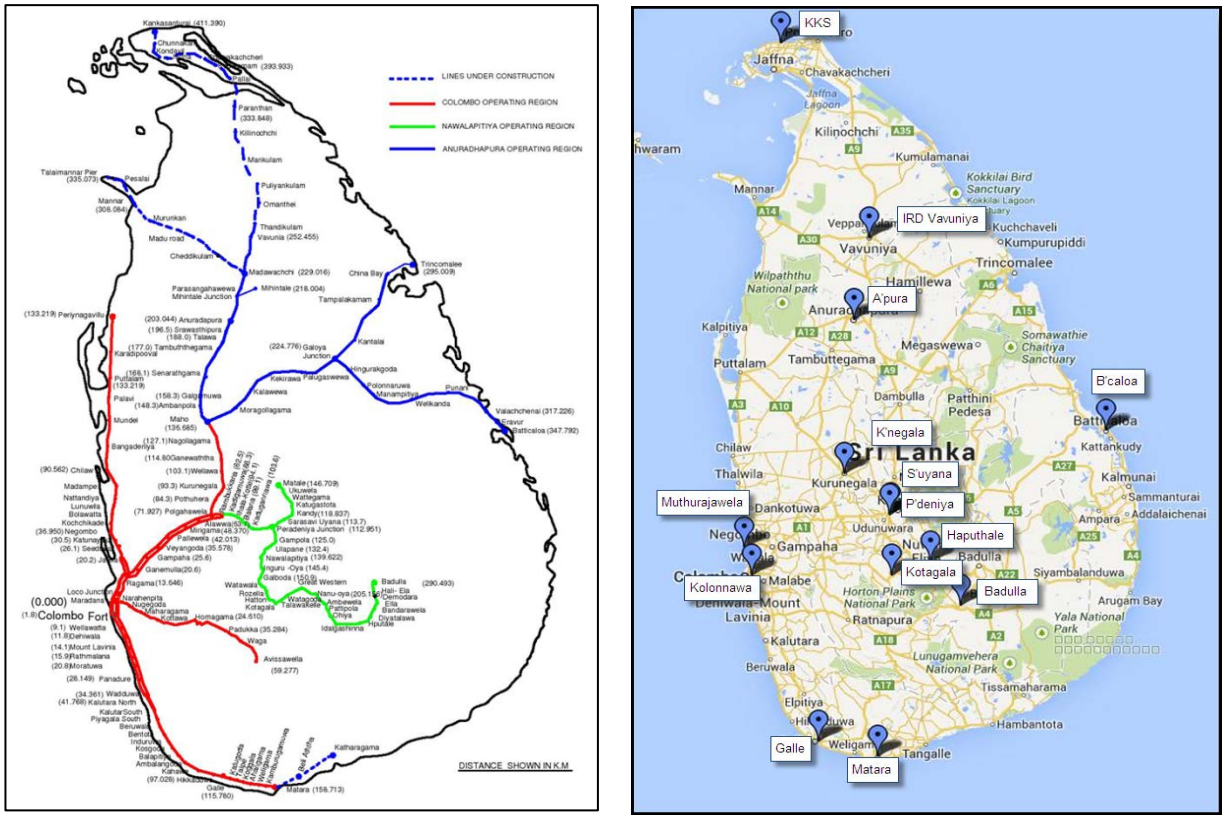


Fig. 1: Sri Lanka Railways Map and the Island-wide CPSTL Bulk Depots

Overview of Operations

CPSTL Kolonnawa installation is connected to the Sri Lanka railways network. Currently 10 out of the 12 CPSTL bulk depots and the Katunayake international airport are reachable via rail. The logistics operation is achieved by 05 trains which are operated on a daily basis. The SLR operations are carried out via the SLR sub station located inside the CPSTL Kolonnawa terminal premises. The up- country terrain constitute of relatively lower capacity wagons, due the train engine capability and the steepness of the journey.

Train	*Wagon Capacity (Litres)*	*Railway Engine No.*	*Railway Unit Allocation*	*Destinations*	*Weekly Availability*
Up-Country	26,370 22,275 22,460	160	42 Units	▪ Peradeniya ▪ Kotagala ▪ Haputhale ▪ Badulla	06 days
North-Central	45,400 50,000	497	60 Units	▪ Anuradhapura ▪ Vavuniya	06 days
Batticaloa	45,400 50,000	493	40 Units	▪ Batticaloa	03 days
Galle	45,400 50,000	776	40 Units	▪ Galle ▪ Matara	06 days
Katunayake	45,400 50,000	492, 413, 421, 429	40 Units	▪ Katunayake Aviation	07 days

Table 1: Rail facilities used for bulk petroleum product delivery

There are dedicated wagons for delivering Jet-A1 and furnace oil. As per the case of petrol, diesel and kerosene, the same wagon is utilized randomly.

Product	*Capacity (ltrs)*	*Quantity*
Jet-A1	45,400	31
Petrol/Diesel/Kerosene	26,370	135
	45,400	81
	50,000	16
Furnace Oil	26,370	3
	45,400	3
Total		263

Table 2: Railways wagon availability

Cost concerns

SLR wagon transport tariff is based on the tonnage of the wagons. Therefore, unlike the road transportation which is fixed for all the products, it varies from product to product.

CPSTL is the higher revenue generator for SLR. This is the most cost efficient mode of transportation for CPSTL while comparing the cost against road transportation. Therefore, the CPSTL strategy is to maximize the utilization of rail transport, for its bulk product transfers.

Plant	*Distance (Km)*	*Cost per Litre (Rs.)*			
		LS	*LAD*	*LK*	*Avg.*
A'pura	207	0.6755	0.7877	0.7285	0.7306
Badulla	294	1.0725	1.2506	1.1567	1.1599
Batticaloa	351	1.1454	1.3356	1.2353	1.2388
Galle	127	0.4144	0.4833	0.4470	0.4482
Haputhale	250	0.9050	1.0553	0.0000	0.6534
KKS	-	-	-	-	-
Kotagala	182	0.6461	0.7534	0.6968	0.6988
Kurunegala	97	0.3165	0.3691	0.3414	0.3423
Matara	170	0.5547	0.6469	-	0.4005
Peradeniya	116	0.3948	0.4604	0.4258	0.4270
Sarasavi Uyana	-	-	-	-	-
IRD V'niya	256	-	0.9741	0.9010	0.6250
Total		0.6125	0.8116	0.5932	0.6725

Table 3: Distance and cost details for bulk product delivery

Factors affecting petroleum product delivery via rail.

There are various factors affecting the rail transportation of the bulk petroleum products.

1) Trade union actions of SLR employees.
2) Low priority given for petroleum product transfer against passenger transportation.
3) Less availability of railway wagons during festive seasons. (Ex: April, December)
4) Difficulty of locating the whereabouts of the railway wagons.
5) Difficulty of placing wagons to bulk depots after arriving at the railway station.
6) Difficulty of collecting and returning empty railway wagons.
7) Maintenance issues with where some become unusable due to valve/tank related issues.

CPSTL is directly communicating with the SLR authorities regarding the optimization and maximum utilization of railway wagon related operations.

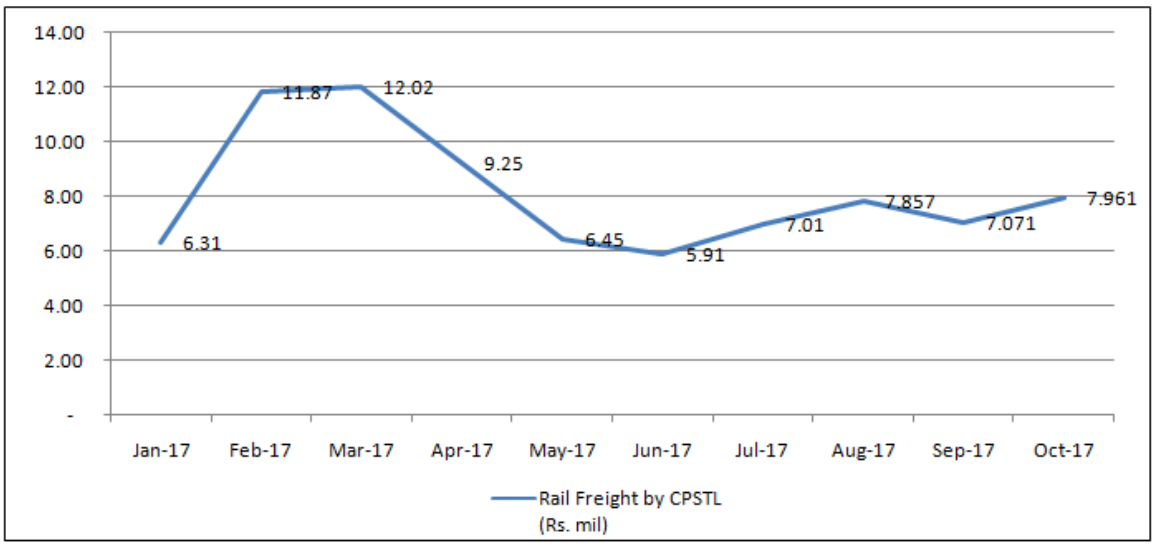
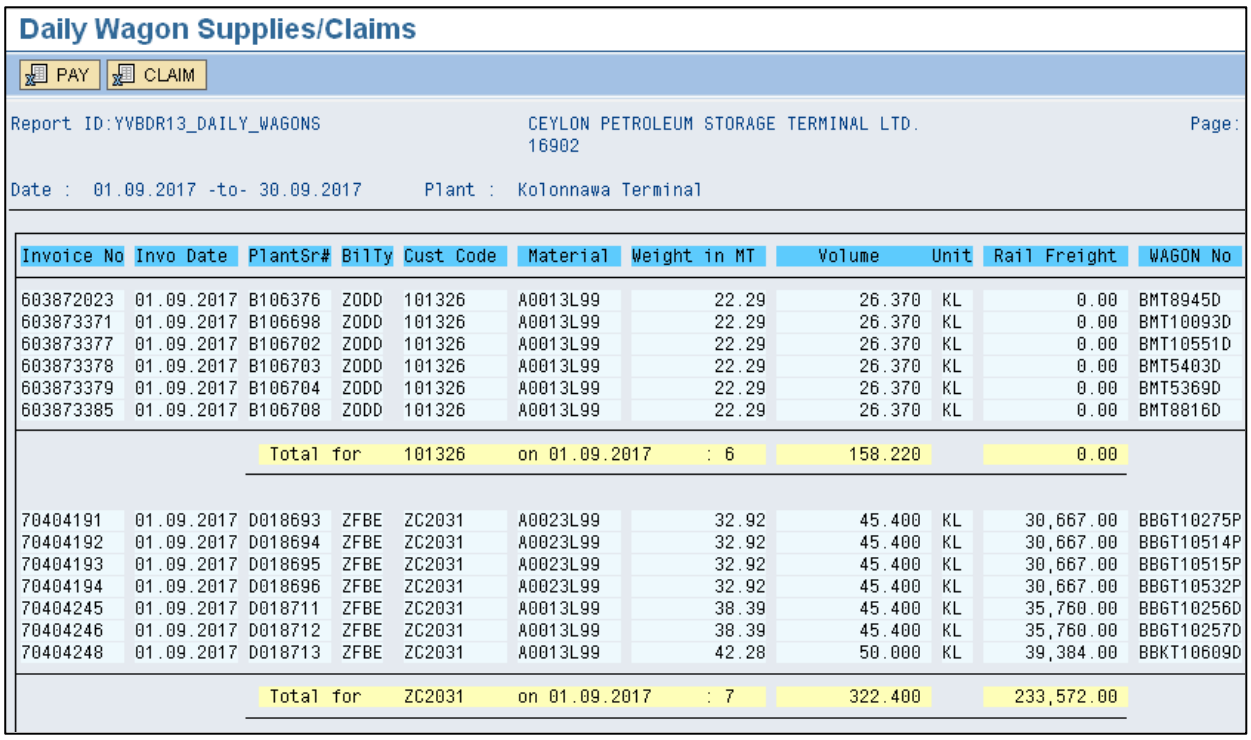


Fig. 2: 2017 Railway freight tariff for CPSTL

Optimization of railway wagon operations

CPSTL utilizes the SAP ERP system to facilitate their sales and bulk product transfer process. The system provides solutions to schedule the railway wagons and monitors the bulk transfer operation.



Daily Wagon Supplies/Claims

PAY CLAIM

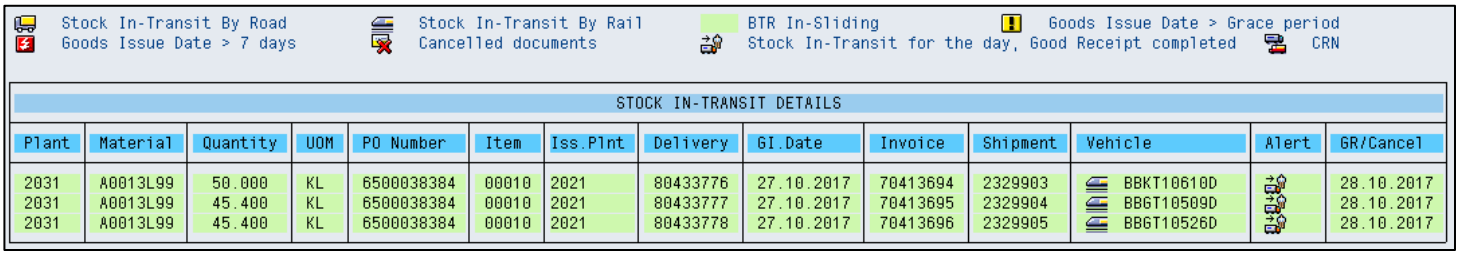
Report ID:YVBDR13_DAILY_WAGONS CEYLON PETROLEUM STORAGE TERMINAL LTD. Page:
16902

Date : 01.09.2017 -to- 30.09.2017 Plant : Kolonnawa Terminal

Invoice No	Invo Date	PlantSr#	BilTy	Cust Code	Material	Weight in MT	Volume	Unit	Rail Freight	WAGON No
603872023	01.09.2017	B106376	ZODD	101326	A0013L99	22.29	26.370	KL	0.00	BMT8945D
603873371	01.09.2017	B106698	ZODD	101326	A0013L99	22.29	26.370	KL	0.00	BMT10093D
603873377	01.09.2017	B106702	ZODD	101326	A0013L99	22.29	26.370	KL	0.00	BMT10551D
603873378	01.09.2017	B106703	ZODD	101326	A0013L99	22.29	26.370	KL	0.00	BMT5403D
603873379	01.09.2017	B106704	ZODD	101326	A0013L99	22.29	26.370	KL	0.00	BMT5369D
603873385	01.09.2017	B106708	ZODD	101326	A0013L99	22.29	26.370	KL	0.00	BMT8816D
		Total for		101326	on 01.09.2017	: 6	158.220		0.00	
70404191	01.09.2017	D018693	ZFBE	ZC2031	A0023L99	32.92	45.400	KL	30,667.00	BBGT10275P
70404192	01.09.2017	D018694	ZFBE	ZC2031	A0023L99	32.92	45.400	KL	30,667.00	BBGT10514P
70404193	01.09.2017	D018695	ZFBE	ZC2031	A0023L99	32.92	45.400	KL	30,667.00	BBGT10515P
70404194	01.09.2017	D018696	ZFBE	ZC2031	A0023L99	32.92	45.400	KL	30,667.00	BBGT10532P
70404245	01.09.2017	D018711	ZFBE	ZC2031	A0013L99	38.39	45.400	KL	35,760.00	BBGT10256D
70404246	01.09.2017	D018712	ZFBE	ZC2031	A0013L99	38.39	45.400	KL	35,760.00	BBGT10257D
70404248	01.09.2017	D018713	ZFBE	ZC2031	A0013L99	42.28	50.000	KL	39,384.00	BBKT10609D
		Total for		ZC2031	on 01.09.2017	: 7	322.400		233,572.00	

Fig. 3: Payments and reconciliation of wagon deliveries.

The payment and reconciliation process is being catered via the SAP ERP system. The daily scheduling of railway wagons as per their arrival and the product requirement of the CPSTL bulk depots is performed via the system. The good issue and good receipt operations determine the actual product delivery via wagons. Each CPSTL destination has a trip time for which the relevant wagon to reach its destination. Railway wagons failing to do so will be captured by the system. SLR is notified regarding the delays via system generated reports.



Stock In-Transit By Road
Goods Issue Date > 7 days
Stock In-Transit By Rail
Cancelled documents
BTR In-Sliding
Stock In-Transit for the day, Good Receipt completed
Goods Issue Date > Grace period
CRN

STOCK IN-TRANSIT DETAILS

Plant	Material	Quantity	UOM	PO Number	Item	Iss.Plnt	Delivery	GI.Date	Invoice	Shipment	Vehicle	Alert	GR/Cancel
2031	A0013L99	50.000	KL	6500038384	00010	2021	80433776	27.10.2017	70413694	2329903	BBKT10610D		28.10.2017
2031	A0013L99	45.400	KL	6500038384	00010	2021	80433777	27.10.2017	70413695	2329904	BBGT10509D		28.10.2017
2031	A0013L99	45.400	KL	6500038384	00010	2021	80433778	27.10.2017	70413696	2329905	BBGT10526D		28.10.2017

Fig. 4: Wagon in-transit details via SAP ERP system.

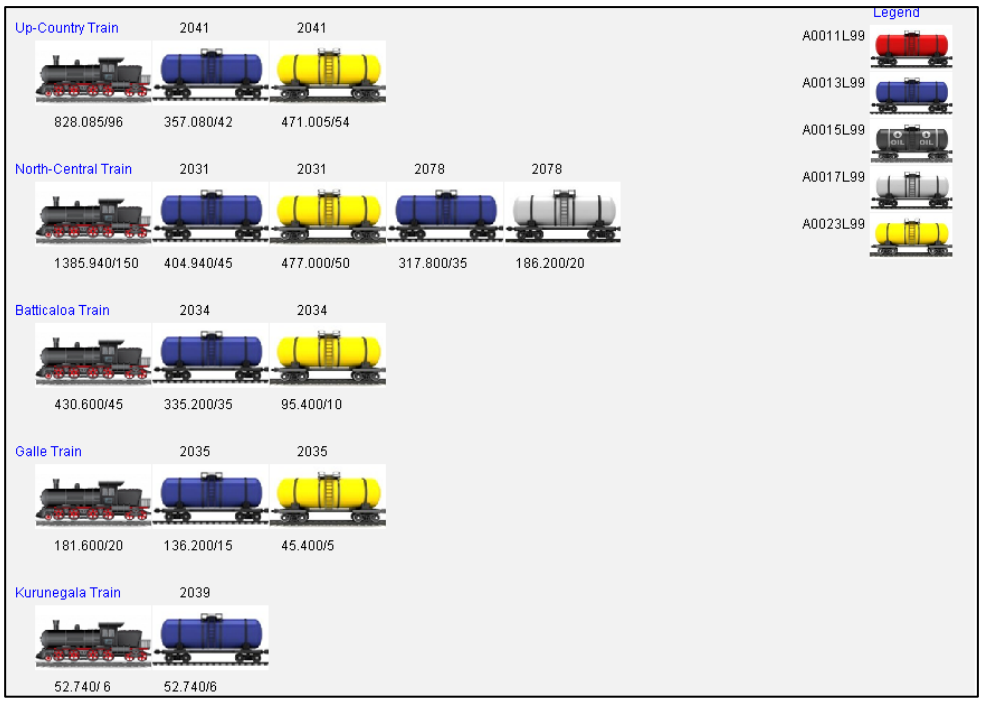


Fig. 5: Wagon scheduling via SAP ERP system.

Although, there are systems in place at CPSTL, the authority of the wagons are with SLR, once it leaves the Kolonnawa terminal. Tracking the whereabouts of the wagons is a difficult task. Currently a system has been proposed to locate the railways wagons via a GPS system.

Recommendations

01) Replenishing of CPSTL Bulk Depot Batticaloa via rail.

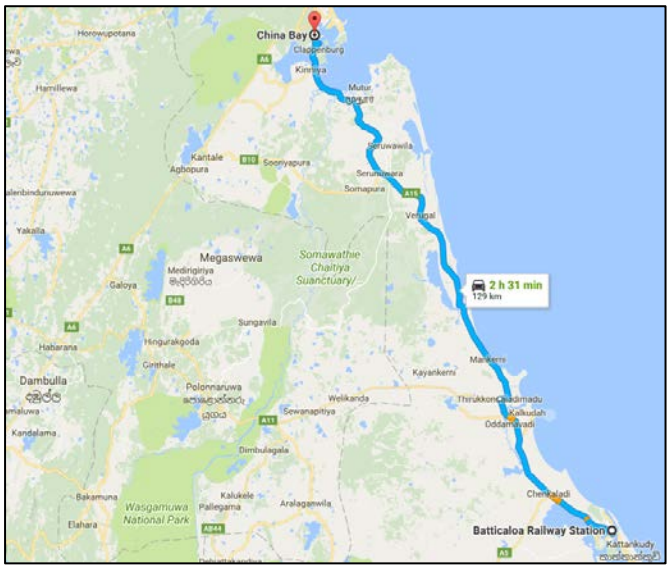


Fig. 6: Road distance from Chinabay terminal Batticaloa bulk depot.

The CPSTL Batticaloa bulk depot replenishment can be performed via rail from the LIOC Chinabay terminal. This rail track existed before the break of war. If the train infrastructure and the facilities are in place, it is a quite viable and cost effective method.

Mode of Transport	*Source*	*Distance (km)*	*Cost per 1km per 1 litre (Rs.)*
Rail	*Chinabay Terminal*	*186.5*	*0.66*
Hired Tank Lorry	*Chinabay Terminal*	*129.0*	*1.36*
Rail	Kolonnawa Terminal	351.0	1.24
Hired Tank Lorry	Kolonnawa Terminal	310.5	3.28
Hired Tank Lorry	Muthurajawela Terminal	317.0	3.34
Average cost Saving (via Rail)			0.58
Average cost Saving (via Hired Tank Lorry)			1.92

Table 4: Cost comparison for replenishing Batticaloa bulk depot.

The above table depicts the costs incurred by currently adopted methods and the proposed methods.

Product	*Avg. qty per month (litres)*	*Cost of delivery from Kolonnawa via Rail (Rs.)*	*Cost of delivery from Chinabay via Rail (Rs.)*	*Cost saving for CPSTL Via Rail (Rs.)*
Lanka Auto Diesel	3,936,041.11	4,875,491.47	2,590,538.91	2,284,952.55
Petrol 92 Octane	3,001,818.89	3,718,290.02	2,447,224.18	1,271,065.84
Total	6,937,860.00	8,593,781.49	5,037,763.10	3,556,018.39

Table 5: Simulated savings for replenishing Batticaloa bulk depot.

By adopting the above proposed methods, CPSTL can save approximately Rs. 3.5 million out of their transport tariff.

02) Replenishing of CPSTL Bulk Depot Kankasanthurayi (KKS) via rail.

Replenishing the KKS bulk depot has been an important factor since it's critical to national security and facilitating the fuel requirement of the Jaffna peninsula. The direct railway facilities were destroyed due to the war activities. Although the rail track is being established up to KKS, the infrastructure has not been developed for bulk petroleum product transport via rail.

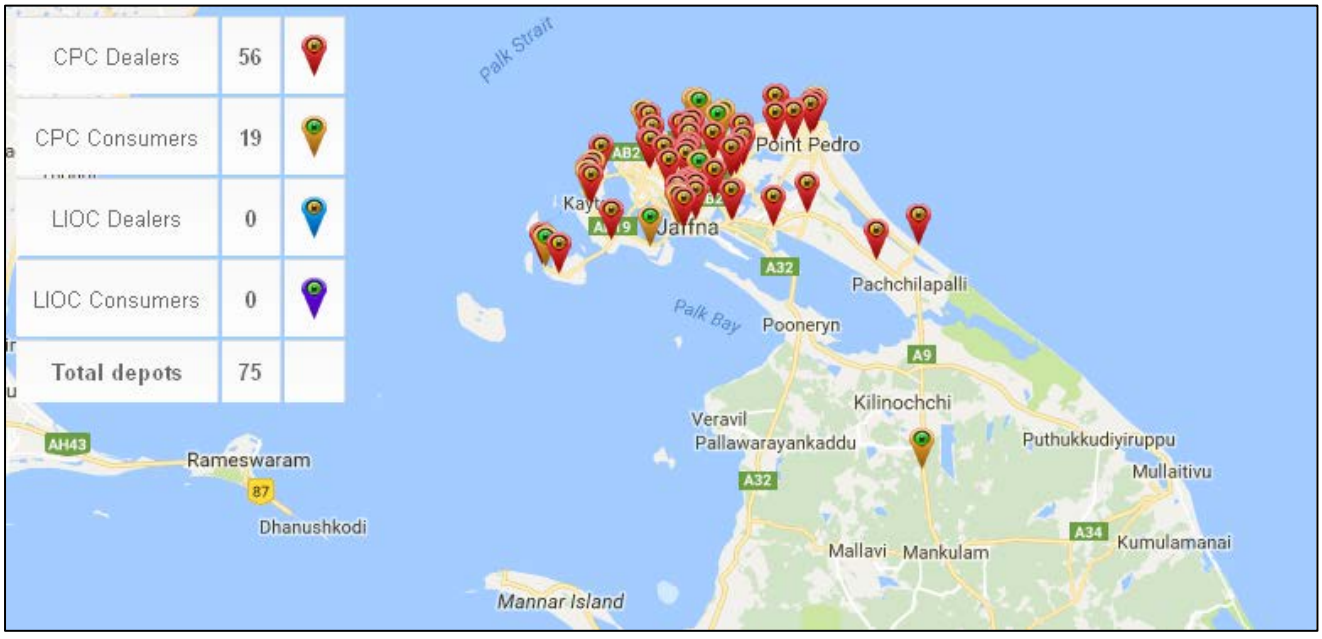


Fig. 7: Customers served by CPSTL bulk depot KKS.

Mode of Transport	**Source**	**Destination**	**Distance** (km)	**Cost per 1km per 1 litre** (Rs.)	**Final Cost per 1km per 1 litre** (Rs.)
Rail	*Kolonnawa Terminal*	*KKS Bulk Depot*	*412*	*1.45*	*1.45*
Combined method	Kolonnawa Terminal	IRD Vavuniya	256	0.90	
	IRD Vavuniya	KKS Bulk Depot	152	1.60	2.51
Combined method	Kolonnawa Terminal	A'pura Bulk Depot	196	0.69	
	A'pura Bulk Depot	KKS Bulk Depot	206	2.17	2.86
Average of the Above 02 methods					2.69
Cost Saving					1.23

Table 6: Cost comparison for replenishing KKS bulk depot.

03) Replenishing of Galle and Matara bulk depots entirely via rail.

Currently the Galle train is operating for 06 days a week. It has a high potential to be operated twice a day with comparison to the other trains. If an extra train engine can be placed to collect the empty wagons and return them to Kolonnawa terminal, the daily delivery can be expanded by 100%.

Currently the Galle train is operating for 06 days a week. It has a high potential to be operated twice a day with comparison to the other trains. If an extra train engine can be placed to collect the empty wagons and return them to Kolonnawa terminal, the daily delivery can be expanded by 100%.

Product	*Total deliveries for Jan. - Oct 2017 (Kl)*	*Monthly delivery Avg. (Kl)*	*Daily Avg. delivery qty. (Kl)*	*Current Daily delivery capability (Kl)*	*Proposed Daily delivery capability (Kl)*
Auto Diesel	183,292.88	18,329.29	704.97	-	-
Super Diesel	3,603.60	360.36	13.86	-	-
Petrol 92 Oct.	8,626.20	862.62	33.18	-	-
Kerosene	89,074.73	8,907.47	342.60	-	-
Total	284,597.41	28,459.74	1,094.61	363.20	726.40

Table 7: Statistics and feasibility of proposal for Galle and Matara bulk depots.

As per the statistics, only a portion of the daily product demand is catered via rail and there is sufficient capacity to be delivered via rail. These will double the SLR revenue for the Galle train. Since it is cheaper to utilize rail, it will drastically reduce CPSTL transport tariff.

Conclusion

Transportation of bulk petroleum products via railways has been an effective strategy since its inception. Its relevance is applicable to the date due to cost concerns and convenience. Delay of infrastructure development has withheld the Sri Lanka railways from reaping the maximum benefits. It is of high important to expedite developments related to Sri Lanka railways and the Sri Lankan petroleum industry, in order to productively cater to ever rising energy demand of the country.

References

- Ceylon Petroleum Storage Terminals Ltd. (2017) Retrieved from http://www.cpstl.lk/aboutcpstl.php
- Ceylon Petroleum Storage Terminals Ltd. (2017) *Executive Summary Report – September 2017.*
- Sri Lanka Railways. (2017) Retrieved from http://www.railway.gov.lk/web/index.php?lang=enhttp://www.railway.gov.lk/web/ index.php?lang=en

APPLICATION OF ARTIFICIAL NEURAL NETWORK FOR THE INVENTORY MANAGEMENT OF THE FAST-MOVING CONSUMER GOODS DISTRIBUTORS

Nancy Deraz[1, 2], Yi Wang[2], Jonathan Moizer[2] and Irina Neaga[3]
[1]College of International Transport and Logistics, Arab Academy for Science, Technology and Maritime Transport, Alexandria, Egypt
[2]Plymouth Business School, University of Plymouth, Plymouth, UK
[3]School of Engineering, Logistics and Transport, University of Wales Trinity St David, Swansea, UK

1. Introduction

Distribution is among the most critical and problematic issues for firms seeking to establish themselves in competitive markets where institutional voids can seriously affect the effectiveness of distribution strategies (Khanna *et al.,* 2005). Fast Moving Consumer Goods (FMCGs) companies with great diversity of customers must integrate the systems components of distribution to achieve an acceptable customer service level and avoid reduction of market share (Bowersox, 2008). Achieving high service levels and increasing the profit explain the issue of getting the right quantity of the right product to the right place at the right time and at the least possible cost. This challenge has confronted companies with issues such as meeting delivery due dates and operating an efficient distribution network. During an interview conducted on 7 May 2017, Dr Hamido stated that the FMCGs industry in Egypt is one of the most growing sectors in the Egyptian economy, it represents a significant proportion of the expenditure of Egyptian citizens. A significant number of practitioners in multinationals and big locals tackled the topic of suppliers and retailers as they are easily accessible, but it's very rare to find researchers who have tackled the topic of distribution in the Egyptian FMCGs sector.

In supply chains, forecasting is usually based on the history of orders provided by the closest SC's member to costumers, since he is closer to the market and has a better view on demand levels. In the industrial world, firms cannot risk waiting for the actual demand to occur so they can react and determine the quantities to purchase, produce and deliver (Slimani *et al.,* 2015). Keeping demand and supply in balance reduce excess and shortage of inventories and improve profitability. Therefore, the accurate demand forecast is a real challenge for participants in the supply chain. The ability to forecast the future based on past data is a key tool to support individual and organizational decision making. Traditional forecasting methods suffer from serious limitations which affect the forecasting accuracy. ANN have been found to be useful techniques for demand forecasting due to their ability to accommodate non-linear data, to capture indirect functional relationships among empirical data (Kochak and Sharma ,2015). The research problem to be addressed in this study is that the distributors have problems with managing their inventories as they relied on the traditional techniques used by most of them. Therefore, the researcher chose to implement the artificial neural network as a better forecasting tool to be used by the FMCGs distributors.

2. Literature review

2.1 Distribution in Supply Chain Management

A supply chain is a network that consists of suppliers, manufacturers, warehouses, distributors and retailers who coordinate their plans and activities to convert raw materials to finished goods (Chandra and Grabis, 2007). The required materials and products must be provided to customers in the right quantities and best quality, at the right location, at the right time and at the lowest cost. In addition, the most important supply chain processes include product development, procurement, manufacturing, physical distribution, customer relationship management and performance measurement (Olson, 2012). Distribution consists of one or more companies or individuals who participate in the flow of goods,

services, information, and finances from the producer to the final user or consumer (Coyle *et al.,* 2013). Distribution includes a coordinated preparation of manufactured goods according to their type and volume, space and time, so that supply deadlines can be met or estimated demand can be efficiently satisfied when producing for an anonymous market (Domschke and Schield, 2010). Existence of many FMCGs distributors from different companies creates an intense competition in the market and this makes it difficult for most of the FMCGs companies to distribute a large volume of products in the target market.

Bala *et al.,* (2010) highlight the issues faced by the FMCG supply chains which started with that supply chains own various production plants, including co-manufacturers and copackers, which increase complexities in the supply chain. Furthermore, another issue was that distribution is handled by specialized firms, which increases the pressure on relationships. Also, the retail sector is pressurizing the industry to manufacture and supply at the lowest possible price and to decrease the response time. Likewise, Aljunaidi and Ankrah (2014) discussed other major issues within the FMCG industry which are forecast accuracy, seasonal shifts in demand and supplier reliability. Forecast difficulties are a problem throughout the whole industry and they are due to the consumer's decision to purchase. Therefore, the need for effective supply chains is crucial to compensate for uneven demand and uneven production. If the supply chains and production are well designed and managed, it constitutes a competitive advantage.

2.2 Inventory management in distribution supply chain

Hamisi (2011) stated that inventory management is about low inventory levels, low prices, and high customer satisfaction; value added procedures and processes which are profitable. Inventory management's role is about the balance in relation to the minimization of total cost and expansion of customer satisfaction. Bloom (2013) agrees that there is massive variance of demand uncertainty across countries; developing countries are the most affected than the developed countries. Effective inventory control cut down these costs since it cuts the total volume of inventory required to operate the organization. Inventory control checks and tracks the levels of inventory and manages obsolescence and deterioration by ordering in proper volumes (Mwangi and Nyambura, 2015). When the costs are up so being the inventory levels and the direct and indirect costs will be measured (Rai, 2012).

Berling (2011) said that holding best possible levels of inventory is very essential in any organization, this is due to having too much of inventory will create holding costs on inventory such as (space rent costs, costs of decision making, old unused stock costs, damages, theft) and insufficient inventory is very costly as consumers may stop supporting the organization but go to competitors. The primary aim of a good inventory management is to excel in customer satisfaction and offer the vital customer service in control of the lowest everyday inventory costs. Good customer service is resulted from ordering the right materials and quantities of the stock at the right time. Inventory optimization tools assist organizations generate consistent decisions on ordering of products. Making these correct decisions increases efficiency by improving the forecasting of future demand (Panigrahi, 2013).

2.3 Main inventory management problems and challenges

Inventory forecasting and demand planning play an important role in the wholesale distribution of durable goods as it involves predicting the demand and sales patterns for various goods to ensure that stock is maintained at optimum levels without over incurring costs due to too much inventory while also not running into stock out situations. There are common demand planning challenges that face distributors in all different types of industries, Fritsch (2015) highlighted some of them like, accurate monitoring of all SKU's and stock levels, availability of historic sales forecasting data, calculating correct supplier lead-times and new product introductions. Bai and Zhong (2008) explained that forecasting demands results in two problems, which are in opposite extreme, overstock and stock-out of inventory. As companies strive to avoid lost sales from stock-out of inventory, there is a tendency to

overstock. Because keeping inventory is costly which reduces the profit margin, companies try to reduce the inventory level, so appears the tendency to stock-out of inventory. It is hard to balance the two powers all the time and station the inventory at the right level constantly.

There are two approaches to modeling and forecasting time series: linear approach and nonlinear approach. Linear models (Box and Jenkins, 1976) were used for a long time and are still very useful, but linearity assumptions underlying these models may be too restrictive. A nonlinear model more flexible is Artificial Neural Networks (ANN), which have received attention recently. The major advantage of neural networks is that they are data driven and does not require restrictive assumptions about the form of the basic model (Dumitru and Maria, 2013). Therefore, this research will emphasize the use of neural networks in demand forecasting the inventory levels of the FMCGs distributors.

2.4 Artificial Neural Networks

With the development of computing capabilities, there was a need for computers to learn from data so they could be smart and make decisions more like humans. This necessity created a field in the science called machine learning. In this field, scientists have studied how computers can learn and then change behaviors. This field is concerned with making computers modify their actions so they will be accurate in reflecting the right ones, according to Marsland (2011). There are many techniques that have been created with the purpose of learning from observations and then using that knowledge to judge between different possibilities and pick the right one. One of these techniques is the Artificial Neural Networks (ANN).

According to Silva *et al.,* (2016) each ANN has an architecture of three layers. These layers are: input layer, hidden layers and output layer. The information in the ANN is passed from one layer to the next, starting at the input layer, and then going to the hidden layers and finally passing through the output layer where the result is defined. Each layer receives a value as input and generates a value as output. The input value of a layer is the output value of the previous one. As stated before, artificial neural networks have the capability of learning from observation. This process is done as weights are adjusted until the artificial neural network can generalize the results generated by the outputs. When the learning process is complete, the artificial neural network can be used with new inputs to make new predictions or describe existing patterns in the data.

According to Haykin (2009), there are three fundamentally different classes of network architectures:

- single-layer feed forward networks, that consists of a single layer of output nodes and the inputs are fed directly to the outputs via a series of weights.
- multilayer feed forward networks, that distinguishes itself by the presence of one or more hidden layers.
- recurrent networks, that distinguishes itself from a feed forward neural network by at least one feedback loop.

ANN learning paradigms can be classified as supervised, unsupervised and reinforcement learning. Supervised learning model assumes the availability of a supervisor who classifies the training examples into classes and utilizes the information on the class membership of each training instance, while, Unsupervised learning model identify the pattern class information heuristically and Reinforcement learning learns through trial and error interactions with its environment (Sathya and Abraham,2013).

Supervised learning, the one that will be used in the research, is based on training a data sample from data source with correct classification already assigned. Such techniques are utilized in feedforward or Multilayer Perceptron (MLP) models. Learning through training in a supervised ANN model also called as

"error back-propagation algorithm". Supervised learning paradigm of an ANN is efficient and finds solutions to several linear and non-linear problems such as classification, plant control, forecasting, prediction, robotics (Awodele and Jegede, 2009).

Hakimpoor *et al., (*2011) mentioned that neural network approaches differ from traditional statistical techniques in many ways. They are powerful alternative tools and a complement to statistical techniques when data are multivariate with a high degree of interdependence between factors, when the data are noisy or incomplete, or when many hypotheses are to be pursued and high computational rates are required. The most frequently quoted advantages of the application of neural networks that fit the nature and the problem of this research are:

- Neural networks are very flexible with respect to incomplete, missing and inaccurate data which makes them fault tolerant (Venugopal and Baets, 1994).
- Neural networks models can be easily updated. It means they are suitable for dynamic environment (Venugopal and Baets, 1994).
- ANN is a reliable tool for predicting the determinants of relationship quality (Mitoma et *al*.2008).

2.5 Applications of Neural networks in Inventory Management

Neural networks that are currently applied in the supply chain management are mainly focused in the following three areas: optimization, forecasting and decision support (He *et al.*,2002; Liu,2015). Dong and Wen (2006) had mentioned that attention has focused on developing better forecasting models that reduce or eliminate inventories, which reflects the cost of inventory management in supply chain. ANN, as a new tool, has already been used in forecasting field due to their ability to learn complicated functions. Although there are various neural network models, BP neural network is the most widely used model because of its simple structure and strong ability to learn.

Since ANN algorithms can accommodate non-linear data, to capture functional relationships among empirical data, they have been widely used in solving demand forecasting and scheduling problems. The use of ANNs for forecasting has received great attention from many different fields. Given the fact that forecasting problems arise in so many different disciplines and the literature on forecasting with ANNs is scattered in so many diverse fields, it is difficult to cover all neural network forecasting applications. Table 1 provides a sample of SCM applications with ANNs reported in the literature from 2002 to 2016.

Table 1. Classification of the research studies on the ANN applications in SCM with respect to focus and contribution

No.	Author	Year	Focus	Contribution
1	Dong & Wen	2006	Managing inventory management uncertainty	Developed a recurrent-based neural network forecasting model to reduce uncertainty for inventory management.
2	Megala & Jawahar	2006	Inventory management lot-sizing problem	Used genetic algorithm and Hopfield neural network to address a dynamic lot-sizing problem.
3	Aburto & Weber	2007	Demand forecasting	Proposed a hybrid system that combines neural network and autoregressive integrated moving average models for demand forecasting.
4	Zhu	2010	Supply chain performance evaluation	Developed a BP neural network model for supply chain performance evaluation.

5	Hong *et al.*	2010	Supply chain optimization	Developed an online neural network controller for supply chain optimization.
6	Huang *et al.*	2010	Decreasing inventory carrying cost	Applied a BP neural network model to evaluate the criticality class of spare parts.
7	Hachicha	2011	Inventory management lot-sizing problem	Used neural network to deal with lot-sizing problem in the supply chain by metamodeling simulation.
8	Paul & Azeem	2011	Inventory levels optimization	Developed a feed-forward neural network model that determines the optimum level of finished goods inventory for any manufacturing enterprise.
9	Wang	2012	Inventory levels optimization	Proposed a BP neural network approach to inventory risk level of spare parts.
10	Mansur & Kuncoro	2012	Inventory levels prediction	Used Market Basket Analysis and BP neural networks for inventory level prediction.
11	Zhang *et al.*	2013	Inventory control	Proposed a new inventory control method for supply chain management using BP neural networks.
12	He	2013	Inventory levels prediction	Proposed a new BP neural network algorithm for inventory levels prediction.
13	Kochak & Sharma	2015	Demand forecasting	Developed a neural network based mechanism that acted as a decision support tool in forecasting.
14	Slimani *et al.*	2015	Demand forecasting	Tested many MLP neural networks for demand forecasting.
15	Sustrova	2016	Order cycle optimization	Developed a feed-forward BP neural network model for order cycle optimization.

3. Problem description

The major drivers that keep the distribution function in any supply chain working efficiently are the working capital and the warehousing spaces. Many researchers highlighted the importance of inventory management for the success of the manufacturing organizations but very few addressed the issues of inventory management in the distribution organizations. Inventory management's role in most of the industries is about the balance between minimizing the total cost increasing customer satisfaction. In this research, the addressed entity are the FMCGs distributors along with emphasizing their main inventory management goal which is to reduce holding cost and to find the optimal mix between the slow and fast-moving goods in the distribution center. This goal will not be achieved unless the distributor has accurate demand planning and forecasting. And because the FMCGs environment is very dynamic and it changes due to the change in product demand, setup cost, holding cost and other factors, the traditional forecasting techniques could not cope with these changes anymore and therefore the forecasting results were not satisfying (Hamido 2018, pers.comm.,25 April).

Therefore, as mentioned before in the literature, the researcher considered using the neural networks to achieve more accurate results through their ability to capture non-linear relationships. Megala and Jawahar (2006) and Hachicha (2011) addressed a lot-sizing problem as one of the inventory management trade-offs and no research addressed the product-variety trade-off concerning the distribution sector. Therefore, in order to fill this gap, the researcher will develop a BP neural network model for inventory level prediction to optimize the FMCGs distributor inventory levels to be able to decrease the carrying costs and to find the optimal mix of the products.

4. Research work

This research is directed by the positivism philosophy because the researcher will establish the findings on observable phenomenon. A positivism aspect can assist the researcher to make generalizations of phenomena into simplest fundamentals. An interpretivism aspect is not suitable for this study since it is subjective.

Golicic and Davis (2012) mentioned that the mixed methods research design begins with the choice of an initial research approach and then progresses through the circles tacking between qualitative and quantitative approaches. The phenomenon of using neural networks as a demand forecasting tool for distributors would be an appropriate topic for initiating research with the qualitative approach. Then the quantitative research methodology will take place when the research will start to explain the relationships among the variables (Creswell, 1998). The quantitative research methodology will be conducted to create the framework of this study, while the empirical validation of the research framework requires both quantitative and qualitative research methodologies. The main constructs of the BP neural network model would be identified firstly from the literature then through semi structured interviews and surveys, these constructs would be the building blocks of the model. The model would then be validated through case studies from the FMCGs distribution sector in Egypt.

This research deals with developing an ANN model which can be used to optimize inventory level, decrease the carrying cost, and finding the optimal product mix and thus improve inventory management of the distribution companies. This study develops the model of neural network to determine the optimum amount of ordered goods to optimize the current inventory amount. The model below is developed based on the finished goods inventory level optimization models created by (Sustrova, 2016 and Paul and Azeem, 2011). The previous models focused on most of the variables mentioned in the below model, but they did not include some variables that would affect the distributor's activities. Therefore, the working capital and the seasonality variables have been added to the model to fit the aim of the research. A feed-forward backpropagation network model with one hidden layer and output layer is used, while the number of hidden neurons can be defined. The proposed network architecture below, consisting of 7 input neurons (inputs), at least 8 neurons in hidden layer and one output neuron (target) based on the model constructed by (Sustrova,2016). The input variables are briefly defined as follows:

- **Historical demand (x1):** it refers to the number of products that have been ordered during a specific period of time in the past, and this input will be used to forecast the demand. (Paul and Azeem, 2011)
- **Historical sales (x2):** it refers to the historical amount of product sales during a specific period of time. (Author's own study)
- **Forecast demand (x3):** it refers to the predicting future demand of a product during a specific period of time. (Sustrova, 2016)
- **Current inventory (x4):** it refers to the actual number of products currently existing in the warehouse. (Sustrova, 2016)
- **Purchase price (x5):** it refers to the purchase price of products that the distribution pays for buying products from the suppliers. (Sustrova, 2016)
- **Working capital (x6):** it refers to the difference between the distributor's current assets (cash, inventory of finished goods) and the distributor's current liabilities. (Author's own study)
- **Seasonality (x7):** it refers to the seasonal changes in the distributor demand during a specific time of the year. (Author's own study)

The output parameter (z) of the model is the optimal amount of purchased goods which will achieve the optimal product mix between the slow and fast-moving goods. Inputs and output are presented in Figure 1. Real data from FMCGs distribution companies will be used for establishing and validating the proposed ANN model. The impact of these factors on the predicted number of products to be ordered is non-linear, that's why the researcher chose to use a 3-layer BP neural network as a good demand forecasting tool for the FMCGs distributors.

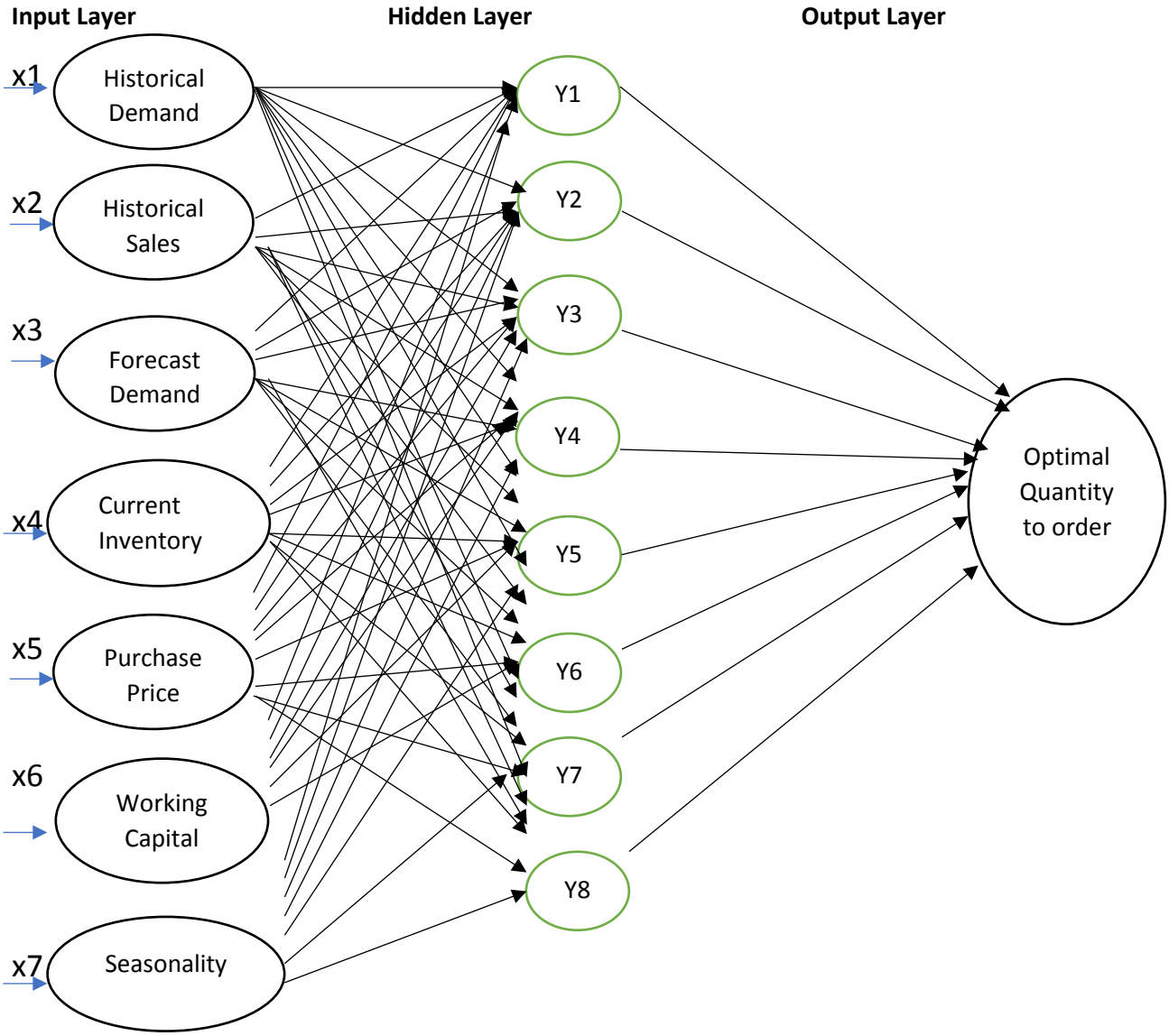


Figure 1. The Three-Layer BP Neural Network.

5. Conclusion and Further Development

This research is a work in progress. The findings at this stage represent a general structure of the BP neural network inventory management model based on the literature review. This model will be further developed based on analyzing the interviews collected from the distributor practitioners in the industry. This paper combines all aspects of neural networks applications in inventory management which have been not holistically researched.

References

- Aburto, L. & Weber, R. (2007), 'Improved supply chain management based on hybrid demand forecasts', *Applied Soft Computing*, Vol.7, pp. 136–144.
- Aljunaidi, A. & Samuel Ankrah, S. (2014), 'The Application of Lean Principles in the Fast-Moving Consumer Goods (FMCG) Industry', *Journal of Operations and Supply Chain Management*. Vol.7, pp. 1-25.
- Awodele,O. & Jegede, O. (2009), 'Neural Networks and Its Application in Engineering', *Proceedings of Informing Science & IT Education Conference*, pp. 83-95.
- Azizul,B. & Anton, A.K.(2009), 'Inventory Management Systems with Hazardous Items of Two Parameter Exponential Distribution', *Journal of Social Sciences*, Vol.5, pp .183-187.
- Bai, L. & Zhong, Y. (2008), Improving Inventory Management in Small Business: A Case Study.
- Bala, M., Prakash, S. & Kumar, D. (2010), 'Risk management in the FMCG industry', *Transport World*, Vol. 8, pp. 28-33.
- Berling, P.A. (2011), Characterization of optimal Base Stock levels for a Continuous Stage Serial Supply Chain, IESE Business School. University of Navara.
- Bloom, N. (2013), Fluctuations in uncertainty.
- Bowersox, P.D. (2008), 'Information asymmetry and levels of agency relationships', *Journal of Marketing Research,* Vol.XXXV, pp. 277–295.
- Box, G.E.P. & Jenkins, G.M., (1976), Time Series Analysis: Forecasting and Control. Holden-Day, San Francisco, CA.
- Chandra, C., Grabis, J. & Tumanyan, A. (2007), 'Problem taxonomy: a step towards effective information sharing in supply chain management', *International Journal of Production Research*, Vol.45, pp. 2507-44.
- Ciobanu, D. (2012), 'On a model for predicting the exchange rate euro-leu with a NAR neural network', *Proceedings of the 19th International Economic Conference* – IECS.
- Coyle, B., Hunter, G.L. & Singuaw, J.A. (2013), 'An evolving theory of hybrid distribution: Taming a hostile supply network'. *Industrial Marketing Management,* Vol.36, pp. 604-616.
- Creswell, J.W. (1998), *Qualitative Inquiry and Research Design: Choosing Among Five Research Traditions*, Sage, Thousand Oaks, CA.
- Domschke, H. & Schield, O. (2010), A Marketing Rationale for the Distribution of Automobiles. *2 Studies in Automobile Franchising.* Ann Arbor, The University of Michigan.
- Dong,X. & G.Wen (2006), 'An improved neural networks prediction model and its application in supply chain', Nature and Sci., Vol.4, pp. 23-27.
- Dumitru, C., Maria,V. (2013), Advantages and disadvantages of using neural networks for predictions Ovidius Univ. Ann. Econ. Sci. Ser., XIII, pp. 444-449.
- Fritsch (2015), '5 Demand Planning Challenges Facing Distributors Today', [online]. Available at: https://www.eazystock.com/blog/2015/10/02/5-demand-planning-challenges-facing-distributors-today/.
- Golicic,S. & Davis,D. (2012), 'Implementing mixed methods research in supply chain management', *International Journal of Physical Distribution & Logistics Management*, Vol.42, pp.726-741.
- Hachicha, W. (2011), 'A simulation meta-modelling based neural networks for lot-sizing problem in MTO sector', *International Journal of Simulation Modelling,* Vol.10, pp. 191–203.
- Hakimpoor,H., Arshad, K. A. B., Tat, H. H., Khani, N. and Rahmandoust, M., (2011), 'Artificial Neural Networks' Applications in Management', *World Applied Sciences Journal*, Vol.14, pp. 1008-1019.
- Hamisi, S. (2011). Challenges and opportunities of Tanzanian SMEs in adapting supply chain management, Vol.5, pp. 1266-1276.

- Haykin, S.S., (2009). Neural networks and learning machines.10. Prentice Hall Upper Saddle River, NJ.
- He, W. (2013), 'An inventory controlled supply chain model based on improved BP neural network', *Discrete Dynamics in Nature and Society*, Vol. 1, pp. 1–7.
- He, Y., Li, F., Song, Zh. & Zhang, G. (2002), 'Neural networks technology for inventory management', *Computer engineering and application*, Vol.15, pp.182-184.
- Hong, S.R., Kim, S. T., & Kim, C. O. (2010), 'Neural network controller with on-line inventory feedback data in RFID-enabled supply chain', *International Journal of Production Research,* Vol.48, pp. 2613–2632.
- Huang, Y., Sun, D. X., Xing, G. P., & Chang, H. (2010), 'Criticality evaluation for spare parts based on BP neural network', in *Proceedings of the International Conference on Artificial Intelligence and Computational Intelligence (AICI '10)*, Vol. 1, pp. 204–206.
- Kiridena, S. B. & Fitzgerald, A. (2006), 'Case study research in operations management', *In: ACSPRI Social Science Methodology Conference, Sydney: ACSPRI,* pp.1-18.
- Kochak, A. & Sharma, S. (2010), 'Demand forecasting using neural network for supply chain management', *International Journal of Mechanical Engineering and Robotics Research*, Vol.4.
- Kumar, P., Herbert, D. M. & Rao, D. S. (2014), 'Demand forecasting Using Artificial Neural Network Based on Different Learning Methods: Comparative Analysis', *International journal for research in applied science and engineering technology*.
- Liu, H. (2015), Forecasting Model of Supply Chain Management Based on Neural Network.
- Mansur, A. & Kuncoro, T. (2012), Product inventory predictions at small medium enterprise using market basket analysis approach-neural networks, *Procedia Economics and Finance*, Vol.4, pp. 312–320.
- Marsland,S. (2011), Machine Learning: An Algorithmic Perspective New York NY USA.
- Megala, N., & Jawahar, N. (2006), 'Genetic algorithm and Hopfield neural network for a dynamic lot sizing problem', *The International Journal of Advanced Manufacturing Technology,* Vol.27, pp. 1178–1191.
- Mitoma, T., Wang, H. & Chen, P. (2008), 'Fault diagnosis and condition surveillance for plant decision rotating machinery using partially-linearized neural network', *Computers and Industrial Engineering*, Vol.55, pp. 783-794.
- Mwangi, W. & Nyambura, M. (2015), 'The role of inventory management on performance of food processing companies: A case study of Crown foods Limited Kenya', *European Journal of Business and Social Sciences*, Vol.4, pp. 64-78.
- Olson, L.D. (2012), Supply Chain Information Technology S. Nahmias (Ed.), The Supply and Operations Management Collection., Business Expert Press, New York.
- Panigrahi, A.K. (2013), 'Relationship between inventory management and profitability: An empirical analysis of Indian cement companies', *Asia Pacific Journal of Marketing & Management Review*, Vol.2.
- Paul, S. K. & Azaeem, A. (2011), 'An artificial neural network model for optimization of finished goods inventory', *International Journal of Industrial Engineering Computations*, Vol.2, pp. 431–438.
- Rai, S. (2012), 'Inventory flow management process: FMCG (beverages) sector', *International Journal of Research in Science and Technology*.
- Sathya R. & Abraham, A. (2013), 'Comparison of Supervised and Unsupervised Learning Algorithms for Pattern Classification', *International Journal of Advanced Research in Artificial Intelligence* (IJARAI), Vol.2.

- Shaik, M.N. & Abdul-Kader, W. (2013), 'Interorganizational Information Systems Adoption in Supply Chains: A Context Specific Framework', *International Journal of Information Systems and Supply Chain Management*, Vol.6, pp. 24-40.
- Sharma, A. & Chopra, A. (2013), 'Artificial Neural Networks: Applications in Management', *Journal of Business and Management (IOSR-JBM)*, Vol.12, pp: 32-40.
- Silva, I. N. d., Spatti, D. H., Flauzino, R. A., Liboni, L. H. B.& dos Reis Alves, S. F. (2016), *Artificial Neural Networks: A Practical Course*: Springer.
- limani, I., Elfarissi, I. & Achchab, S. (2015), 'Application of game theory and neural network to study the behavioral probabilities in supply chain', *Journal of Theoretical and Applied Information Technology*, Vol.82, pp. 411-416.
- Šustrová, T. (2016), 'A Suitable Artificial Intelligence Model for Inventory Level Optimization', *Trendy ekonomiky a Managementu*, Vol.25, pp. 48-55.
- Venugopal, V. & Baets, W. (1994), 'Neural Networks and Statistical Techniques in Marketing Research: A Conceptual Comparison', *Marketing intelligence and planning*, Vol.12, pp.30-38.
- Wang, W. P. (2012), 'A neural network model on the forecasting of inventory risk management of spare parts', in *Proceedings of the International Conference on Information Technology and Management Science (ICITMS '12)*, pp. 295–302.
- Xia, W. L. & Lv, X. Q. (2005), 'The evaluation and application research about technologic innovation capability of an enterprise based on BP neural network', *Research & Development Management*, Vol.17, pp. 50-55.
- Young, S. (2007), 'Comparing Best Practice Cases in Creating an Environment Conducive to Development Benefits, Growth and Investment - Developing a Case Study Methodology', *In: United Nations Conference on Trade and Development, Geneva.*
- Zhang, Z. X. & Zhang, Q. S. (2002), 'The evaluation of technical innovation capability of an enterprise based on BP neural network', *Science & Technology Progress and Policy*, Vol.19, pp. 130-131.
- Zhang, Z., Xu, J. & Zhang, J. (2013), 'A new adaptive inventory control method for supply chains with non-stationary demand', *in Proceedings of the 25th Control and Decision Conference (CCDC '13)*, pp. 1034–1038.
- Zhu, J. (2010), 'Evaluation of supply chain performance based on BP neural network', *in 2nd International Conference on Computer Engineering and Technology*, pp. 495–499.

AN ASSESSMENT OF SUPPLY CHAIN VULNERABILITIES TO DYNAMIC DISRUPTIONS IN THE PHARMACEUTICAL SUPPLY CHAIN

Emilia Yaroson[1], Karam Sharief[2], Awn Shah[2] and Liz Breen[2]
[1]University of Bradford, School of Management, UK
[2]University of Bradford, School of Pharmacy and Medical Sciences, UK

Introduction

Supply chain disruptions impede the flow of products, hamper firms' abilities to produce their goods as well as adversely impact on the financial performance of a supply chain (Juttner and Maklan, 2011; Thekdi and Sarvos, 2016; Hendricks et al. 2017). Some studies have identified the existence of vulnerabilities within supply chains as pertinent to the ability of firms in withstanding the impact of these disruptions (Juttner and Maklan, 2011; Thun and Hoenig, 2011; Purvis et al., 2016). The argument for the inclusion of supply chain vulnerability stems from the underlying idea that supply chain weaknesses expose them to diverse impacts of disruptive activities (Juttner and Maklan, 2011; Pettit et al. 2013; Christopher and Holweg, 2017). This therefore calls for the need to qualify as well as quantify the vulnerabilities the supply chain is exposed to in an attempt to evaluate the need for costly strategies for resisting disruptions that may rarely occur (Wagner and Neshat, 2010). This is line with the accepted adage which states that 'you can't manage, what you don't measure''.

More specifically, there is the need to understand supply chain vulnerabilities within the pharmaceutical supply chain. Shah, (2004) explains that the complexity of the PSC burden it bears in trying to ensure that the right drugs, reach the right people at the right time and in the right condition to fight against ailments. Furthermore, high regulations require collection of variety of information that may be difficult to decipher (Zhang et al., 2009). Pharmaceutical supply chains are also encumbered with diverse forms of disruptions which to are large extent are termed as dynamic. In view of the foregoing, the aim of this study is to assess the vulnerabilities of the pharmaceutical supply chain in the face of a dynamic disruption like drug shortage. This section introduces the paper. The next section provides a brief overview of the main concepts under study. Following this, the methodology and findings are presented. The paper is concluded in the final section.

Review of literature

Supply chain vulnerability as a concept within supply chain risk management literature remains inconclusive as it varies with regards to its research contexts, definition and framework (Liu et al., 2018). Most studies, present supply chain vulnerability as an elusive concept that occurs through certain traits of a supply chain, such as its design and the environment in which the supply chain exists. The concept and or definition of supply chain vulnerability may however differ with regards to supply chains, modes of occurrences or in the face of a disruptive event like drug shortages or counterfeiting. This study, therefore views supply chain vulnerability as the points at which the supply chain is exposed to varying degrees of attacks, damages, and adverse impacts which emanate from disruptions such as natural hazards, strikes, global warming, thefts and counterfeiting. The fact that not all supply chain risks can be controlled means that every supply chain has some degree of vulnerability – and this is the premise on which SCRES is built (Christopher and Holweg, 2011; Hohenstein et al. 2015; Elleuch et al. 2016). However, the underlying assumptions that supply chain vulnerability is as a result of a supply chain's lack of resilience to varying forms of threats remain inconclusive (Jüttner and Maklan, 2011).

For instance, while Sheffi and Rice (2005) argued that reducing vulnerability implies reducing the likelihood of a disruption and thereby enhancing resilience. Jüttner and Maklan (2011) claim that a highly vulnerable supply chain may either have a high or low resilience based on their ability to plan and recover from a disruption. The contention here is that there are some strategies which may reduce supply chain vulnerability without necessarily improving the resilience of the supply chain. For instance, some risk strategies are adopted to mitigate geographical risk thereby reducing vulnerability, this does not necessarily translate to resilience (Pettit et al. 2013). Also, the decisions of a supply chain manager to stop outsourcing production and or packaging may reduce the supply chain vulnerability as it shortens the supply chain. This strategy does not imply resilience, as the reaction and response in the face of a disruption is classified as supply chain resilience (Tukamuhabwa et al., 2015). Therefore, appreciation of supply chain vulnerability aids in developing effective capabilities required to cope with disruptions.

Existing literature suggests various factors that may contribute to exposing the supply chain to various degrees of disruptive impact. These include; supply chain complexity, managerial practices (Blackhurst et al. 2011), supply chain structure, supply chain characteristics and supply chain density. Some researchers contend that managerial practices, for instance the application of JIT principles, reduces the firms shock absorbers through low inventories and as such a supply chain may not be able to withstand the impact of a disruption (Thun and Hoenig, 2011).

In the same vein, outsourcing and global sourcing have been credited as essential in propelling firms operations'. However, these practices reduce a supply chains visibility thereby making it difficult to pinpoint the source or cause of a disruption for quicker resolutions (Steecke and Kumar, 2009). Also outsourcing increases the length of the supply chain as longer supply and multiple layered chains have been suggested to reduce the transparency of the supply chain thereby heightening vulnerabilities (Craighead et al. 2007; Wagner and Neshat 2010). Further, supply chain characteristics which identify the degree of dependence on suppliers or consumers for the manufacture and or distribution of products may expose a supply chains' susceptibility to disruptions (Bode and Wagner, 2006; Blackhurst et al., 2017). These characteristics may increase loss of power, offer less advantageous contracts and put at stake continuous replenishment.

Although the arguments for supply chain vulnerabilities are emerging in theoretical supply chain management literature, empirical evidence supporting these assertions remains scanty (Wagner and Neshat, 2012). More specifically, examining these vulnerabilities in the face of a disruption bearing in mind the features of the supply chain is also limited. For instance, is it possible to conclude that the complexities, structure or managerial decisions of the pharmaceutical supply chain may be the leading cause of the impact of a disruption like drug shortages? Sousa et al (2011) even go so far as to question whether there are other underlying intricacies unexplored in literature? This therefore calls for the need to explore the vulnerabilities of the pharmaceutical supply chain in the face of a disruptive event as it will aid in understanding the degree of the impact and the necessary strategies to be employed. Also, in order to effectively manage supply chain vulnerabilities, it is necessary to have empirically validated methods at hand that support managers in measuring and tracking vulnerabilities, as such; understanding why supply chains are vulnerable to disruptions is of import (Peck, 2005; Wagner and Bode, 2006; Wagner and Neshat, 2012).

Methods

In order to achieve the research objective, data was collected using mixed methods strategy which involves the integration of qualitative and qualitative research approaches in a single study (Teddlie and Tashakkori, 2009; Golic and Davis, 2012). The first stage of data collection in this study was the qualitative

method which involved conducting semi-structured interviews with the downstream sector of the supply chain where five community, online and hospital pharmacists were recruited for participation. This approach was based on the idea that the phenomenon (dynamic disruptions as well as pharmaceutical supply chain vulnerabilities) is under-explored and the variables were difficult to identify (Creswell, 2013). This stage also provides a framework for comprehending detailed description by providing high level data. The interview questions therefore included questions such as: 'Could you describe a time your firm faced any form of disruptive activities?' 'Do you know what caused these disruptions and why they persisted?' The formulated key question emanated from theoretical literature, while thematic analysis was used for analysing the generated data through a reductionists approach.

The second phase of the data collection process was the administering of questionnaires to a wider audience. The questionnaire was kept simple and ensured a good flow, thus keeping users engaged as well as facilitating clearer outcomes. There were a range of question which were multiple choice questions close ended responses. The anonymised questions reduced the potential for bias, and the online nature of the questionnaire meant that it was easily available through a number electronic devices. The nature of the questionnaire meant that it was relatively easy and fast to answer it, and it was hoped that this would have increased participation. Branches across the UK were used to increase the generalizability of the results. The link to the online survey was sent to the three community pharmacy chains and requested that it be distributed to each individual branch. CPWY invitation letters were also handed out, and a direct email was sent to the Bradford School of Pharmacy staff to reach out to as many liaising participants as possible. The link was also distributed through the social media platforms 'Twitter' and 'LinkedIn'. Data here was analysed using simple statistical techniques.

Analysis of the data and discussions

Five downstream actors of the pharmaceutical supply chain were recruited for this research. They were chosen specifically because of their activities, experience and position within the pharmaceutical supply chain. A number of clear themes developed from this phase of the data generation process. When asked about 'forms of disruptions' that had been encountered in their firms. The participants did not refer to static forms of disruptions like earthquakes, fire, labour strikes or general nomenclatures employed by researchers such as accidents or intentional disruptions (Peck, 2005). Instead, they referred to drug shortages as disruptions and explained the various forms in which these drug shortages impeded the flow of goods to their consumers. The participants also identified characteristics of the pharmaceutical supply chain, regulations, and imbalance of market power, price manipulation as well as managerial decisions as reasons why the supply chain was weak and as such increased the constant incidences of drug shortages. The next stage of the data generation process involved the administering of questionnaires to first tier consumers on a national level. 22 responses were received and the findings further confirmed the themes that emerged from the interviews. For instance in table 1 below, the highest response rate for the causes of disruptions were price manipulations. This finding indicates that first tier consumers attribute price manipulations as a major cause of disruptions of goods to their patients with a 515 response rate. This implies that price manipulation which entails the distortion of prices for profit hampers the integrity of the supply chain and as such exposes the supply chain to diverse impacts of disruptions (Berg, 2017).

Similarly, managerial decisions such as bulk buying were also identified as vulnerability in the pharmaceutical supply chain with a response rate of 31.8%. These decisions stem from managers of pharmacists who engage in panic buying when they are forewarned about a disruptive activity and in some cases may sell to their counterparts who failed to take up that decisive action. This finding is also in consonance with existing literature that suggests managerial decisions as a major vulnerability within a supply chain (Craig et al., 2007).

Causes of Disruptions	% Response Rate
Pharmacies buying bulk stock and selling it to other parties	(31.8)
Inefficiencies and ineffectiveness of the manufacturing process	(31.8)
Lack of active pharmaceutical ingredients	(18.2)
Natural disasters and uncontrollable events	(0)
Ever increasing competition within the pharmaceutical supply chain	(18.2)
Monopoly within the pharmaceutical supply chain	(36.4)
Price manipulations	(59.1)

Table 1: Online survey responses causes of disruption

The analysis also indicated that the impact of the existing vulnerabilities extends beyond the operations of the pharmaceutical supply chain to also have adverse impact on its stakeholders. The results suggested that employee's engagement in the firms operations during these dynamic disruptions were often stressed as a result of having to deal with consumers as well as the process of sourcing alternative product. Only 59.1% of the respondents felt that they had been trained to manage disruptions effectively, to recover from these in order to offer a high quality and uninterrupted service. This highlights the technicalities involved in dealing with drug shortages as a disruptive event and as such requires skills and development in certain capacity. There were some participants who did not identify drug shortages as a pertinent problem within their pharmacy. This may be attributed to the fact that they had developed coping mechanisms that aided in assuaging the impact of this disruptive activity. These findings are in consonance with previous surveys conducted by GPs in 2014 (Drugs.com, 2017).

The analyses at both phases of the study reveal that lack of trust was a major weakness within the supply chain which exacerbated the impact of the disruption. The severance of trust may be between the patients and the pharmacists and or between pharmacists and their first tier suppliers. Losing distressed patients, or having to deal with confused and frightened patients due to delayed treatment, results in pharmacy staff passing the blame and frustration onto the supply chains. This then leads to fractured relationships. A lack of trust within a supply chain can hinder the ability of members of the chain to prepare for the future and make calculated decisions (Christopher, 2016). The resultant effect is an increased complexity of the supply chain. If medicine shortages were reduced, pharmacy workers would have more time to focus on and improve their services, enhancing patient treatment. The continuous shortages can expose the supply chain to greater financial security as well as counterfeiting risk.

With regards to policies, the study found that there were no laid down rules to facilitate operational recovery within the supply chain when disruptions occurred. For instance, the survey showed that 72.7% of the participants felt that there was a lack of guidance offered by the governing agencies e.g. the Medicines and Healthcare products Regulatory Agency (MHRA) and the General Pharmaceutical Council (GPHC).

Inefficient or inadequate information sharing can, therefore, lead to reduced efficiency and drug shortages (Riley, et al., 2016). A fragile chain is unreliable and so consumers (patients) may looks elsewhere to source their desired medicines. This can put patients at significant risks as they may be, either knowingly or unknowingly, sold counterfeit medicines. Previous literature suggested that

pharmacists are often pressed into prescribing second choice medicines, providing suboptimal treatment for patients. This can lead to an increase in adverse effects and complications. It is also possible that continuous patient use of alternative medicines can lead to shortages of these as well. The results also mention that drug shortages lead to treatment delays, something which can be undesirable and potentially dangerous for patients. Patients being sent to alternative pharmacies can also delay treatment and there is no guarantee that patients go to the other pharmacy immediately, or even at all. Patients are recipients and consumers of medication, and so they are understandably anxious when their desired medications are no longer available. Previous literature such as (Fox et al., 2009) and (Yaroson et al., 2017) showed a lack of information sharing and price manipulations for profit to be key reasons for supply chain shortages.

These findings concurred with our results, as 81% of respondents mentioned that they received no alerts prior to drug shortages, and 12 respondents blamed price manipulations (at least partly) for drug shortages. Tackling price manipulations was suggested when respondents were asked about potential improvements to the supply chain. The respondents also advocated that drug prices be fixed and not fluctuate thus preventing the NHS from being overcharged. This would in turn eliminate supplier selection issues as suppliers are mainly chosen based on best value for money. It would also stop pharmacies stock piling in the fear prices would be raised again in the near future with drug tariffs being so temperamental (Chopra and Meindl, 2007).

Conclusion

The aim of this study was to explore the vulnerabilities of the pharmaceutical supply chain in the event of a dynamic disruptive activity. This is geared towards developing resilience strategies that will aid in reducing these vulnerabilities thereby mitigating the impact of supply chain disruptions that may occur. The finding from the survey complements the interviews which indicate that dynamic disruptions (medicines shortages) in the UK are the result of: a lack of active ingredients, manufacturing inabilities, monopolistic wholesaler markets, offshore trading, strict regulatory frameworks, lack of information sharing as well as price manipulations for financial gain. The impact of these shortages on patients is significant and it can continue long after the shortage expires. The study also identified the need to develop recovery mechanisms in order to overcome the impact of these disruptive activities.

Reducing bureaucracy, preventing monopolisation of pharmaceutical markets, and training staff to cope with shortages have been recommended as strategies which can curb the impact of these disruptive activities. External associations and governing bodies e.g. MHRA, Department of Health and the Association of the British Pharmaceutical Industry (ABPI), have a key role in developing staff and supply chain resilience in the face of disruptions.

References

- Alexander, C.S. and Becker, H.J., (1978). The use of vignettes in survey research. Public opinion quarterly, 42(1), pp.93-104.
- Berg, A.F., (2017). *What Is Market Manipulation? An Analysis of the Concept in a European and Nordic Context* (Doctoral Dissertation, Det Juridiske Fakultet).
- Blackhurst, J., Rungtusanatham, M. J., Scheibe, K., & Ambulkar, S. (2017). Supply chain vulnerability assessment: A network based visualization and clustering analysis approach. *Journal of Purchasing and Supply Management*.
- Chopra, S. and Meindl, P., 2007. Supply chain management. Strategy, planning & operation. In *Das summa summarum des management* (pp. 265-275). Gabler.
- Christopher, M., 2016. *Logistics & Supply Chain Management*. Pearson UK.
- Christopher, M., & Holweg, M. (2017). Supply Chain 2.0 Revisited: A Framework For Managing Volatility-Induced Risk In The Supply Chain. *International Journal of Physical Distribution & Logistics Management*, *47*(1), 2-17.
- Creswell, J.W., (2013) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* Sage publications
- Elleuch, H., Dafaoui, E., Elmhamedi, A. and Chabchoub, H., (2016). Resilience and Vulnerability in Supply Chain: Literature review. *IFAC-PapersOnLine*, 49(12), pp.1448-1453.
- Fox, E. R., Birt, A., James, K. B., Kokko, H., Salverson, S., & Soflin, D. L. (2009). ASHP Guidelines on Managing Drug Product Shortages in Hospitals and Health Systems. *American Journal of Health-System Pharmacy*, *66*(15), 1399-1406.
- Golicic, S. L., and Davis, D. F. (2012*)* Implementing Mixed Methods Research in Supply Chain Management. *International Journal of Physical Distribution & Logistics Management, 42(8/9), 726-741.*
- Hendricks, K.B., Jacobs, B. and Singhal, V.R., (2017). Stock Market Reaction to Supply Chain Disruptions from the 2011 Great East Japan Earthquake. *Georgia Tech Scheller College of Business Research Paper No. 17-18*
- Hohenstein, N.O., Feisel, E., Hartmann, E. and Giunipero, L., (2015). Research on the Phenomenon of Supply Chain Resilience: A Systematic Review and Paths For Further Investigation. *International Journal of Physical Distribution & Logistics Management*, *45*(1/2), pp.90-117.
- Jüttner, U., and Maklan, S., (2011). Supply Chain Resilience in The Global Financial Crisis: An Empirical Study. *Supply Chain Management*: *An International Journal, 16(4), 246-259.*
- Liu, H., Tian, Z., Huang, A. and Yang, Z., (2018). Analysis of Vulnerabilities In Maritime Supply Chains*. Reliability Engineering & System Safety*, 169, pp.475-484.
- Peck, H., 2005. Drivers Of Supply Chain Vulnerability: An Integrated Framework. *International Journal of Physical Distribution and Logistics Management*, 35(4), pp.210-232.
- Pettit, T.J., Croxton, K.L. and Fiksel, J., 2013. Ensuring Supply Chain Resilience: Development And Implementation Of An Assessment Tool. *Journal of Business Logistics*, 34(1), pp.46-76.
- Purvis, L., Spall, S., Naim, M. and Spiegler, V., 2016. Developing A Resilient Supply Chain Strategy During 'Boom'and 'Bust'. *Production Planning & Control*, *27*(7-8), pp.579-590.
- Riley, J. M., Klein, R., Miller, J., & Sridharan, V. (2016). How Internal Integration, Information Sharing, And Training Affect Supply Chain Risk Management Capabilities. *International Journal of Physical Distribution & Logistics Management*, *46*(10), 953-980.
- Shah, N., (2004). Pharmaceutical Supply Chains: Key Issues And Strategies For Optimisation. *Computers And Chemical Engineering*, 28(6), pp.929-941.
- Sheffi, Y. and Rice Jr, J.B., 2005. A supply chain view of the resilient enterprise. *MIT Sloan Management Review*, *47*(1), p.41.

- Stecke, K.E. and Kumar, S., (2009). Sources of Supply Chain Disruptions, Factors That Breed Vulnerability, and Mitigating Strategies. *Journal of Marketing Channels*, 16(3), Pp.193-226.
- Thekdi, S.A. and Santos, J.R., (2015). Supply Chain Vulnerability Analysis Using Scenario-Based Input-Output Modeling: Application to Port Operations. *Risk Analysis*.
- Thun, J. H., & Hoenig, D. (2011). An Empirical Analysis of Supply Chain Risk Management In The German Automotive Industry. *International Journal Of Production Economics*, *131*(1), 242-249
- Tukamuhabwa, B. R., Stevenson, M., Busby, J., & Zorzini, M. (2015). Supply Chain Resilience: Definition, Review and Theoretical Foundations For Further Study. *International Journal of Production Research*, *53*(18), 5592-5623.
- Wagner, S. M., & Bode, C. (2006). An Empirical Investigation into Supply Chain Vulnerability. *Journal Of Purchasing And Supply Management*, *12*(6), 301-312.
- Wagner, S. M., & Neshat, N. (2010). Assessing the vulnerability of supply chains using graph theory. *International Journal of Production Economics*, *126*(1), 121-129.
- Wagner, S. M., & Neshat, N. (2012). A Comparison of Supply Chain Vulnerability Indices for Different Categories of Firms. *International Journal of Production Research*, *50*(11), 2877-2891.
- Yaroson, E. V., Breen, L., & Matthias, O. (2017). An evaluation of the applicability of complex adaptive system theory in the pharmaceutical supply chain. Proceedings of the 22nd LRN Conference 6th to 8th September 2017 at Southampton Solent University
- Zhang, X., Song, H., & Huang, G. Q. (2009). Tourism Supply Chain Management: A New Research Agenda. *Tourism Management*, *30*(3), 345-358.

WHAT DRIVES A FIRM'S SUSTAINABILITY MANAGEMENT?: DEVELOPING A HOLISTIC MODEL

Nur Fatin Abd Hamid, Ming K. Lim, Devon Barrow and Dong-Wook Kwak
Centre for Business in Society, Coventry University, UK

Introduction

Sustainable management is created based on the current environmental issues which are considered to affect the industry. Companies pursue sustainability management for various reasons, including morality and intergenerational equity, survival and organisation benefits, and risks management. A number of companies have demonstrated the transformations on technologies, products and business model. This transformations happened because companies are aware of their responsibilities towards the triple bottom lines of business.

The concept of sustainability has been acknowledged for many years, but not every individual has a full understanding of it (Whitten, 2013). The sustainability knowledge is crucial to support industries in implementing and managing both forward and reverse flows of materials. Without basic sustainability understanding, company strategies would not work effectively. Developing a fundamental and comprehensive understanding of sustainable management would help managers consider and improve business operations in sustainable ways especially if they are working with a competitive sector like automobile industry. The automobile industry involves a series of complicated supply chains due to its involvement in thousands of components and parts when producing vehicles. Advance technology and innovation enables components and parts to be reused, recycle or remanufacture. These activities are known as reverse logistics (RL).

RL is one of the initiatives to attain sustainability in supply chain management. RL makes a significant contribution to the sustainable initiatives of organisations (Sarkis et al., 2011) because it leads to greener products and products available for recycling or remanufacturing. RL is quite complex in terms of amount of input, quality, types of return and others. Even though RL is complex, it can be a cost centre as well as a sustainability driver to the company if it is appropriately managed.

This study investigates the relationships of the influential sustainability drivers. It focuses on the understanding of practitioners and academics on the fundamentals of implementing sustainability actions. In particular, it highlights how the influential sustainability drivers are interrelated to assist the development of sustainable reverse logistics in the UK automobile sector. The research questions to be addressed in this study are "what are the drivers in sustainability management?' and 'how are these drivers interacting with each other?'. The answer to these questions will cover the grey area between existing and future solutions for reverse supply chains (Bouzon et al., 2015).

The remaining of this paper is organised as follows. Section 2 reviews the literature on the influential sustainability drivers and Section 3 describes the methodology used in this study. The analysis result is presented in Section 4, followed by discussions and conclusion in Section 5.

Overview of sustainability drivers

The modern industrialisation applies sustainable development as strategic plans to address environmental issues. The strategic plans in tackling the environmental issues are essential because they drive the beneficial agenda towards social and economic aspects. As an action to support sustainable development in their supply chains, companies often apply reverse logistics (RL) practices.

Influential drivers are the variables or conditions which comprehensively contribute to the success of the implementation of a strategy or management approaches. This study discusses the critical influential drivers of the sustainability implementation. The categorisation of the drivers is based on the triple bottom line; economic, environmental and social aspects. The selection of the drivers is also based on the notion of reverse logistics, but they might be slightly related with forward logistics. It is because forward logistics notions and techniques play a big role in RL concepts. More specifically, this research reviewed the literature from automobile industry's perspectives. After a thorough literature review, 11 sustainability drivers were emerged as below.

Saving Energy Cost: Energy saving is an efficient way of dealing with the rise of energy prices. Automobile companies must design an efficient cost management strategy to minimise their utility expenses. Volvo implemented a reverse logistics process of salvaging and dismantling cars and generated revenues by selling the used metal, plastics and car parts (Stock et al., 2002). Companies reduce consumption of energy through reverse logistics activities (Marchi and Zanoni, 2017). The function of reverse logistics information system also helps to improve processing efficiency of products return, thus saving the energy and costs on inventory and transportation.

Energy Efficiency Target: An energy efficiency target plan and monitoring the energy performance would help to ensure the constant improvement of energy efficiency (Ngai et al., 2013). This plan brings benefits because it guides company to manage the right collection routes and modes in reverse logistics. Different transportation modes have variations in the total energy consumption.

Material Recyclability Target: Automobile companies committed to increasing the recycle rate for their products (Blanco, 2014). In the UK, 85% of car materials are recyclable. The strategies to reach the maximum recovered rate could be seen in many business plans. For instance, Renault used more than 30% recycled materials in their new vehicles meanwhile Jaguar designed their products to be 95% recoverable and 85% recyclable.

Product Innovation and Development: R&D is essential for companies to strive for upcoming products at the same time meeting the business pressures. Experiments regarding suitable new service technologies have been found such as replacing the small modules with 3D Print. Also, some mechatronic components that are ideal for remanufacturing have been found, such as window lifter, turbo charger and air flow meter.

Enhancement of Sustainability Technology: Companies can enhance sustainability technology as a strategic method to support their contribution to achieving the sustainability agenda (Bhanot et al., 2015). General Motors (GM) simplified its process for returning automotive parts by allowing parts to be returned to a single facility using GM's pre-printed shipping labels (Stock et al., 2002).

Meanwhile, Bosch builds sensors into its power tools that indicate if the motor is worth reconditioning. The sensors reduce inspection and disposition costs hence allowing the company to realise profits on the remanufactured power tools (Guide Jr and Wassenhove, 2002).

Alternative Energy: Due to the rising price of fossil fuels, companies start turning onto alternative energy sources. In Stockham, electric trucks have already been used for a year to collect recycled goods. Substituting diesel with biofuel makes it possible to reduce energy usage and climate change. (Hassan and Kalam, 2013). In the same context, General Motors (GM) and subsidiary GM Ventures installed the solar panel charging canopies at GM facilities and Chevrolet auto dealerships as an action for reduction of electrical energy consumption.

Worker's Health and Safety: Companies are responsible to ensure their workers to be safe and not to be exposed to hazardous materials or chemicals while sorting the returned products. ELV Directive

stated that recovery of batteries requires pre-treatment since it contains hazardous materials which will pollute the environment and cause health and safety problems. Hazardous materials like lead in lead-acid batteries and cadmium in electric vehicle batteries should require special handling and extensive care.

Stakeholder Pressure: The automobile industry is now working on a strategic management, which is based on the sustainable contexts to attract public attentions and to encourage people to put trust on their products. In addition, there are relations between public concerns, companies' R&D and sustainability. The rising stakeholder concerns on sustainability have encouraged companies to enhance their interactions and needs that affect business orientations (Pfeffer, 2005).

Waste Management: Manufacturer produces the highest proportion of waste. Zero Waste concept is applied within the automobile industry. There have been many success stories related to the implementation of Zero Waste. For instance, Toyota Motors North America Inc. declared that it reached near zero waste to landfill.

Emission Target: The entry point of development of green industries and sustainable development is CO2 and another pollutant emission (Wang and Zou, 2015). Air pollution is harmful to people and the environment. EPA put forth an international standard such as ISO14001 to guide companies reduce the greenhouse gas. If companies apply a low-carbon principle, it will help them reduce the emission in a better way. Delivery activities within RL require a proper truck routing to minimise the emission. It is because the increase of transportation kilometres will rise the carbon emission propotionately by up to 65%.

Compliances with Directives and Policies: There are various laws to protect the growing volume estimated car to be scrapped. For instance in China, between 3 to 6 million cars are expected to be scrapped but only 380 thousand units were dismantled for recycling (Yan and Yan, 2009). In the EU, between 7 to 8 million tons of waste generated from End-of-life vehicles (ELV). ELV Directive has been created as an action to tackle this situation. Also many regulations underline sustainability, such as EU Directive (2008/98/EC) and Industrial Emission Directive (2010/75/EU). These types of notable regulations are applied by governments to motivate the public and people in the industry to increase their attentions to the environment.

Methodology

Interpretive Structural Modelling (ISM) is a method which enables individuals or groups to develop graphical demonstration related to a particular problem. Many researchers have applied ISM to sustainability topics. For instance, Thirupathi and Vinodh (2016) used ISM in analysing the sustainable manufacturing factors in Indian automotive component sector. The general process of ISM is described in Figure 1. Details of each step will be discussed in the following section with the results. To fully reflect automobile industry's contexts, practitioners were invited to Step 1 and Step 2 for deciding sustainability drivers and their contextual relationships.

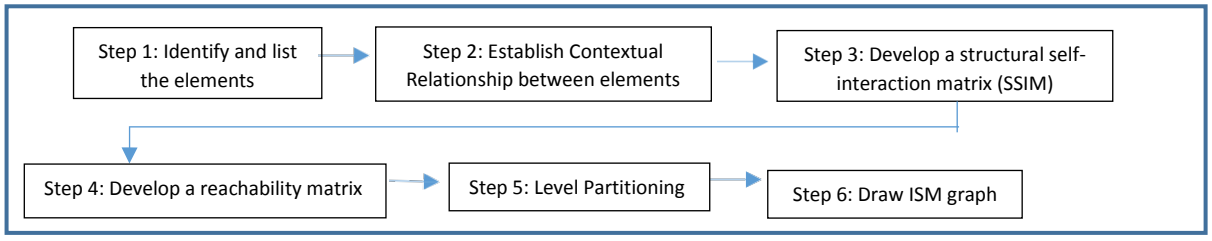


Figure 1: ISM Steps

Results

The results present ISM steps to develop a graphical structural map of the sustainability drivers and highlighting the causal connection between the drivers. It also gives a holistic view of how sustainability drivers influence the implementation of sustainability agenda in the automobile industry.

Step 1: Identifying and listing the elements: A set of sustainability drivers was defined from literature and has been validated by 55 UK automobile practitioners through a questionnaire survey. The validation results are shown in Table 1. It can be seen that Stakeholder Pressure has been rejected. Therefore, it was removed from the list. Meanwhile, there is new driver has been found. Internal Culture was suggested by practitioners as a driver that caused the sustainable management. To avoid rearrangement of the entire list, Internal Culture is replacing Stakeholder Pressure and marked as driver number eight.

	Drivers Title	*Acceptance*	*Rejection*	*Amended*	*Validity*
1	Saving Energy Rate	42	13	2	✓
2	Energy Efficiency Target	40	15	1	✓
3	Material Recyclability Target	40	15	0	✓
4	Product Innovation and Development	35	20	0	✓
5	Enhancement of Sustainability Technology	38	17	0	✓
6	Alternative Energy	33	22	0	✓
7	Worker's Health and Safety	37	18	1	✓
8	Stakeholder Pressure	26	29	0	✗
9	Waste Management	38	17	0	✓
10	Emission Target	40	15	0	✓
11	Compliance with Directives and Policies	44	11	0	✓
*	Additional driver: Internal Culture				✓

Table 1: Sustainability Driver List

Step 2: Establishing Contextual Relationships between Elements: In this step, the contextual type of "leads to" was selected to constraint the relationship to direct effects. The 11 drivers generated 55 questions on pair-wise interrelationships between two elements. In this study, 5 academics were asked to make decisions on the contextual relationships between the sustainability drivers.

***Step 3: Developing a Structural Self-Interaction Matrix (SSIM)*:** The contextual relationships were summarised into a SSIM by assigning one of the four symbols to (*i,j*) entry. The academics were requested to classify the relationships between two sustainability drivers as V (elements i leads to elements j), A (elements j leads to elements i), , X (elements i and j cause each other) or O (elements i and j are not related at all). Table 2 shows the final result of SSIM.

Step 4: Developing a Reachability Matrix (RM): RM is developed from SSIM by filling each (i,j) entry with 1, 0 or 1*. The initial reachability matrix (Table 3) was created by following rules; If the (i,j) entry in the SSIM is V, then the (i,j) in the RM becomes 1 and the (j,i) entry becomes 0. If the (i,j) entry in the SSIM is A, then the (i,j) in the RM becomes 0 and the (j,i) entry becomes 1. If the (i,j) entry in the SSIM is X, then the (i,j) in the RM becomes 1 and the (j,i) entry becomes 1. If the (i,j) entry in the SSIM is O, then the (i,j) in the RM becomes 0 and the (j,i) entry becomes 0. In the final reachability matrix, transitivity (1*) can be checked by considering any indirect relationships among elements (Table 4).

Step 5: Level Partitioning*:* Based on the given final reachability matrix, reachability set, antecedent set and intersection set can be generated as can be seen in Table 5. Reachability set consists of the element itself and other elements which will be driven by the element. The antecedent set consists of the element itself and other elements which affected the element. Intersection set is derived by comparing previous two sets. There are 8 level were found in this study.

Step 6: Drawing an ISM-based Model. A graph was generated by arranging 11 elements according to the partitioned levels and reconnecting those elements to final reachability matrix. There are no transitivity (1*) were taken into account. The ISM analysis demonstrated the most sustainability drivers were interacted with each other except for awareness of emission rate. The compliances with directives and policies occupied at the bottom of the model since it influenced most of the drivers.

j →

i ↓

No	1	2	3	4	5	6	7	8	9	10	11
1		A	V	V	V	V	O	O	V	V	O
2			V	V	V	V	O	O	O	V	A
3				A	A	O	O	A	A	V	A
4					V	V	O	A	V	V	A
5						X	O	X	X	V	A
6							O	O	O	V	A
7								X	O	O	A
8									X	O	A
9										V	A
10											A
11											

Table 2: Structural Self-Interaction Matrix (SSIM)

	1	2	3	4	5	6	7	8	9	10	11
1		0	1	1	1	1	0	0	1	1	0
2	1		1	1	1	1	0	0	0	1	0
3	0	0		0	0	0	0	0	0	1	0
4	0	0	1		1	1	0	0	1	1	0
5	0	0	1	0		1	0	1	1	1	0
6	0	0	0	0	1		0	0	0	1	0
7	0	0	0	0	0	0		1	0	0	0
8	0	0	1	1	1	0	1		1	0	0
9	0	0	1	0	1	0	0	1		1	0
10	0	0	0	0	0	0	0	0	0		0
11	0	1	1	1	1	1	1	1	1	1	

Table 3: Initial Reachability Matrix

	1	2	3	4	5	6	7	8	9	10	11	Driving Power
1	1	0	1	1	1	1	0	1*	1	1	0	8
2	1	1	1	1	1	1	0	1*	1*	1	0	9
3	0	0	1	0	0	0	0	0	0	1	0	2
4	0	0	1	1	1	1	0	1*	1	1	0	7
5	0	0	1	1*	1	1	1*	1	1	1	0	8
6	0	0	1*	0	1	1	0	1*	1*	1	0	6
7	0	0	1*	1*	1*	0	1	1	1*	0	0	6
8	0	0	1	1	1	1*	1	1	1	1*	0	8
9	0	0	1	1*	1	1*	1*	1	1	1	0	8
10	0	0	0	0	0	0	0	0	0	1	0	1
11	0	1	1	1	1	1	1	1	1	1	1	10
Degree of dependence	2	1	10	8	9	8	5	9	9	10	1	

Table 4: Final Reachability Matrix

No	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,3,4,5,6,8,9,10	1,23	1	7
2	1,2,3,4,5,6,8,9,10	1,11	1	7
3	3,10	1,2,3,4,5,6,7,8,9,11	3	2
4	3,4,5,6,8,9,10	1,2,4,5,7,8,9,11	4,5,8,9	5
5	3,4,5,6,7,8,9,10	1,2,4,5,6,7,8,9,11	4,5,6,7,8,9	3
6	3,5,6,8,9,10	1,2,4,5,6,8,9,11	5,6,8,9	4
7	3,4,5,7,8,9	5,7,8,9,11	5,7,8,9	6
8	3,4,5,6,7,8,9,10	1,2,4,5,6,7,8,9,11	4,5,6,7,8	6
9	3,4,5,6,7,8,9,10	1,2,4,5,6,7,8,9,11	4,5,6,7,8,9	3
10	10	1,2,3,4,5,6,8,9,10,11	10	1
11	2,3,4,5,6,7,8,9,10,11	11	11	8

Table 5: Level Partitioning Results

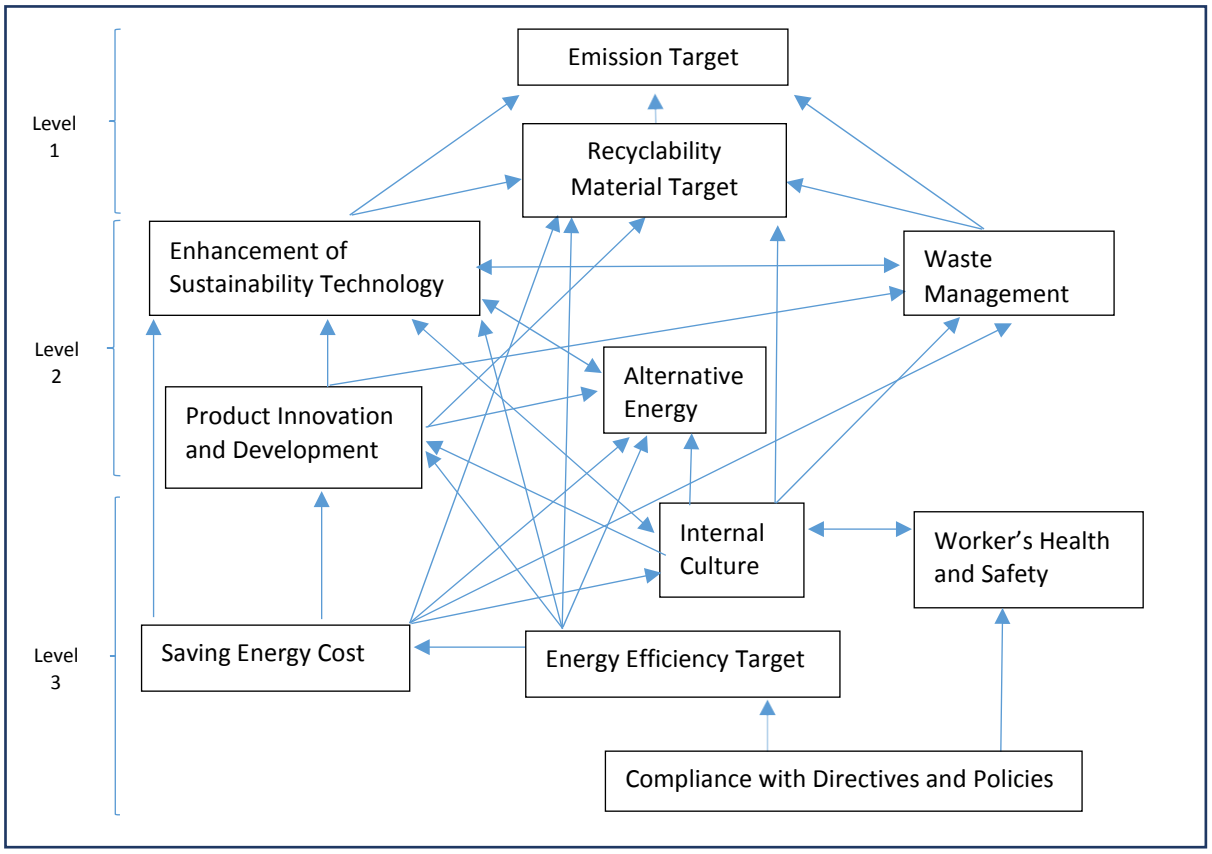


Figure 2: The ISM-based Model of 11 Driver Elements

Discussions and Conclusion

The objective of the ISM in this study is to develop a hierarchy of sustainability drivers that would help in assisting the development of sustainable reverse logistics in the automobile sector. The developed model provides opportunity to understand the sustainable management driver networks. It is clear that identification of drivers is important as it would lead to the highest effectiveness in managing the sustainable management. There were 11 sustainability drivers proposed by literature. It has been validated by practitioners, and then further discussed by academics. This study applied data triangulation to improve the validity and reliability of the research.

The ISM model shows there are three level of sustainability drivers: Level 1-Results Drivers, Level 2-Action Drivers and Level 3-Planning Drivers. The categorisation of these levels are adapted from the fundamental functions of management; planning, organising, leading and controlling. The researchers used these fundamentals to interpret the drivers' levels because the effectiveness of sustainable management implementation can be measured through the level of actions. Company need a proper plan and integrate it with the best actions to achieve the best results (Maheshwari, 2004).

Level 3 consists of the drivers of planning that are related to the internal and external necessities to attain the sustainability. There are five drivers under this level, which are compliance with directives and policies, energy efficiency target, saving energy cost, worker's health and safety and internal culture. Álvarez-Gil et al. (2007) argued that the success of sustainability result is from a combination of external pressures and an organisational factor. Companies are having internal commitments such as requirements for saving the costs and improving the worker' welfare. They are also required to be aware hence taking steps to comply with policies and regulations to show their contributions to sustainability.

Level 2 includes all the activity drivers to support the planning stage. Integrated actions are required to move the sustainability concept along the supply chain to meet the planned expectations (Jedlinski, 2014). There are four drivers are categorised under Level 2; alternative energy, waste management, enhancement of sustainability technology and product innovation and development. Companies use their capabilities to get resource-efficient solutions, effective waste management system and enhance products and technologies to capture the values in business and contribute to sustainability (Kurdve et al., 2015).

Level 1 consists of the two main drivers; emission target and material recyclability target. This level generates insights on how the actions (Level 2) affects the outcome (Level 1) on ISM model. In other words, Level 1 is the consequence of Level 2 and Level 3. For instance, internal culture driver leads (Level 1) the product innovation (Level 2). Then it leads the material recyclability rate (Level 1).
Organisational culture is one of the key areas for effective implementation of innovation (Loewe and Dominiquini, 2006). The continuous process of innovation drives companies' stepping in increasing the product recyclability level (Biddle, 1993).

Emission target is positioned as the top driver on the model. All the causal relationships are pointing to this driver at the end of the network. This is because this driver consists of the highest degree of dependence and emission peaks are the entry points to the sustainability actions (Wang and Zou, 2014). The attribution of this driver is supported by Nishitani et al. (2016) that stated companies are having a better performance if they adopt low-carbon supply chain principle.

Several managerial implications can be drawn from this study. This paper demonstrates a sustainability driver model and applies it to the reverse logistics of the automobile sector. It will encourage practitioners to understand the importance of each driver and to evaluate how core drivers influence their organisations' sustainability practices. Organisations can then develop specific response strategies in relation to these drivers. For future work, this study can be tested in different industries.

References

- Álvarez-Gil, M. J., P. Berrone, F. J. Husillos, and N. Lado. 2007 'Reverse Logistics, Stakeholders' Influence, Organizational Slack, and Managers' Posture'. *Journal of Business Research* 60 (5), pp 463–473.
- Biddle, David (1993) Recycling for Profit: The New Green Business [online] Available at: Frontierhttps://hbr.org/1993/11/recycling-for-profit-the-new-green-business-frontier [11 June 2018].
- Bhanot, N., Rao, P. and Deshmukh, S. (2015). 'Enablers and Barriers of Sustainable Manufacturing: Results from a Survey of Researchers and Industry Professionals'. Procedia CIRP, 29, pp.562-567.
- Blanco, S. (2014). Ford using lots of old recycled materials in new cars. [online] Autoblog. Available at: http://www.autoblog.com/2010/04/20/ford-using-lots-of-old-recycled- materials-in-ne/ [Accessed 11 Jan. 2017].
- A. Bouzon, Mariona., Spricigo, Rodrigo., M.T. Rodriguez, Carlos., A. de Queiroz, Abelardo., and A. Cauchick Miguel , Paulo (2015) 'Reverse logistics drivers: empirical evidence from a case study in an emerging economy'. *Production Planning & Control*, 26(16), pp. 1368-138.
- Guide Jr., Daniel and Wassenhove, Luk (2002) *The Reverse Supply Chain*. England: Harvard Business Review.
- Hassan, M. and Kalam, M. (2013). 'An Overview of Biofuel as a Renewable Energy Source: Development and Challenges'. Procedia Engineering, 56, pp.39-53.
- Jedliński, M. (2014) 'The Position of Green Logistics in Sustainable Development of a Smart Green City'. *Procedia - Social and Behavioral Sciences*, 151, pp.102-111.

- Kurdve, M., Shahbazi, S., Wendin, M., Bengtsson, C. and Wiktorsson, M. (2015) 'Waste flow mapping to improve sustainability of waste management: a case study approach'. *Journal of Cleaner Production* 98, 304-315.
- Lee, K. H.,&Cheong, I.M. (2011) 'Measuring a carbon footprint and environmental practice: the case of Hyundai Motors Co. (HMC)'. *Industrial Management &Data Systems,* 111(6), 961- 978.
- Loewe, P., Dominiquini, J. (2006) 'Overcoming the barriers to effective innovation'. *Strategy and Leadership*, 34(1), pp.24-31.
- Marchi, Beatrice,. and Zanoni, Simone (2017) 'Supply chain management for improved energy efficiency: Review and opportunities', *Energies*, 10(10),pp.1618.
- Maheshwari, R.P (2004) *Principles of Business Studies*, 8edn New Delhi: Pitambar Publishing
- Ngai, E.W.T., Chau, D.C.K., Poon, J.K.L., & To, C.K.M. (2013) 'Energy and utility management maturity model for sustainable manufacturing process'. *International Journal of Production Economics*, 146, pp.453–464.
- Nishitani, K., Kokubu, K., & Kajiwara, T. (2016). 'Does low- carbon supply chain management reduce greenhouse gas emissions more effectively than existing environmental initiatives? An empirical analysis of Japanese manufacturing firms'. Journal of Management Control, 27(1), pp.33–60.
- Pfeffer, J. (2005). 'Producing sustainable competitive advantage through the effective management of people'. *Academy of Management Executive*, 19(4), pp.95-106.
- Sarkis, J., Q. Zhu, and K. H. Lai. 2011. 'An Organizational Theoretic Review of Green Supply Chain Management Literature'. *International Journal of Production Economics*, 130(1), pp.1–15
- Stock, James., Speh, Thomas., and Shear, Herbert. (2002) 'May Happy (Product) Returns'. *Harvard Business Review*, 80(7).
- Thirupathi, R.M. and Vinodh, S. (2016) 'Application of interpretive structural modelling and structural equation modelling for analysis of sustainable manufacturing factors in Indian automotive component sector', *International Journal of Production Research*, 54(22), pp.6661-6682.
- Wang, Yi. and Zou, Le-Le., (2014) 'The economic impact of emission peaking control policies and China's sustainable development' . *Advances in Climate Change Research,* 5, pp162-168.
- Whitten, M. (2013). What does sustainability mean to you?. [Blog] Sustainability at LSE. Available at: http://blogs.lse.ac.uk/sustainability/2013/06/05/definingsustainability/ [Accessed 17 Oct. 2017].
- Yan X, Yan L. (2011) The present development situation and counter measures of waste automobile reverse logistics in China. Log Sci-Tech No.1 [Internet]. Available from: http://en.cnki.com.cn/Article_en/ CJFDTOTAL-LTKJ201101036.htm[12 April 2018].

THE PROMOTION OF INNOVATION IN THE EU MARINE EQUIPMENT SECTOR

Noor Hasanuddin, Sarah Tuck and Saeyeon Roh
University of Plymouth, Plymouth, UK

Introduction

The global shipping industry plays a significant role in international trade and the world economy. In addition to these significant positive contributions, shipping activity have an adverse impact on society and the global environment. The external cost of shipping activities includes, but is not limited to, air pollution, water pollution, oily discharge, garbage disposal and the discharge of biological contaminants present in ballast water. With increased freight volumes being transported over longer distances worldwide, there is a growing awareness of environmental impacts caused by shipping. The release of air pollutants, such as greenhouse gases and a range of noxious gases and particulate matters into the atmosphere, impact human health and the health of the climate. As a result, a number of international maritime regulations have been issued to reduce ship emissions and to improve the overall environmental performance of new and existing ships. Such regulatory and commercial measures taken by regulatory bodies have been claimed to spur the development of green ship technology. This is imperative as innovative marine equipment are needed as part of the solution to curb air pollution.

Review of relevant literature

The International Maritime Organization (IMO) is the regulatory body that establishes international regulations that is applicable to all ships globally. The Organisation has an important role in ensuring that lives at sea are not put at risk and that the environment is not polluted by ships' operations – as summed up in IMO's mission statement: *Safe, Secure and Efficient Shipping on Clean Oceans*. The structure of the IMO consists of a number of main organs that are supported by a number of sub-committees. With regards to environmental matters, the Marine Environment Protection Committee (MEPC) plays the most important role. The Committee is also responsible for promoting the measures for facilitation of enforcement of international marine environment conventions. Other than the IMO, the European Union (EU) is another regulatory body that has its own set of maritime transport policy to govern ships. Most of the maritime transport treaties and conventions are regulated internationally due to the very nature of it being an international mode of transportation. The international treaties and conventions are mostly negotiated and concluded within the IMO.

Air pollution regulation

The air pollution regulation that this paper is based on is with reference to IMO's MARPOL Annex VI which covers regulations for the prevention of air pollution from ships. More specifically, the revisions made to this regulation provides the basis of this paper. The amendments were done with the aim of significantly strengthening the emission limits in light of technological improvements and implementation experience (IMO, 2005). The main amendments made were to progressively reduce the emissions of SOx, NOx and PM globally and the introduction of Emission Control Areas (ECAs). This involves having the maximum global SOx limits to be capped at 0.5 percent by 1 January 2020. The EU has incorporated these rules adopted by the IMO into its own law under Directive 1999/32/EC. Significant revision was done to the Directive due to EU's strategy in reducing atmospheric emissions from seagoing ships. This involves ensuring that ships operating at berth or anchorage in EU ports are using fuels with sulphur content not exceeding 0.1 percent.

In light of these regulations, ship-owners have to implement measures on their fleet to comply. One of the measures ship-owners could implement is by opting for fuel alternatives. There are a few types of fuel alternative that ship-owners could switch to such as low-sulphur fuel (LSF), liquefied natural gas (LNG), methanol and biofuels. Another option is to adopt technological products on their ships.

Technology such as wind turbines, exhaust gas scrubbers and solar panels are such innovative products that ship-owners could retrofit on their fleet.

There are a number of sources available which discussed the issue on how environmental regulation encourage innovations in firms, and on the economic, environmental and health impacts of IMO regulations (European Commission, 2011). These issues had been discussed separately in the past but when it comes to verifying the accuracy of the statements concerning the innovation inducement impact of environmental regulations, examples such as the marine scrubber systems are hardly reviewed. It is therefore important to link these varying strands of research by analysing the literature between the industry and legislative-regulatory sides of the debate in order to lessen the distinct contrast (economy-environment), which exists between these differing strands of thought (Makkonen and Repka, 2016). There are contrasting views with regards to whether stricter air quality regulation would in fact, promote competitiveness amongst firms by the introduction of innovation. In other words, growing environmental legislation and concerns could drive the need to develop and apply innovative alternative power and propulsion technology for ships. Matters pertaining to environmental protection were traditionally viewed by economists and managers to have additional costs imposed on firms, which could possibly diminish their global competitiveness (Ambec *et al.*, 2011). According to Makkonen and Repka (2016), environmental regulations impose heavy costs and slows growth. This therefore hinders national and organisational competitiveness. Environmental taxes, technological standards and tradable emissions permits are examples of regulations that would force firms into allocating certain inputs, such as labour and capital investment, in order to reduce pollution. However, some firms may lack the resources that are required to invest on innovation (EC, 2013). From firms' business viewpoint, allocating the various inputs to reduce pollution were deemed to be unproductive as it diverts capital away from productive investments.

This traditional viewpoint that views environmental regulation as being costly and restricts growth for firms, was challenged notably by Porter (1991). Based on case studies, Porter suggested that pollution was often a waste of resources and that a reduction in pollution could potentially result to improvement in the productivity with which resources were used (Ambec *et al.*, 2011). Having stricter but properly designed environmental regulations could "trigger innovation [broadly defined] that may partially or more than fully offset the costs of complying with them" in some instances (Porter and van der Linde, 1995). In other words, well-designed environmental regulations could possibly lead to a win-win situation in some cases, by not only protecting the environment, but also improving profits and competitiveness through the improvement of the products or their production process, or through enhancement of product quality (Ambec *et al.*, 2011). It is also important to note that the Porter hypothesis does not say that all regulation leads to innovation. It is only those regulations that are well-designed do. This is in line with the growing trend towards performance-based and/or market-based environmental regulations (Ambec *et al.*, 2011). In addition, the Porter hypothesis does not state that this innovation necessarily offsets the cost of regulation. It does however, claim that in most cases these innovations would more than offset the cost of regulation.

Environmental regulations that are already in existence or would be enforced in the future would also have to be considered by firms. This is due to the corporate environmental (and social) responsibility that exists in most firms which promotes the discussion on how the company would provide their products and services in an ethically and environmentally sound performance (Yliskylä-Peuralahti and Gritsenko, 2014). These regulations are expected to lead to health and environmental benefits and more importantly, encourage firms in finding new ways of doing things. Therefore, there is a possibility that environmental regulation would increase the need for higher research and development allocation for new environmentally friendly innovations.

Porter hypothesis therefore raises important questions for policymakers as to how to design and implement policies that would induce environmental innovation and how to protect and diffuse these

innovations among firms (Ambec *et al.*, 2011). A number of studies have been carried out throughout the years to empirically test the statements made by Porter. According to Makkonen and Repka (2016) however, it was found that there is relatively little evidence to support the hypothesis. At the same time, evidence to support the opposite hypothesis of adverse impacts were also found to be insignificant. Therefore, Jaffe, Peterson and Portney (1995) concludes that the true impact of environmental regulation on innovativeness and competitiveness seems to lie in between these two extremes of this economic debate. The conclusion was made after extensive work to validate Porter hypothesis has not produced a consensus.

The shipping industry should not always consider environmental regulations as being a negative factor on productivity at the firm level. Conversely, environmentalist should not regard the shipping industry as being environmentally unconscious. The unwillingness of companies to accept stricter environmental regulations is more due to the fact that in most situations, the costs and benefits are levied on different industries and on different geographical areas, where some face the costs while others enjoy the benefits (Makkonen and Repka, 2016).

According to Lambertini and Tampieri (2012), the reasons companies show resistance towards environmental regulations may be due to the strict timelines imposed or on the method of implementation; when in fact, the companies may choose to 'go green' even without environmental regulations. In order for a successful innovative and environmental future, it is important to investigate on these conceptions. Therefore, it is crucial to have more discussions on how to better encourage environmental innovations with policy instruments (Veugelers, 2012). This should be viewed in a broad scale including not only the policy document itself, but also on the importance of discussion, guidance and meeting in facilitating the acceptance of environmental regulations.

Challenges to meet the stricter regulation

Innovative marine equipment is needed as part of the solution to curb air pollution. The majority of the innovative equipment are now supplied by the marine equipment sector. This sector is responsible for all products and services that are supplied for the building, conversion, maintenance of ships (seagoing and inland) and maritime structures. This includes technical services in the field of engineering, installation and commissioning, and ship maintenance (including repair). In addition, the availability of regulatory or commercial drivers to reduce or prevent air pollution is also important as it will prelude ship-owners from running their ships on low-cost fuels, unless their ships are fitted with abatement technology (such as scrubber units) that would result in lower emission rate. It is therefore important to discover the variables that encourages or restricts innovation in the marine equipment sector, whilst also determining the roles governments and institutional bodies, such as the EU and IMO, can play in supporting this.

As such, there are two research questions that needs to be answered by the end of this study. The first research question is as follows: (1) What impact does the institutional framework of both the EU and the IMO have on innovation in green ship technology in the EU? This question then leads to a second research question: (2) What are the variables that encourage or restrict innovation of green ship technology in the marine equipment sector?

The research work

This research is grounded in the social constructivist paradigm, which emphasises the socially construed nature of reality. This study aims to gain a rich and complex understanding of the research topic and not to obtain information which can be generalised to other larger groups. This research therefore, is inductive in nature which means it is aiming to develop a theory or look for a pattern of meaning from the data that are collected. As this paper is focused on a small and specific case – the drivers of green technology – the qualitative method is adopted. This method is appropriate for this research as it requires a deeper understanding of the problem under investigation. This is in line with

Denscombe (2007) who argues that knowledge generated through qualitative research is embedded in the conditions of social existence. Furthermore, adopting a qualitative research strategy allows for more flexibility in research design and opening up possibilities for using and combining a range of data collection techniques according to the social context in which the data were produced. This includes using interpretivism in this research to add further interpretation and meaning to the quantitative findings. The ambiguities and contradictions surrounding qualitative analysis was also considered. Accordingly, the researcher would be required to demonstrate personal awareness of questions about things, such as the inability of qualitative researchers to verify their truth statements. In addition, there is also the need to reflect on questions of interpretation (Denscombe, 2007) and criticisms about the limitation of findings to the research setting (Greenhalgh, 2006).

Primary data are employed for this paper. This involves the generation of new data set specifically for the research problem at hand. As such, primary data sources can be derived from respondents' analogous situations or experimentations. For this research discussions are limited to respondents' category due to its suitability for the research. Feinberg, Kinnear and Taylor (2012), in situations where a 'study require data about respondents' attitudes, perceptions, motivations, knowledge, and intended behaviour' (p. 66) it is crucial to ask people questions. Taking this into consideration, some of the techniques that are employed in this research includes interviews and questionnaires. Data triangulation is employed for the collection of data. The reason behind employing triangulation lies in the fact that it allows the cross-checking of findings from one method of data collection, with another very different method. This results in a deeper and stronger understanding of the subject being researched. In applying data triangulation in this paper, questionnaires (quantitative) were handed out to gather statistical data about responses, before the findings were cross-checked and researched in greater depth by interviewing (qualitative) selected members of the research sample.

Stage one of the data collection is the research questionnaire. The aim was to gather responses from ship-owners and marine equipment manufacturers on matters related to the global 2020 low sulphur regulation. The set of questionnaires for the ship-owners seeks to investigate the solution or measures that ship-owners has implemented, or will be implementing on ships to meet the regulation. This involves investigating if various factors may impact ship-owners' decision-making process in selecting appropriate measures to meet the regulation. The questionnaire was divided into the following sections covering: (1) sulphur emission control areas; (2) EU Directive 1999/32/EC; (3) possible future ECA; (4) global 0.5 percent sulphur limit implementation date; (5) MARPOL Regulation 14.8 (fuel availability study); (6) sulphur cap deadline of 1 January 2020; (7) retrofitting scrubbers; and (8) solution(s) to meet 2020 regulations. On the other hand, the set of questionnaires for the marine equipment manufacturers seeks to investigate the variables that affects or promotes the level of innovation of green ship technology within the sector. the type of innovation was specifically aimed at offering the market (ship-owners) with technologies to meet the stricter sulphur regulation. The questionnaire was divided into the following sections covering: (1) main product offering; (2) reasons for entering the market; (3) approval/certification process; and (4) factors affecting product innovation.

The second stage of the data collection was to further investigate the drivers for innovation in the marine equipment sector. the data generated from stage one of the data collection was also used as a guide to formulate the questions for the semi-structured interviews. As the focus of this research is in investigating the variables that affects or promotes innovation in the marine equipment sector within the EU, the participants for this stage of the data collection was only aimed at equipment manufacturers. Although participation of ship-owners was not required at this stage, the views and data presented in the questionnaire allowed the researcher to look for relationships between ship-owners and the equipment industry through the semi-structured interviews. This could strengthen the overall study in establishing the roles ship-owners have on innovation levels within the marine equipment sector.

The first step before deciding on the interview questions was to list the topics and issues to be discussed. This was done through brainstorming, reviewing the literature, and listing down key findings from stage one of the data collection. Following that, the general areas for questioning were then organised into order before addressing the wording of the questions. The structure of the interview was divided into the following topics: (1) company's background; (2) drivers of innovation; (3) finance for innovation; and (4) adoption rate of technology.

Results

Results from the ship-owners questionnaire indicates out of the approximately 60 percent of respondents whose fleet are trading in the designated SECAs, almost 85 percent of them were using low sulphur fuel oil to meet the regulation. The majority of these respondents however, were only trading in these areas between 1-15 times as compared to approximately 27 percent who mainly trades within SECAs. Other alternative fuels that ship-owners are using includes gas (19 percent) and biofuels (8 percent). Apart from using alternative fuels, approximately 15 percent of respondents were using scrubbers. 73 percent of respondents whose fleet are trading within SECAs would employ the same solution to comply with the global 0.5 percent sulphur cap coming into effect on 1 January 2020, whilst the rest were undecided.

With regards to the potential of the global sulphur cap regulation being delayed until 2025 based on the fuel availability study, approximately 22 percent of respondent felt that the IMO had not made sufficient efforts to consult with industry players. Overall however, more than 80 percent of respondents felt that they should also have been consulted in the review. Almost 55 percent of respondents would have preferred to have the implementation date put back to 1 January 2025, as compared to just over 27 percent who are against it. Although the study indicated that there is sufficient fuel to meet the demands in 2020, a supplementary study found otherwise. Despite of this, almost 40 percent of respondent indicated that the availability of the required fuel would not have an impact on their decision-making process in using low sulphur fuel as a solution. In contrast, only about 18 percent felt that this would have an impact on their decision. Regardless, more than 46 percent of respondents is making its own efforts to comply with the regulation as compared to 41 percent of respondents who were waiting to see what the industry selects before deciding, and 13 percent who were unsure.

In order to investigate more on the decision-making process involved with using abatement technology, respondents were asked on issues related to retrofitting their fleet with scrubbers. Retrofitting scrubbers meant that ships have to spend time in dry-docks for a period of time. Majority of respondents (53 percent) indicated that this would affect their company's decision-making process in choosing scrubbers. Most of the respondents (31 percent) were also quite concerned with the availability of repair docks as the 2020 deadline nears. Respondents (41 percent) also indicated that they would not pay the minimum to get a scrubber unit but would rather pay more for certainty and quality product (59 percent). Overall, when asked whether their company has chosen a solution to meet the global sulphur regulation, only 31 percent of respondent said 'Yes'. Out of these, more than 80 percent of respondents have opted to use fuel alternative.

As for the equipment manufacturer questionnaire, more than 80 percent of respondents' main product were offered to ship-owners for them to comply with the regulation. When asked on what made their company to enter the market of providing ship-owners with abatement technology, all respondents selected 'Legislations' as being the main reason, and 60 percent of respondent also selected 'Demand from ship-owners' as being a driver. 'Corporate social responsibility' was also a driver for entering the market with 20 percent of the respondents selecting it. Respondents was also asked on the importance of receiving government support before investing in new technology. The average response gathered was that there was some level of importance to be getting government support. Half of the respondents indicated that receiving government support such as incentives and

concessions have a direct impact on the growth of their company in terms of new innovations. However, the other half of respondents indicated it would not affect their company as it is not the government's responsibility to provide support.

Respondents was also asked on whether innovations are capital oriented. The results found that 50 percent of respondents agreed to a large extent with the rest agreeing to different degree of extent. 75 percent of respondents indicated that the availability of capital was affecting their company's investments in new innovations. in order to overcome this barrier, respondents indicated that they were looking at other means to invest in new innovations such as cash reserves (75 percent), cash flow finance (75 percent) joint ventures (50 percent) and partnership (50 percent). In order to investigate market demand as drivers of innovations, respondents were asked to what extent does market demand affect the supply of innovation. 50 percent of respondents indicated 'to a very large extent'. 75 percent of respondents also indicated that market demand for a particular technology would influence their company's decision in entering the market.

The notion of 'corporate social responsibility' as a driver of innovation was also presented to respondents. However, 50 percent of respondents indicated that CSR does not have any influence on the level of innovation within the company. Only 25 percent of respondents indicated CSR to be the general driver of innovation within their company.

With regards to the second stage of the data collection (semi-structured interviews), preliminary results showed that majority of respondents were offering abatement technology to ship-owners as it makes good business sense. Respondents opinions were split when asked about whether regulation from governing bodies affects the level of innovation within companies. One respondent indicated that although policy is really important, it is very slow to materialise. With regards to CSR, majority of respondents mentioned that their company's level of innovation is not defined by their CSR. Respondents also felt receiving government support would encourage companies to invest in new technology. However, as shipping is an international business, there is no government support and there is very little government support in terms of the international governance through the IMO.

Discussion

Based on the results, it was found that majority of respondents were using alternative fuel oil to meet the regulations when trading in the designated SECAs while only a small percentage were using scrubbers. 73 percent of respondents would employ the same solution in meeting the global sulphur regulation. This meant that using alternative fuels are the most preferred option for ship-owners comes 2020. This could be an attractive option for ship-owners as there would be no additional expenses to be incurred with regards to using alternative fuels as compared to installation expenses incurred when opting for scrubbers. Respondents felt that they should have also been consulted in the matter regarding the possibility of having the implementation being pushed back to 1 January 2020 depending on the fuel oil availability study. Majority of respondents preferred to have the implementation date delayed. This would have provided ship-owners with more time to make better judgements on the approach the company is taking in meeting the regulation. However, almost half of the respondents are taking the appropriate measure in ensuring that they comply with the regulation before 2020 instead of waiting to see what the rest of the industry selects. Overall, the approach ship-owners are taking seems to fall more towards using alternative fuels. This is due to ship-owners not incurring additional installation expenses and potential loss of earnings from putting their fleet in dry-docks for retrofitting works to take place. Furthermore, ship-owners were also concerned with the availability of repair docks as they would not want to risk being non-compliance by the time the regulation in enforce. Therefore, all this factors affects the decision-making process of companies in choosing scrubbers.

Equipment manufacturer questionnaire shows that majority of respondents were offering products to ship-owners for them to comply with impending regulations. This would indicate that either ship-owners or regulations from regulatory bodies are what drives the demand for innovative technology. This was further confirmed when respondents were specifically asked about whether regulations and demands from ship-owners encouraged them to offer new technologies. The view of CSR being drivers of innovation however, were not shared among respondents. Only 25 percent felt it to be a driver. This indicates that CSR does not have much influence on the level of innovation within a company. Although legislations and demands from ship-owners are drivers of innovation, equipment manufacturers are still affected by finance to invest in new technology. This is especially true for small and medium enterprise who might not have sufficient funds or easy access to funds to invest further. This is one of the barriers that restricts new innovation from materialising. These companies however, are overcoming the barriers through strategic alliance, cash flow finance, and also through joint venture. With regards to getting government support for their investments, the respondents were split between the support being required and not required. However, half of the respondents indicated that the growth of their company in terms of new innovations would be influenced by receiving support from the government. This includes receiving incentives and concessions from the governments.

Overall preliminary findings from the interviews shows that respondents were offering abatement technology to ship-owners as it makes good business sense. This essentially means that there are considerable demands from the industry for abatement technology, which in turn, is due to the regulations from governing bodies. As such, both market demands and regulations are key drivers for innovation within marine equipment companies. CSR was also found to not have any significant impact on companies to invest in new technology, although CSR is the main drivers for some companies.

Conclusions

In just less than two years' time, the global shipping industry would need to comply with the stricter low sulphur regulation. Although some ship-owners already have measures in place to be complying, others are on a 'waiting game' to see what the rest of the industry selects before deciding. Majority of ship-owners are however, opting for the fuel alternative solution rather than retrofitting their fleet with abatement technologies such as scrubbers. The prospect of incurring additional expenses and putting the ship off-hire are factors that makes adopting scrubbers not an attractive solution. Ship-owners are therefore attracted to fuel alternatives due to its flexibility and simplicity. However, the price of LSF and its availability are factors that ship-owners have to take into consideration as these would have an impact on the overall ship's operation.

Although ship-owners have yet to adopt technological measures by the numbers, equipment manufacturers companies are still offering ship-owners with a number of different products to meet the regulation. This includes the most popular and readily available product – scrubbers, that allows ship-owners to continue burning high sulphur content fuel, to products that harvest the wind such as a Flettner Rotor. This paper has found that regulations from regulatory bodies such as the IMO and the EU does encourage new innovations in firms. Companies are driven by the good business sense to enter the market, where the demands from the market was a direct result from regulations.

As companies are restricted to investing in new innovations as a result of difficulties in access to finance, government could also provide these companies with the required support. Not only would this allow companies to innovate more in green technology, it would also significantly improve human health and health of the environment.

References

- Ambec, S. *et al.* (2011) *The Porter Hypothesis at 20. Can Environmental Regulation Enhance Innovation and Competitiveness?* Washington.
- Denscombe, M. (2007) *The Good Research Guide for Small-Scale Social Research*. 3rd edn. Maidenhead: Open University Press.
- EC (2013) *European Commission Memo: Questions and Answers on Greenhouse Gas Emissions From Shipping*. Brussels.
- European Commission (2011) *Impact Assessment SEC(2011) 918*. Brussels: European Commission
- Feinberg, F. M., Kinnear, T. and Taylor, J. R. (2012) *Modern Marketing Research: Concepts, Methods, and Cases*. 2nd edn. Mason, Ohio: Cengage Learning.
- Greenhalgh, T. (2006) *How to Read A Paper: The Basics of Evidence-Based Medicine*. 3rd edn. Oxford: Blackwell.
- IMO (2005) *Report of the Marine Environment Protection Committee on its Fifty-Third Session*. London
- Jaffe, A. B., Peterson, S. R. and Portney, P. R. (1995) 'Environmental regulation and the competiveness of U.S. manufacturing: What does the evidence tell us?', *Journal of Economic Literature*, 33(1), pp. 132–163.
- Lambertini, L. and Tampieri, A. (2012) 'Vertical differentiation in a Cournot industry: The Porter hypothesis and beyond', *Resource and Energy Economics*, 34(3), pp. 374–380. doi: doi:10.1016/j.reseneeco.2012.03.001.
- Makkonen, T. and Repka, S. (2016) 'The innovation inducement impact of environmental regulations on maritime transport: a literature review', *International Journal of Innovation and Sustainable Development*, 10(1), pp. 69–82.
- Porter, M. E. (1991) 'America's green strategy', *Scientific American*, 264(4), p. 168.
- Porter, M. E. and van der Linde, C. (1995) 'Toward a new conception of the environment-competitiveness relationship', *The Journal of Economic Perspectives*, 9(4), pp. 97–118.
- Veugelers, R. (2012) 'Which policy instruments to induce clean innovating?', *Research Policy*, 41(10), pp. 1770–1778. doi: doi:10.1016/j.respol.2012.06.012.
- Yliskylä-Peuralahti, J. and Gritsenko, D. (2014) 'Binding rules or voluntary actions A conceptual framework for CSR in shipping', *WMU Journal of Maritime Affairs*, 13(2), pp. 251–268. doi: 10.1007/s13437-014-0059-8.

THE IMPACT OF WORKING CAPITAL MANAGEMENT ON FINANCIAL PERFORMANCE: AN EMPIRICAL RESEARCH IN UK FOOD SMEs

Denghao Wei, Michael Bourlakis and Emel Aktas
Cranfield School of Management, Cranfield, Bedfordshire, MK43 0AL, UK

Introduction

The recent economic downturn has brought considerable challenges to businesses, such as insufficient cash and increased costs of corporate borrowing (Gelsomino et al., 2016), which have raised the attention of companies to supply chain finance, especially working capital management (WCM). Compared to large companies, small and medium-sized enterprises (SMEs) are more vulnerable to financial challenges because they have fewer resources by nature and are readily exposed to harsh payment terms proposed by their powerful supply chain partners (Maglaras et al., 2015). Therefore, SMEs should pay attention to the management of their working capital.

On the other hand, WCM is important for SMEs due to their heavy dependence on owners' finances, trade credit and short-term loans (Nobanee and Abraham, 2015). Companies with financial difficulties tend to capitalise on WCM to liberate cash through lowering the overall inventory level, extending trade credit from suppliers and shortening the debtor collection period (Coulibaly et al., 2013). Thus, WCM can be broken down into three components, namely, inventory management, accounts receivable management, and accounts payable management.

WCM can drive the financial performance of companies and achieve a balance between profitability and liquidity (Peel and Wilson, 1996; Welsh and White, 1978), but most relevant studies focus on large organisations and profitability only. Considering the resource scarcity feature of SMEs and the fact that SME owner-managers still plan, monitor, and control their working capital intuitively (Orobia et al., 2013), it is essential to understand the association between WCM and the financial performance of SMEs. Besides profitability, liquidity is also a critical financial dimension for SMEs and is commonly addressed by SME owner-managers in practice because it determines SMEs' survival (LeCornu et al., 1996; McMahon and Stanger, 1995; Patrone and DuBois, 1981). As inventory, accounts receivable and accounts payable can all influence the efficiency of WCM, a clear impact of them on SMEs' financial performance and the priority of them in improving SMEs' financial performance will contribute to the decision-making on resource allocation in SMEs.

The objective of this research is to empirically examine the relationship between WCM and the financial performance of SMEs considering both profitability and liquidity and reveal the priority of three WCM components in driving SMEs' financial performance based on the financial data of UK food SMEs. The UK food industry is adopted as the context of this study due to the significant number of SMEs in this sector. According to Food and Drink Europe (2017), 99.1 per cent of companies in the European food sector are SMEs, employing 62.1 per cent of the workforce in the food industry. In the UK, 94 per cent of businesses in this sector are SMEs (Riley et al., 2016), making it comparable to the European food industry.

The remainder of this paper is structured as follows. Section 2 provides a review of extant literature and develops hypotheses, followed by a description of the methodology adopted. Following the empirical results in Section 4, conclusions are drawn in Section 5.

Literature review and hypotheses development

Working Capital Management

According to the Chartered Institute of Management Accountants (CIMA, 2005), working capital is the fund available for conducting the day-to-day operations of an organisation, normally the excess of current assets over current liabilities. The primary objective of WCM is to ensure that firms have

sufficient cash flows to run daily operations in such a way that minimises the risk of inability to pay short-term liabilities (Şamiloğlu and Akgün, 2016). The cash conversion cycle (CCC) is widely adopted to measure the WCM (Lind et al., 2012), which also indicates the efficiency of WCM as it suggests how quickly current assets are converted into cash (Yazdanfar and Öhman, 2014).

Working Capital Management and Profitability

Despite many studies examining the relationship between WCM and profitability, this relationship is still inconclusive in the literature. It is argued that any change in working capital is associated with both costs and benefits (Baños-Caballero et al., 2012; Tauringana and Afrifa, 2013). Specifically, companies that adopt an aggressive strategy tend to reduce the investment in working capital by reducing inventory levels, decreasing accounts receivable and delaying payment to suppliers (Afrifa, 2016). Inventory reduction leads to improved profitability due to reduced associated costs, such as storage costs and insurance costs (Johnson and Templar, 2011). A reduction in accounts payable also contributes to profitability by liberating cash tie up, which can be invested into products with higher returns (Tauringana and Afrifa, 2013). However, reducing inventory and accounts receivable is also harmful to sales, which deteriorates profitability (Afrifa, 2016; Tauringana and Afrifa, 2013). Additionally, extending trade credit from suppliers also both improves profitability by increasing cash flows and damages profitability due to the loss of discount (Afrifa, 2016; Tauringana and Afrifa, 2013).

By contrast, companies that adopt conservative strategies and increase the investment in working capital are also confronted with both benefits and costs (Afrifa, 2016; Baños-Caballero et al., 2012). On that account, many researchers advocate the concave relationship between CCC and firm profitability, and some studies have empirically verified it (e.g., Afrifa, 2016; Baños-Caballero et al., 2012). The literature also identifies a concave association between the amount of working capital invested and firms' stock performance measured by the market-to-book ratio (e.g., Afrifa et al., 2016; Aktas et al., 2015; Baños-Caballero et al., 2014).

However, most studies support a linear relationship between WCM and profitability, especially in the context of SMEs. Through analysing the extent of the adoption of WCM practices by SMEs in Turkey, Karadağ (2018) posits that all three WCM practices are positively associated with the financial performance of SMEs, while inventory management has the weakest correlation. Based on the financial value chain analysis, Lind et al. (2012) examine the WCM along the automotive value chain and find that the amount of working capital tied up in the value chain negatively affects the profitability of automotive companies. Studies also examine the impact of WCM on SMEs' profitability in different countries, such as Sweden (Yazdanfar and Öhman, 2014), Norway (Lyngstadaas and Berg, 2016), Portugal (Pais and Gama, 2015), and Vietnam (Tran et al., 2017), and they all identify a significantly negative association.

Due to high costs of losing sales and weak supply chain powers, SMEs tend to invest more in working capital than would be appropriate by increasing inventory and accounts receivable. The costs of increasing working capital have exceeded the benefits yielded. In addition, trade credit is one of the most critical sources of funds for SMEs (Nobanee and Abraham, 2015), so improving cash flows by extending accounts payable days contributes to the profitability of SMEs. We therefore hypothesise:

H1. CCC is negatively associated with SMEs' profitability.

H1a. The inventory holding day is negatively associated with SMEs' profitability.

H1b. The accounts receivable day is negatively associated with SMEs' profitability.

H1c. The accounts payable day is positively associated with SMEs' profitability.

Working Capital Management and Liquidity

Businesses usually take advantage of WCM to eliminate the risk of illiquidity, so it is reasonable to contend that WCM can influence the liquidity of companies (Afrifa, 2016; Orobia et al., 2013; Tran et al., 2017). A reduction in inventory and accounts receivable can liberate the cash tied up (Johnson and Templar, 2011; Tauringana and Afrifa, 2013), which improves firms' liquidity. On the other hand, the longer a firm delays its payment to suppliers, the higher the cash flow it reserves (Tauringana and Afrifa, 2013). Based on the data from 5,802 listed SMEs in the US, Nobanee and Abraham (2015) identify a significantly negative relationship between CCC and the liquidity of SMEs. Because there is a simple mathematical relationship between the three components of WCM and the indicators widely adopted to evaluate liquidity (i.e., the current ratio and quick ratio), the relationship between WCM components and liquidity is not examined in this study. Therefore, we hypothesise:

H2. CCC is negatively associated with SMEs' liquidity.

Methodology

Data

The data used in this study were obtained from FAME, a comprehensive and widely used financial database provided by Bureau van Dijk containing over 11 million companies in the UK and Ireland. The definition of SMEs made by the European Commission (2015) was adopted: SMEs are firms that have fewer than 250 employees and annual turnover no more than €50 million or annual balance sheet no more than €43 million.

The UK SIC code was employed to define the industry: UK companies with primary SIC code 03, 10, 11 and most sub-codes under 01 are in the UK food industry. Only food growers (companies that engage in growing crops or raising animals for food consumption) and manufacturers were included in this research, while food wholesalers and retailers were excluded as they normally engage in other industries apart from food, so their financial performance is not influenced by food products only. UK food SMEs that had all required data available in 2016 were eligible for analysis. In total, 717 SMEs in the UK food industry were included in the sample. To avoid the influence of outliers, extreme values were removed from the dataset.

Variables

Return on assets (ROA) is the dependent variable to measure SMEs' profitability, which is calculated as profit or loss before tax/total assets. The liquidity of SMEs is measured by the quick ratio (QR), defined as ((current assets-inventories)/current liabilities). Independent variables include inventory holding days (IHD), calculated as (inventories/turnover×365); accounts receivable days (ARD), calculated as (accounts receivable/turnover×365); accounts payable days (APD), calculated as (accounts payable/turnover×365), and CCC, defined as IHD + ARD - APD.

The control variables considered in this research include firm size (SIZE), measured as the logarithm of total assets; growth in revenue (GRT), calculated as $((Revenue_1\text{-}Revenue_0)/Revenue_0)$; firm age (AGE), which is the number of years that the firm has been operating; firm leverage (LEV), calculated as total liabilities/total assets; current asset ratio (CAR), calculated as currents assets/total assets; current liability ratio (CLR), measured as current liabilities/total liabilities, and supply chain position (SCP), a dummy variable in which food growers are denoted as 0 while manufacturers are assigned with 1.

Estimation

The multiple regression analysis is adopted to analyse data. We specify the following regression models to examine the relationship between WCM and the financial performance of SMEs:

$$\mathrm{ROA}_i = \beta_0 + \beta_1 IHD_i + \beta_2 SIZE_i + \beta_3 GRT_i + \beta_4 AGE_i + \beta_5 LEV_i + \beta_6 CAR_i + \beta_7 CLR_i + \beta_8 SCP_i + \varepsilon_i \quad (1)$$

$$\mathrm{ROA}_i = \beta_0 + \beta_1 ARD_i + \beta_2 SIZE_i + \beta_3 GRT_i + \beta_4 AGE_i + \beta_5 LEV_i + \beta_6 CAR_i + \beta_7 CLR_i + \beta_8 SCP_i + \varepsilon_i \quad (2)$$

$$\mathrm{ROA}_i = \beta_0 + \beta_1 APD_i + \beta_2 SIZE_i + \beta_3 GRT_i + \beta_4 AGE_i + \beta_5 LEV_i + \beta_6 CAR_i + \beta_7 CLR_i + \beta_8 SCP_i + \varepsilon_i \quad (3)$$

$$\mathrm{ROA}_i = \beta_0 + \beta_1 CCC_i + \beta_2 SIZE_i + \beta_3 GRT_i + \beta_4 AGE_i + \beta_5 LEV_i + \beta_6 CAR_i + \beta_7 CLR_i + \beta_8 SCP_i + \varepsilon_i \quad (4)$$

$$\mathrm{QR}_i = \beta_0 + \beta_1 CCC_i + \beta_2 SIZE_i + \beta_3 GRT_i + \beta_4 AGE_i + \beta_5 LEV_i + \beta_6 CAR_i + \beta_7 CLR_i + \beta_8 SCP_i + \varepsilon_i \quad (5)$$

where ROA is return on assets; QR, quick ratio; CCC, cash conversion cycle; IHD, inventory holding days; ARD, accounts receivable days; APR, accounts payable days; SIZE, firm size; GRT, growth in revenue; AGE, firm age; LEV firm leverage; CAR, current asset ratio; CLR, current liability ratio; SCP, supply chain position, and ε is an error term.

Descriptive Statistics

Table 1 presents the descriptive statistics of the variables in the study sample. ROA on average is 8 per cent while the median is 7 per cent, indicating most SMEs in the UK food industry are profitable. Considering the common rule of thumb that companies with a QR greater than 1.0 are able to meet their short-term liabilities (Atrill and McLaney, 2015, p.207), the average QR of 1.53 suggests most sample firms do not have liquidity issues. It takes on average 45 days for UK food SMEs to turn over their inventory, and their ARD and APD are around 45 and 31 days respectively, resulting in an average CCC of approximately 57 days.

Firm size does not differ greatly between firms in the sample, and the average age of sample firms is around 30 years. Their average sales growth is 4 per cent and their mean leverage ratio is 0.24. Their current assets account for on average 58 per cent of their total assets, and 75 per cent of their total liabilities are current liabilities. The mean of the SCP dummy variable is 0.69, indicating that 69 per cent of sample firms are food manufacturers while the rest are food growers.

	Minimum	Maximum	Mean	Median	SD
ROA	-0.48	0.49	0.08	0.07	0.11
QR	0.02	8.88	1.53	1.10	1.39
IHD	0.38	480.26	44.75	28.63	58.02
ARD	0.00	128.72	45.19	43.84	24.81
APD	0.48	92.71	31.12	28.68	16.52
CCC	-45.92	384.41	57.41	46.07	57.55
SIZE	1.60	4.68	4.13	4.20	0.39
GRT	-0.60	1.49	0.04	0.01	0.21
AGE	1.00	120.00	30.41	24.00	23.27
LEV	-0.69	0.98	0.24	0.22	0.28
CAR	0.03	1.00	0.58	0.60	0.24
CLR	0.02	1.00	0.75	0.82	0.23
SCP	0	1	0.69	1.00	0.46

Table 1: Descriptive Results

Results and discussion

Correlation Analysis

Table 2 presents the results of Pearson correlation analysis. It is observed that CCC is significantly and negatively correlated with firm profitability, as measured by ROA. Regarding the components of WCM, both IHD and APD have significantly negative relationships with ROA, while ARD has no significant association with profitability. On the other hand, CCC has no significant correlation with SMEs' liquidity, measured by QR. The significant relationships between IHD, ARD and APD and QR verify the mathematical relationship between them, justifying it does not make sense to examine their relationships in the regression analysis.

	ROA	QR	IHD	ARD	APD	CCC	SIZE	GRT	AGE	LEV	CAR	CLR	SCP
ROA	1												
QR	.228**	1											
IHD	-.173**	-.076*	1										
ARD	-0.004	.096*	0.031	1									
APD	-.225**	-.316**	.076*	.279**	1								
CCC	-.117**	0.065	.857**	.361**	-0.071	1							
SIZE	.143**	-.114**	-.228**	.119**	0.05	-.224**	1						
GRT	0.05	0.031	0.059	0.068	0.045	.085*	-0.052	1					
AGE	-0.073	.241**	.093*	0.036	-.124**	.126**	0.006	-.077*	1				
LEV	0.002	-.310**	-.081*	.091*	.192**	-.084*	.261**	0.045	-.138**	1			
CAR	.243**	.262**	0.005	.243**	-0.025	.108**	.317**	0.017	-.089*	.470**	1		
CLR	0.015	-0.003	-0.026	0.006	0.003	-0.011	.111**	-0.001	0.011	.107**	.090*	1	
SCP	.154**	.103**	-.192**	.216**	-.084*	-.097**	.292**	0.064	-.077*	.186**	.359**	.082*	1

Note: Statistically significance at: **α= 0.01 and *α= 0.05

Table 2: Correlation Matrix

Regression Analysis

The multiple regression analysis was performed via SPSS to test for significant coefficients between the dependent and independent variables (Tran et al., 2017). The results of the regression analysis are presented in Table 3.

The multiple regression results reveal that IHD is negatively associated with ROA with beta1 = -0.16 significant at $p < 0.001$ (model 1), which is consistent with the finding in correlation analysis, so the hypothesis H1a is supported. Although the model explains only 11.1 per cent of the variation in profitability, the relatively low adjusted R^2 is common in similar previous studies (e.g., Afrifa, 2016; Tauringana and Afrifa, 2013). The results of model 2 show that ARD has a significantly negative relationship with ROA at the alpha = 5 per cent level, so H1b is supported, while H1c is not supported because APD is significantly and negatively associated with ROA (model 3). Model 4 reveals that as the proxy of WCM, CCC is negatively associated with ROA at the 0.1 level of significance, suggesting SMEs can improve their profitability through decreasing the amount of working capital tied up, so H1 is supported. The robustness of findings regarding profitability (model 1 to model 4) was examined by regressing another representative profitability indicator return on equity (ROE) on the same independent and control variables, and the same findings were obtained.

Although possessing more inventory and providing additional trade credit to customers can potentially increase sales (Pais and Gama, 2015), the costs associated exceed the benefits yielded, resulting in a low profitability. Therefore, to increase profitability, SME owner-managers are encouraged to hold fewer inventories and shorten the ARD. The significantly negative association between APD and profitability identified is consistent with the findings of Lyngstadaas and Berg (2016), Pais and Gama

(2015), Tauringana and Afrifa (2013) and Tran et al. (2017). One possible explanation for the negative relationship is as follows: because of the difficulty in accessing external financing, SMEs are inclined to overly extend their payable days, which is harmful to the relationship with their suppliers and further their profitability. On the other hand, SMEs can obtain discount if they speed up the payment to suppliers (Deloof, 2003).

Dimension	Profitability	Profitability	Profitability	Profitability	Liquidity
Model	Model 1	Model 2	Model 3	Model 4	Model 5
Dependent Variable	ROA	ROA	ROA	ROA	QR
IHD	-.160***				
ARD		-.079*			
APD			-.213***		
CCC				-.145***	-.128***
SIZE	.043	.102**	.115**	.043	-.204***
GRT	.072*	.048	.052	.073*	.062*
AGE	-.052	-.051	-.081*	.050	.248***
LEV	-.201***	-.172***	-.115**	-.207***	-.531***
CAR	.300***	.282***	.236***	.312***	.603***
CLR	-.012	-.011	-.014	-.011	.013
SCP	.043	.069	.036	.056	.059
F	11.731	9.532	13.464	11.117	58.574
R^2	.121	.101	.136	.116	.410
Adjusted R^2	.111	.090	.126	.106	.403

Note: Statistically significance at: ***α= 0.001, **α= 0.01, and *α= 0.05

Table 3: Regression Analysis Results

Among the three WCM components, APD has the strongest correlation with ROA, followed by IHD and ARD. Therefore, to improve profitability through WCM, SME owner-managers should pay the most attention to accounts payable management by shortening their APD, followed by inventory management and accounts receivable management. Regarding the liquidity performance, the results of model 5 show that CCC has a significantly negative relationship with QR at the 0.1 per cent level, so H2 is supported. This model explains 40.3 per cent of the variability in liquidity. As a result, through shortening CCC by reducing the amount of working capital tied up, SME owner-managers can improve the liquidity of their firms.

In control variables, LEV has significantly negative relationships with both profitability and liquidity, indicating that SMEs should minimise the scale of their liabilities to enhance their financial performance. By contrast, CAR is significantly and positively associated with both profitability and liquidity, which implies that SMEs can improve their financial performance by increasing the proportion of current assets in total assets. There is evidence that SIZE and GRT have a positive association with firm profitability, but it is not significant in every model. On the other hand, SIZE is significantly and negatively associated with liquidity while GRT has a significantly positive relationship with liquidity. The association between AGE and profitability is inconclusive in the results, while the relationship between AGE and liquidity is significantly positive, suggesting that the longer the company has been operating, the fewer liquidity problems it will have. However, neither CLR nor SCP has a significant relationship with profitability or liquidity.

Conclusions

As an important source of financing, working capital is critical for the survival and success of SMEs, which are usually financially constrained. Therefore, it is essential to understand the association

between WCM and the financial performance of SMEs with considering both profitability and liquidity. Based on the multiple regression analysis of data from 717 SMEs in the UK food industry in 2016, this study reveals that CCC is negatively associated with both profitability and liquidity of SMEs, suggesting that the efficient WCM through reducing the amount of working capital tied up helps improve the financial performance of SMEs. Furthermore, all three working capital components – IHD, ARD and APD have significantly negative relationships with the profitability of SMEs, while APD has the strongest correlation. Therefore, to improve profitability through WCM, SME owner-managers should pay the most attention to accounts payable management by shortening their APD, followed by inventory management and accounts receivable management.

This study contributes to both financial management and supply chain management by revealing the criticality of WCM in driving the financial performance of SMEs. Considering the scarcity of resources in SMEs, a better understanding of the impact of WCM on firm financial performance and the importance rankings of three components of WCM assists SME owner-managers in making more informed decisions on resource allocation.

As the sample consists of SMEs in the UK food industry only, the generalisability of findings in this paper to other countries or industries may be limited. Future research is suggested to replicate this study in other countries and industries. Instead of analysing cross-sectional data, further research can focus on panel data, which allows for the control of unobservable heterogeneity and the exclusion of biases deriving from the existence of individual effects (Afrifa et al., 2016).

References

- Afrifa, G.A. (2016), "Net working capital, cash flow and performance of UK SMEs", *Review of Accounting and Finance*, Vol. 15, No. 1, pp. 21–44.
- Afrifa, G.A., Tauringana, V. and Tingbani, I. (2016), "Working capital management and performance of listed SMEs", *Journal of Small Business and Entrepreneurship*, Vol. 27, No. 6, pp. 557–578.
- Aktas, N., Croci, E. and Petmezas, D. (2015), "Is working capital management value-enhancing? Evidence from firm performance and investments", *Journal of Corporate Finance*, Vol. 30, pp. 98–113.
- Atrill, P. and McLaney, E. (2015), *Accounting and Finance: For Non-Specialists*, 9th ed., Pearson, Harlow.
- Baños-Caballero, S., García-Teruel, P.J. and Martínez-Solano, P. (2012), "How does working capital management affect the profitability of Spanish SMEs?", *Small Business Economics*, Vol. 39, No. 2, pp. 517–529.
- Baños-Caballero, S., García-Teruel, P.J. and Martínez-Solano, P. (2014), "Working capital management, corporate performance, and financial constraints", *Journal of Business Research*, Vol. 67, No. 3, pp. 332–338.
- CIMA (2005), *CIMA Official Terminology*, CIMA, Oxford.
- Coulibaly, B., Sapriza, H. and Zlate, A. (2013), "Financial frictions, trade credit, and the 2008–09 global financial crisis", *International Review of Economics and Finance*, Vol. 26, pp. 25–38.
- Deloof, M. (2003), "Does working capital management affect profitability of Belgian firms?", *Journal of Business Finance and Accounting*, Vol. 30, No. 3–4, pp. 573–587.
- European Commission (2015), *User Guide to the SME Definition*, *User Guide to the SME Definition*, Publication Office of the European Union, Luxembourg, available at: https://doi.org/10.2873/782201 (Accessed: 1 June 2018).
- Food and Drink Europe (2017), *Data & Trends: EU Food and Drink Industry*, Brussels, available at: http://www.fooddrinkeurope.eu/uploads/publications_documents/DataandTrends_Report_2017.pdf (Accessed: 1 June 2018).

- Gelsomino, L.M., Mangiaracina, R., Perego, A. and Tumino, A. (2016), "Supply chain finance: A literature review", *International Journal of Physical Distribution and Logistics Management*, Vol. 46, No. 4, pp. 348–366.
- Johnson, M. and Templar, S. (2011), "The relationships between supply chain and firm performance: The development and testing of a unified proxy", *International Journal of Physical Distribution and Logistics Management*, Vol. 41, No. 2, pp. 88–103.
- Karadağ, H. (2018), "Cash, receivables and inventory management practices in small enterprises: Their associations with financial performance and competitiveness", *Small Enterprise Research*, Vol. 25, No. 1, pp. 69–89.
- LeCornu, M.R., McMahon, R.G.P., Forsaith, D.M. and Stanger, A.M.J. (1996), "The small enterprise financial objective function", *Journal of Small Business Management*, Vol. 34, No. 3, pp. 1–14.
- Lind, L., Pirttilä, M., Viskari, S., Schupp, F. and Kärri, T. (2012), "Working capital management in the automotive industry: Financial value chain analysis", *Journal of Purchasing and Supply Management*, Vol. 18, No. 2, pp. 92–100.
- Lyngstadaas, H. and Berg, T. (2016), "Working capital management: evidence from Norway", *International Journal of Managerial Finance*, Vol. 12, No. 3, pp. 295–313.
- Maglaras, G., Bourlakis, M. and Fotopoulos, C. (2015), "Power-imbalanced relationships in the dyadic food chain: An empirical investigation of retailers' commercial practices with suppliers", *Industrial Marketing Management*, Vol. 48, pp. 187–201.
- McMahon, R.G.P. and Stanger, A.M.J. (1995), "Understanding the small enterprise financial objective function", *Entrepreneurship: Theory and Practice*, Vol. 19, No. 4, pp. 21–39.
- Nobanee, H. and Abraham, J. (2015), "Current assets management of small enterprises", *Journal of Economic Studies*, Vol. 42, No. 4, pp. 549–560.
- Orobia, L.A., Byabashaija, W., Munene, J.C., Sejjaaka, S.K. and Musinguzi, D. (2013), "How do small business owners manage working capital in an emerging economy?", *Qualitative Research in Accounting and Management*, Vol. 10, No. 2, pp. 127–143.
- Pais, M.A. and Gama, P.M. (2015), "Working capital management and SMEs profitability: Portuguese evidence", *International Journal of Managerial Finance*, Vol. 11, No. 3, pp. 341–358.
- Patrone, F.L. and DuBois, D. (1981), "Financial ratio analysis for the small business", *Journal of Small Business Management*, Vol. 19, No. 1, pp. 35–40.
- Peel, M.J. and Wilson, N. (1996), "Working capital and financial management practices in the small firm sector", *International Small Business Journal*, Vol. 14, No. 2, pp. 52–68.
- Riley, L., Rumsey, J., Worth, I., Lee, D. and Scaife, A. (2016), *Food Statistics Pocketbook 2016*, Department for Environment, Food & Rural Affairs, York, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/608426/foodpocketbook-2016report-rev-12apr17.pdf (Accessed: 1 June 2018).
- Şamiloğlu, F. and Akgün, A.İ. (2016), "The relationship between working capital management and profitability: Evidence from Turkey", *Business and Economics Research Journal*, Vol. 7, No. 2, pp. 1–14.
- Tauringana, V. and Afrifa, G.A. (2013), "The relative importance of working capital management and its components to SMEs' profitability", *Journal of Small Business and Enterprise Development*, Vol. 20, No. 3, pp. 453–469.
- Tran, H., Abbott, M. and Jin Yap, C. (2017), "How does working capital management affect the profitability of Vietnamese small- and medium-sized enterprises?", *Journal of Small Business and Enterprise Development*, Vol. 24, No. 1, pp. 2–11.
- Welsh, J.A. and White, J.F. (1978), "Return on investment...or liquidity? A manager's dilemma", *Journal of Small Business Management*, Vol. 16, No. 2, pp. 14–21.
- Yazdanfar, D. and Öhman, P. (2014), "The impact of cash conversion cycle on firm profitability: An empirical study based on Swedish data", *International Journal of Managerial Finance*, Vol. 10, No. 4, pp. 442–452.

INFORMATION TECHNOLOGY AND A DIGITAL DIVIDE IN SUPPLY CHAINS: PERSPECTIVES OF THE UK SMEs

Witold Bahr and Ed Sweeney
Aston Logistics and Systems Institute, Aston University, Birmingham, UK

Abstract

Purpose: The purpose of this paper is to generate deep insights into the role that information technology plays in supply chains of small and medium enterprises (SMEs). There is significant evidence of a digital divide in this area between large and medium/small companies as evidenced by Evangelista et al. (2013), who studied technology adoption among SME logistics providers in Italy and concluded that few adopt formal management of technology and lack any significant investments in this area. Moreover, SMEs are not benefiting fully from technology based supply chain integration due to lack of technological skills among their workforce.

Research Approach: A largely qualitative study which involves in depth interviews with SME managers from two manufacturers, two third party logistics providers (3PLs), and two retailers from the United Kingdom. This interview protocol is a refined replication of methodology found in Lummus et al. (2001).

Findings and originality: The findings suggest that, while SMEs recognise a positive link between information technology and supply chain integration, there is room for improvement in this area and SMEs could benefit from more guidance on selecting appropriate technologies to suit their needs.

Research impact: Although this study is limited to perspectives of UK SMEs from manufacturing, logistics providers, and retail sectors, the selected sample of companies handles a wide variety of product groups thus enabling the authors to generate a breadth of perspectives.

Practical impact: A profile of perspectives of UK SMEs in relation to information technology and existence of a digital divide in supply chains is presented.

Keywords: Information Technology, Supply Chain, Integration, SME

EXPLORING THE INFLUENCE OF INSTITUTIONAL FORCES AND COMPANY STRATEGY ON SUSTAINABLE SUPPLY CHAIN MANAGEMENT PRACTICE IMPLEMENTATION: EMPIRICAL EVIDENCE FROM CHINA

Haiyan Lu[1], Andrew Potter[2], Donna Marshall[3], Helen Walker[2] and Vasco Sanches Rodrigues[2]
[1]University of Plymouth, UK
[2]Cardiff University, UK
[3]University College Dublin, Ireland

Research background

From a historical perspective, the environmental and sustainable agenda has been shaped by the great waves of public pressure since 1960 (Elkington, 1994). Sustainability is one key area in which to explore why and how supply networks are influenced by institutional pressures and stakeholder expectations (Carter and Easton, 2011). Prominent studies have addressed the impact of stakeholders on organisations' adoption and dissemination of environmental and social practices (Wolf, 2014; Varsei and Polyakovskiy, 2017). For example, Mani and Gunasekaran (2018) discussed the power of regulatory compliance to determine the extent to which a company practices SSCM. More generally, within the current literature, institutional forces are identified as the prime driver of SSCM (Sarkis, 2011; Touboulic and Walker, 2015).

Due to institutional forces, companies adjust their company strategies and implement and report economic, environmental and social sustainability performance to both internal and external stakeholders.

However, an 'organization's sustainability initiatives and its corporate strategy must be closely interwoven' (Carter and Rogers 2008, p. 367). Therefore, another precursor to the implementation of SSCM practices is company strategy. This requires a company to be proactive and adjust its business model and adopt environmental and social SSCM practices (Pagell et al., 2009). For this research, we use the Reactive-Defensive-Accommodative-Proactive (RDAP) Scale developed by Clarkson (1995).
Even though the current literature has made significant contributions to the understanding of the literature on SSCM, research on organisational practices considering both external pressure and company strategy is still limited. To address the specific research gap, this study aims to answer the research question: ***how do companies address institutional forces using their company strategy and how does this impact the implementation of SSCM practices?***

Institutional theory (DiMaggio and Powell, 1983; Bhakoo and Choi, 2013) and company strategy (Clarkson, 1995) are analysed in this study to help understand how and when organisations implement SSCM practices. Institutional theory states that organisational processes are institutionalised via consistent adaptation (Colwell and Joshi, 2013). These adaptive processes explain why organizations, on one hand, attempt to customise niche markets to gain competitive advantage, while on the other hand they gradually approach to organizational homogeneity toward government and regulatory norms (Kauppi, 2013; Dubey et al., 2015). Besides, company strategy nuances organisation practices in sustainability according to stakeholder pressures with balance of company capability and operational issues to solve with.

Research method

Given that different industries have various ways to implement SSCM practices (Easton, 2011), a focus on exemplars will allow for a reliable comparison across different sectors. Exemplars are organisations that are well ahead of their industry on either environmental and/or social performance. Multiple-case sampling was chosen as the most appropriate method to understand the complexity of the phenomenon and purposive sampling led to the focus on three specific supply networks (e.g. Walker et al., 2011; Pagell and Wu, 2009; Lazzarini et al. 2001).

This study used supply networks in the automotive, food, and beverage industries in China. 16 companies participated, framing 3 supply networks. Multiple sources of data were collected, included semi-structured interview, factory site visits, observation and documentation, in order to give a comprehensive view of each case. Pattern coding and theoretical coding methods were applied to control researchers' biases (Miles and Huberman, 1994). All materials were coded and analysed in Nvivo 11.

Findings and analysis

Observation showed that coercive isomorphism was the dominant driver for SSCM implementation, meanwhile firms react on normative and mimetic isomorphism according to their company strategies. Examples of company strategy and the relative action were given in Table 1. Details in each case are explained afterward. In addition, reactive strategy was barely indicated from the participants to deny SSCM responsibility.

Table 1: Strategy type, actions and examples

Strategy Type	Actions	Case Examples
Defensive	Admit responsibility but fight it	Observation in the factory contradicted the participants' claim that the employees were required to use masks and gloves in production (Plating B)
Accommodative	Accept responsibility	'In fact, our business are in international standards after joining the WTO….' (Carton Package)
Proactive	Anticipate responsibility	'I provide and tell them (the farmers) how to use the seeds and pesticides […] In the long-term, as long as they planted them, I have to buy the vegetable, at least I have a reserve price for them' (Vegetable Trader)

Table 1: Strategy type, actions and examples

Automotive

Coercive isomorphism and company strategy Automotive companies emphasise coercive isomorphisms (see Figure 1 below).

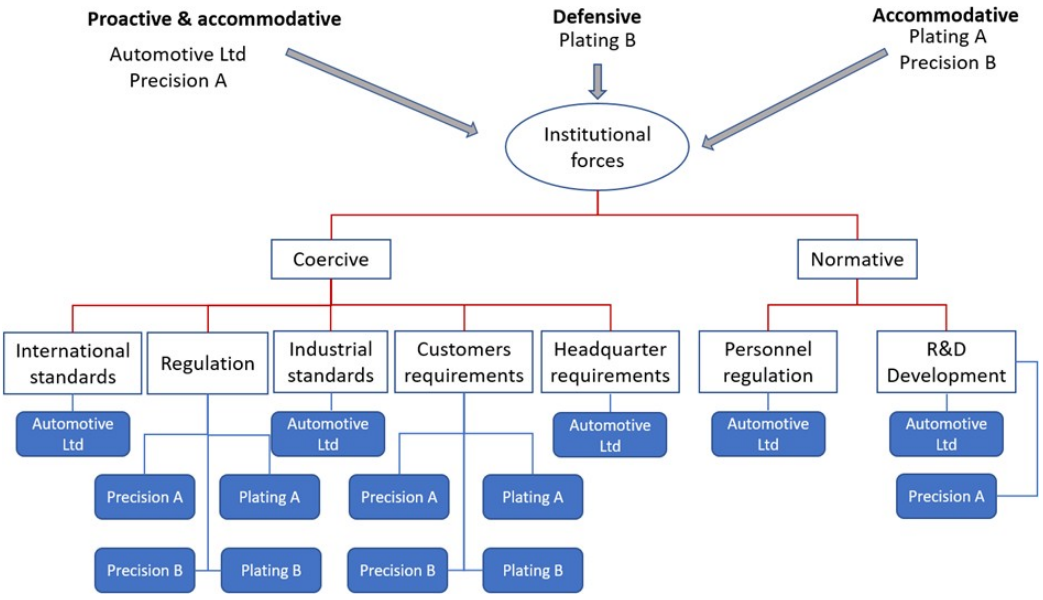


Figure 1: Forces and strategies in the sequential network

The primary reason for this is the focal company, Automotive Ltd, is foreign-owned and headquartered in Germany. In other words, coercive pressure is mainly from international regulations and industrial

standards. Automotive Ltd participants stated: *'Germany has a guiding program for specific approaches. Such as requiring use of a yellow line for any pedestrian region, but where to set up the yellow line is according to the actual situation of the factory.'* There is some degree of localisation, however, the headquarters have a guiding programme and standardised operation systems. For example, requests for RoHS and REACH compliance to address sustainable impact on both human health and the environment. Therefore, Automotive Ltd ensures compliance from its suppliers for environmental responsibility. '*Social responsibility is also in the corresponding codes, but only when customers require will we then ask for compliance from our suppliers'*, stated the Automotive Ltd quality control manager. As well as standardised compliance, the headquarters list the '*must-have*' facilities for employees: in addition to the yellow lines there must be a designated area for casual interaction and on the back of each door in the washroom, a picture is presented to remind employees to drink sufficient water.

Coercive pressures for companies Plating A, Plating B, Precision A, Precision B are mainly from government regulations and customer requirements. However, different company strategies moderate the impact of institutional forces on SSCM practice implementation (Figure 1).

In the sequential network, a typical proactive company is Precision A. They stated: '*for prime customers, it is very important for their corporate image. They have an annual review which includes the quality system review and reviews for environmental and CSR implementation*'. However, pressures from local government are not a major concern: '*It is more customer-driven and environment-driven because all our customers are high-end, and the products are exported to Europe. Each year we have to meet the declaration […] keeping pace is sustainability.*' For Precision A, being at the forefront of their industry is exhibited through implementing SSCM practices. Not only do they comply with customer requirements, but they also introduce new products to customers; for example, Precision A convinced their customers to use spray-free paint for products, in order to reduce environmental impacts as well as avoid damage to human health from chemical toxins, such as formaldehyde and p-Xylene.

Companies that adopt an accommodative strategy accept institutional forces and implement SSCM practices as required by regulations or contract terms, however, actions are remained in required standards; moreover, success is measured by meeting the highest level of requirements. Managers in Plating A explained that their implementation of ISO14001 and TS16949 is not because of customer requirements, but mainly '*due to the development of the enterprise to some extent. If you want to continue to develop, you have to meet international and industry standards*.'

Plating B adopted a defensive strategy towards institutional forces. Walker et al. (2008) suggested that some companies do not comply with institutional regulation, but implement environmental practices for cost-saving purposes. This was observed in Plating B. Even though managers stated positive attitudes towards national regulation and industrial requirements for environmental and social SSCM practice implementation, the company paid most attention to recycling as the raw materials are valuable commodities: silver and gold. '*The annual recycling amount is more than 100 kilograms … if not recycled, it would be wasted.*' However, in terms of environmental issues, such as water discharge and gas disposal, the company relies solely on central processing within the manufacturing area. ISO 14001 standards are not adopted by the company because they are not required from customers. They update their ISO 9000 certificate every two years purely for quality control reasons. They also claimed that workers must wear masks and earplugs during production, however, observation within the manufacturing facility did not corroborate their statement. Employees were surrounded by gas and noise pollution without any visible protection.

Mimetic isomorphism and company strategy No mimetic isomorphism was found in this case. The reason could be that SSCM standards and regulation has been developed well in automotive industry, which has been strictly followed by companies and implied in their corporate code of conducts.

Another reason could because of the exemplar nature of Automotive Ltd., who are leaders in SSCM practice implementation in the automotive industry. According to the manager in the Automotive Ltd, the headquarter has a guiding programme and standardised operation systems for the Chinese plant, including the SSCM certification and implementation.

Normative isomorphism and company strategy There is no evidence of normative pressures influencing defensive companies. This is not surprising since these companies are doing the least required rather than actively dealing with environmental and social issues.

However, companies with a hybrid accommodative and proactive strategies endeavour to improve both social and environmental SSCM practice implementation. For example, Automotive Ltd accommodative their environmental sustainability by establishing company regulations in a specific Environment Health and Safety (EHS) function, which is responsible for dealing with the company's internal health, safety and environmental issues. Engineers are responsible for conducting special management approaches for dangerous operations. Meanwhile, the company proactively reacts on normative isomorphism. As specified in the EHS statement, all employees benefit from the same type of health insurance and annual health check, regardless of their positions, in consideration of human health and equity. Similarly, Plating A company holds a hybrid strategy: a combination of accommodative and proactive strategies, in their SSCM practice implementation. In terms of environmental practices, the company follows international standards and believes these are higher than national standards. Therefore, they obtain international certificates, such as RoHS, REACH and TS 16949, to meet customer requirements. The company also applies a recycling policy. Similarly, in their social practices, the company is proactive and doing more than required. Not only do they adhere to Chinese labour laws, but they also offer various compensation schemes to employees: when they get married, when family members suffer serious illnesses or pass away, when giving birth, and on Children's Day.

Proactive organizations, such as Precision A, established a research and development (R&D) centre to invest in environmentally-friendly solutions for their product range. At the same time, they try to increase their professionalisation of the field by sending representatives from the R&D centre to participate in relevant seminars each year.

Food case

Coercive isomorphism and company strategy With regard to companies in the food industry, coerciveisomorphism is the major institutional force for driving firms' implementation of SSCM practice implementation (see Figure 2 below), which is consistent with previous studies (Carter and Easten, 2011; Touboulic and Walker, 2015; Varsei et al., 2014).

However, this industry is unusual as there is a lack of standardisation in both regulations and industry standards. Under this circumstance, accommodative firms implied regulation, industrial standards and customers requirement to comply SSCM implementation. However, for companies including the Restaurant Owners, Food processor and Vegetable Ltd that adopted a hybrid of proactive and accommodative strategy, they believed that: '*This is the problem with our laws and regulations […] when cooperatives have spent money but no one does anything [the authority does not regulate and there are no clearly set standards for environmental and social practices] … [so we] cannot achieve the desired goals*'. This has resulted in SSCM practice inconsistencies and coordination difficulties throughout the industry. In this case, for companies with accommodative strategies or a hybrid strategy, including Vegetable Ltd, Carton Packaging, Food Processor, Restaurants Owner and IT provider, the levels of their SSCM practice implementation are relatively low compared with the automotive and beverage sectors.

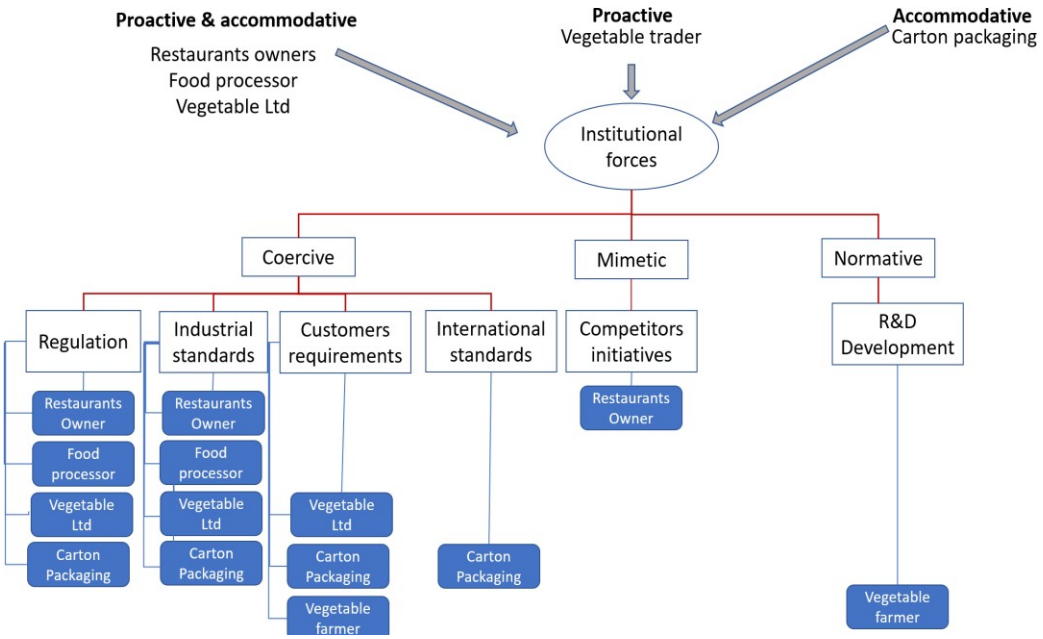


Figure 2: Forces and strategies in the reciprocal network

Mimetic isomorphism and company strategy Restaurants Owner experienced a high level of mimetic isomorphism because of its competitors, such as McDonald's, who they benchmark against in terms of SSCM practices. For example, Restaurants Owner has a proactive strategy for food quality and security. One manager emphasised the supply of hygienic food by adopting the 5S – sort, set in order, shine, standardize and sustain in production throughout their restaurant chain.

Normative isomorphism and company strategy Surprisingly, Vegetable Trader, who directly trade vegetables from farm to Vegetable Ltd, is the only player with a proactive strategy. Not only have they established long-term relationships with the farmers but they also gave environmentally-friendly seeds to farmers to avoid land pollution. Professional and technical staff were also invited to observe and measure whether the land was suitable for farming and with which crops. Vegetable Trader then assigned work according to each farmers' decision regarding they type and quantity of crops, matching the farmers' working capabilities with their expectation. Furthermore, Vegetable Trader has implemented social SSCM practices by guaranteeing a minimum price for all products the farmers have produced. Farmers are considered as vulnerable both to natural disasters, such as typhoons in the summer, when many vegetables are damaged; or when there is overproduction. Vegetable Trader stated: '*It is difficult for the farmers to pay for the loss and uncertainty, so I guarantee a minimum price for the vegetables, whether they are damaged or overproduced, as long as the farmers work closely with me*'.

Beverage Industry

Coercive isomorphism and company strategy Coercive isomorphism is the primary factor for implementing SSCM in the beverage industry. In this industry, domestic companies primarily react to national regulations (see Figure 3 below).For example, firms acting proactively to regulations, such as the focal firm Beverage A, set up a legal department to interpret and discuss government regulations and policies. Sugar Processor, which conducts business internationally, stated that requirements from customers are increasingly rising. In this example, Sugar Processor provided non-negotiable environmental guidelines and customers used authorised third parties to evaluate performance each year. SSCM should be planned strategically. Sugar Trader stated: '*the sustainability and implementation strategy should be set before we start our business activities; otherwise, we will be ruled out*'.

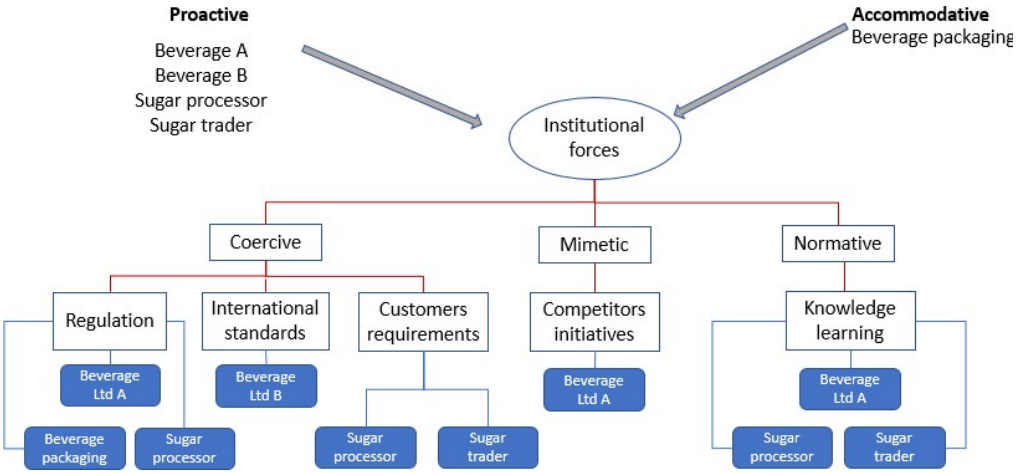


Figure 3: Forces and strategies in the pooled network

Mimetic isomorphisms and company strategy For proactive firms, not only suppliers comply SSCM corporate code of conducts because of coercive isomorphism, but suppliers copy customers and that customers show by setting a good example mimetic force. For Beverage A, Sugar Processor and Sugar Trader, mimetic isomorphisms are essential for guiding environmental and social SSCM practice implementation. Sustainability was '*a company-wide strategy*', not for an individual department or a company. For Beverage A, even though they have a strong market position as a domestic firm, there is substantial competition from international brands. Therefore, environmental issues, such as measuring and assessing chemical composition, are critical before procuring raw materials. The companies are also continually learning and imitating SSCM practice implementation from their competitors.

Normative isomorphisms and company strategy Good practices from customers set benchmarks for proactive suppliers entailing professional skills to implement SSCM for proactive suppliers, shown in the Beverage A, Sugar Processor and Sugar Trader. These companies have also recruited professional staff or external bodies to collect market information and develop their SSCM practices, to enhance company competitiveness. Sugar Processor has also published a sustainability report in order to show transparency and professionalism in their SSCM practices.

Beverage B, the second focal firm, is an international company with well-developed environmental and social SSCM practices. The company has balanced the three institutional pressures with a proactive strategy for sustainable practices with an emphasis on normative isomorphism to maintain their leading position in the market. Being a global leader, the company has applied considerable energy to implementing SSCM practices. An annual report was published to indicate their efforts. As a pioneer in promoting sustainability, the company not only implements environmental SSCM practices, such as reducing usage of electricity and water throughout their supply chain, but also promotes social SSCM practices, by community involvement in raising awareness of how to live a 'Healthy Life'. Beverage B organised charitable outdoor activities in more than 30 cities throughout their supply chain in China; donating clean water for areas in drought and; training employees to lecture as volunteer teachers in impoverished areas. Brand image and corporate reputation are of such importance that the company employed an engineering company to help design and meet the requirements from EHS security.

Discussion and conclusion

Aligning with current literature (Beamon, 1999; Green et al., 1996; Zhu et al., 2005; Walker et al., 2008), this study found that government regulation and customers requirement are the major forces for companies to comply with environmental and social demands. Industry standards also required supply chain actors to carry out audits and gain certifications (Hassini et al., 2012). However, coercive regulatory forces only drive SSCM practice implementation when government leadership and regulation are well developed, as in the automotive industry. In contrast, food companies face

obstacles when implementing SSCM due to a lack of industry standards and government regulation in China. Even though China's food safety regulatory system has experienced major changes over the past 50 years, there remain areas of inconsistencies within the National Food Control Systems and robustness of food safety standards (Zhang et al., 2018). Thereby, for companies adopting accommodative or defensive strategies, the implementation of environmental and social sustainability needs further address on environmental issues and health risk reduction.

Normative and mimetic isomorphisms make up for the regulatory shortfall guiding SSCM practice implementation, which is driven by company's strategy. Company strategy impacts the effect of institutional forces by influencing how companies act when faced with coercive, mimetic or normative isomorphisms. Proactive food and beverage companies invested in professional learning and imitating competitors and customers to gain competitive advantage instead of responding to regulatory needs. Actors in these cases, worked together for information and knowledge sharing for social and environmental practices, joint R&D and integrated production processes for reducing environmental impacts. It is an integrated and collaborative processes to develop intra- and inter-firm capabilities to implement SSCM (Luzzini et al., 2015).

Besides, company can employ a hybrid strategy to SSCM depending on institutional force and internal capabilities. In food and beverage firms, financial factors and company image are the primary considerations for SSCM implementation, thereby companies accommodate regulation and customer's requirement for complying with environmental sustainability. However, for social sustainability where institutional legitimacy has not yet covered, proactive firms make efforts to satisfy employees, suppliers, farmers and the communities where their business operate. 'Doing the right thing' seems to be embraced as the business ethics for considering the development for next generation.

As a conclusion, this study investigates the interaction of institutional force and company strategy and their impact on SSCM. It is rather complex where dynamic situations have been discussed in the automotive, food and beverage cases. The novelty of this research emphases on the consideration not only about external forces but also internal capabilities when implementing environmental and social sustainability in supply chains. The research also shows the evidence when company strategy complements institutional shortfall for SSCM implementation.

Selected key References

- Beske P., Land A. and Seuring S. (2013), Sustainable supply chain management practices and dynamic capabilities in the food industry: A critical analysis of the literature, *International Journal of Production Economics*, 152, pp.131-143.
- Carter, C. R. and Liane Easton, P. (2011), Sustainable supply chain management: evolution and future directions, *International Journal of Physical Distribution & Logistics Management*, 41, pp. 46–62.
- Clarkson, M. E. (1995), A Stakeholder framework for analysing and evaluating corporate social performance, *Academy of Management Review*, 20, pp. 92–117.
- DiMaggio J. P. and Powell W. W. (1983), The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48, 147-160.
- Glover, J. L., Champion, D., Daniels, K. J. and Dainty, A. J. D. (2014) An Institutional Theory perspective on sustainable practices across the dairy supply chain, *International Journal of Production Economics*, 152, pp. 102–111.
- Luzzini D., Brandon-Jones E., Brandon-Jones A., and Spina G. (2015), From sustainability commitment to performance: The role of intra-and inter-firm collaborative capabilities in the upstream supply chain, *International Journal of Production Economics*, 165, pp.51-63.
- Roth A. V., Tsay A. A., Pullman M. and Gray J. V. (2008), Unravelling the food supply chain: Strategic insights from China and the 2007 recall, *Journal of Supply Chain Management*, 44, pp. 22- 38.

- Sarkis, J., Zhu, Q. and Lai, K. H. (2011), An organizational theoretic review of green supply chain management literature, International Journal of Production Economics. Elsevier, 130, pp. 1–15.
- Varsei, M. and Polyakovskiy, S. (2017) Sustainable supply chain network design: A case of the wine industry in Australi, Omega, 66, pp. 236–247.
- Zhang Z., Godefroy B.S., Lyu H., Sun B., Fan Y. (2018), Transformation of China's food safety standard setting system – Review of 50 years of change, opportunities and challenges ahead, *Food Control*, 93, pp.106-111.

THINKING THROUGH THE PLATFORM'S ROLE AS A TOOL FOR SUPPLIER NETWORK MANAGEMENT

Kai Häkkinen[1], Outi Kettunen[1], Kari-Pekka Pitkänen[2] and Merja Airola[1]
[1]Technical Research Centre of Finland, VTT, Finland
[2]Roima Intelligence Inc., Finland

Introduction and motivation

Our motivation to write this paper is based on VTT's R&D work with its customers, especially the Roima Intelligence Inc. (https://roimaint.com/), which is developing their future software applications for their product portfolio. The platform-based business models and applications are one of the most interesting and promising development areas today.

Internet with related technologies and applications has very quickly entered the global market. Mobile technology has rabidly changed people's way of life. There are lot of different social media platforms available for people and companies, which can be operated by different APIs[1] and equipment remotely or locally. Many kinds of platforms have been on the market for more than 20 years. For example, Amazon.com was established 1994.[2] Different kinds of market places are on the market today and they are becoming more and more popular among people and companies. Quite a new phenomenon is the sharing economy (SE), which has attracted a great deal of attention in recent years. The sharing economy is already transforming many sectors, including accommodation, skills and transport. It is spreading across new sectors, including food, fashion and consumer electronics, and changing the way businesses work with each other.[3] Table 1 illustrates some examples of the Sharing Economy platforms:[4]

Hospitality and Dining	CouchSurfing, Airbnb, Feastly, LeftoverSwap
Automotive and Transportation	RelayRides, Hitch, Uber, Lyft, Getaround, Sidecar
Retail and Consumer Goods	Neighborgoods, SnapGoods, Poshmark, Tradesy
Media and Entertainment	Amazon Family Library, Wix, Spotify, SoundCloud, Earbits

Table 1: Different kind of Sharing Economy platforms

Development of the industry-related platforms are at the very beginning phase. In this paper, we concentrate on platform ideas for supplier network management.

Industry-related platforms

There are a number of different classifications of the industry-related platforms. Based on many sources and discussions, we created the following classification in Table 2.

According to Sean T. Monahan, the hot term today is "The Rise of Supply Chain Platforms".[5] He says that platforms create synergies in two ways. First, platforms provide users with sets of standardised tools and processes. Second, platforms allow users to create and harness mutual synergy from one another.

[1] API = Application Programming Interface
[2] See https://en.wikipedia.org/wiki/Amazon.com
[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378291/bis-14-1227-unlocking-the-sharing-economy-an-independent-review.pdf
[4] https://www.pwc.com/us/en/technology/publications/assets/pwc-consumer-intelligence-series-the-sharing-economy.pdf
[5] https://supply-chain.cioreview.com/cxoinsight/the-rise-of-supply-chain-platforms-nid-9907-cid-78.html

Type of the platform	Meaning	Commercial examples
Collaboration platforms	Platforms for online collaboration between people and teams.	ProofHQ, Wrike, 9teams, Wrike, Zoho Docs, Tallium, Sharepoint
Communication platforms	Information sharing, negotiations, discussions and discussion libraries.	Evernote Business, Slack, Basecamp, Yammer, Office365, Glip, Skype, GoToMeeting, TeamViewer
Content-sharing platforms	Content sharing between people and companies	Dropbox, Microsoft OneDrive, GoogleDrive
Project management platforms	Project management and coordination between companies.	Clarizen, Workfront, dapulse
ERP - portals	Extensions of companies' ERP systems to distribute information to their business partners.	SAP, Microsoft Dynamics AX, IFS, Oracle Fusion, Epicor
Unclassified SCM-applications	Applications for SCM and content sharing.	Jakamo, HGI, Team Center Supplier Integration, Plex

Table 2: Supplier network-related platform types.

One of the important papers is Accenture's description of Platform-Driven Business models (Accenture 2016). They say that by embracing the transformational power of platforms, enterprises across all industries are capturing new growth opportunities and changing the way they do business. And it's these new business models and the ecosystems being built around them that are driving the most profound change in the global macroeconomic environment since the Industrial Revolution.

Communication in practice today

Communication and Information flows are the most important issues when managing everyday business. Communication is needed inside every company and between every company to manage and synchronise the manufacturing and logistics operations with related activities.

There are many different communication methods in use. Some of them are: 1) phone, 2) email, 3) SMS messages, 4) social media, 5) extranet, 6) visits, 7) meetings, 8) Skype meetings, 9) video meetings, 10) collaboration platforms and 11) traditional post.

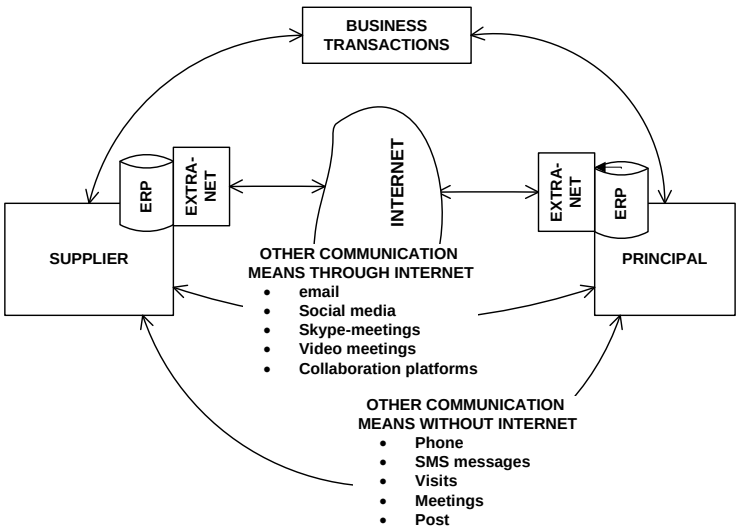


Figure 2: Communication between companies

The everyday way to communicate between companies is the extranet[6] (Figure 2), which is widely used in industry. It is a website which allows controlled access to partners, vendors and suppliers or an authorised set of customers. It is normally used for a subset of the information accessible from an organisation's ERP.

Additionally, there are many people in every company communicating with each other across companies. These companies are very often located in different countries, which means that there are several different concept systems due to the different languages and cultures.

The communication system today is very complex. However, due to the versatile collection of communication methods, it is always easy to find one which is specifically suited to a certain communication situation. Requirements for the future platforms are very demanding and probably not easy to meet.

Theoretical viewpoints

In order to get a more general view to the supplier network management phenomenon, we take a transaction cost theory as a base for our thinking.

This chapter is mainly based on the author's dissertation (Häkkinen 2008).

As Williamson (1985 p. 2 -19) says, the transaction cost approach maintains that economic institutions have the main purpose and effect of economising on transaction costs. Transaction costs are the "costs of running the economic system". Such costs are to be distinguished from production costs. He compares transaction costs to the friction in a mechanical system in which transaction costs are the economic equivalent of friction in a physical system.

The most important dimensions of transactions may be identified as:

1) Complexity, 2) frequency of occurrence, 3) duration or continuity, 4) uncertainty, 5) measurement and monitoring features and 6) implications for interlinked transactions.

Rao (2003) continues; among these, some features run in parallel: asymmetric information and incomplete specifications of transactions and their commitment implications. The sources of transaction costs between seller and buyer are illustrated in Figure 3 (Häkkinen 2008). In order to draw

Figure 3, there is a concept of "Communication solution". "Communication solution" means all of the resources and information usage related to the transaction in question.

Figure 3 illustrates the sources of transaction costs between seller and buyer. The dimensions of transaction are closely connected to the transaction. Their existence and nature determine the design of the communication solution. The second critical gate is the "quality of information" between parties. If the quality of information is symmetrical and all of the specifics during the transaction are perfect, the transaction costs are low. In the opposite case, they are high.

The second path to generate transaction costs is based on the bounded rationality, opportunism and asset specificity needed. These three sources can be seen as largely independent of the sources which are based on the dimensions of the transaction.

Transaction costs are dependent on the nature of the transaction. In the case of subcontract manufacture, we can find many kinds of cases, from simple to very complicated ones.

[6] See https://en.wikipedia.org/wiki/Extranet

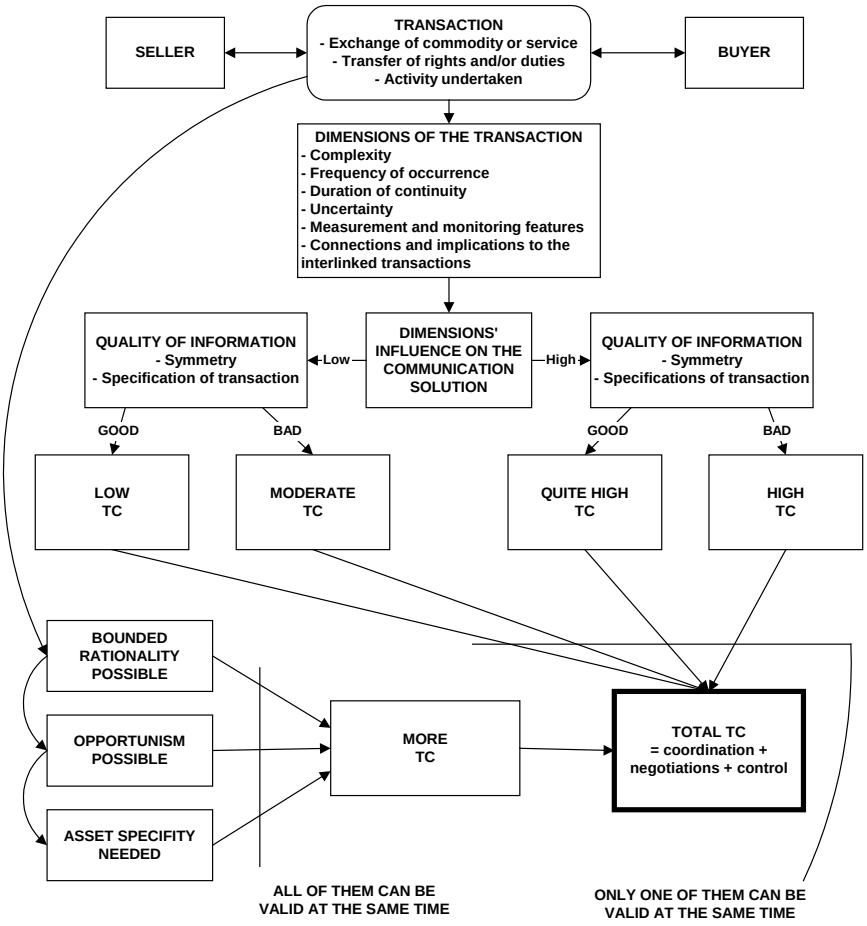


Figure 3: Sources of transaction costs between seller and buyer (Häkkinen 2008).

We think that the transaction cost view is the most valuable when designing the supply chain system. Manufacturing costs in the manufacturing companies are what they are. They are independent of the supply chain system binding the business partners together. A certain amount of the transaction costs is needed. Otherwise, there is no business at all. The challenge is to find the optimum level of the transaction costs. In this paper, the idea is that the collaboration platform could make the communication more effective and in so doing, decrease the transaction costs (Table 3).

Transaction cost sources	**How the communication platform can support TC decrease (a very tentative list of issues)**
Quality of the information symmetry	Platform can be a centralised information storage, where all the business partners can find needed up-to-date information anytime and anywhere.
Quality of the specification of transaction	Platform can give good support for every kind of document changes and in doing so, maintain correct information everywhere.
Bounded rationality	Platform can be an “extension of the human brain”. It can store many things in the memory and it may help to solve problems by using different kinds of algorithms.
Opportunism	Platform may have some kind of programmed mechanisms to control people and company operations to prevent opportunism.
Asset specificity	Platform may have some applications to control the usage of certain investments and other assets.

Table 3: Transaction cost sources

Collaboration processes in the supplier network management

We use the following collaboration processes between suppliers and principals (Häkkinen 2008) as a framework for this paper (Table 4):

Collaboration process	Short explanation
Supplier / principal selecting process	Companies try to seek best possible business partners.
Concurrent engineering process	Both of the business partners are willing to collaborate in the product design phase.
Quality assurance process	Principal's market put certain product-related quality pressures, which flow to the suppliers' operation.
Logistics process	All the physical facilities needed to stock, transport and manage the material flow from the supplier's plant to the principal's address including the order-delivery process.
Manufacturing planning and control process	Balancing both parties' manufacturing capacities with each other.
Financial process	All the money-related activities as invoicing and funding of investments and stocks.
Contract and order process	The six previous processes have an influence on the product cost and price.
Management of the processes above	Many changes happen all the time and both business parties' operations need continuous adjustments based on mutual planning and decision making.

Table 4: Collaboration processes between suppliers and principals (Häkkinen 2008)

All of these processes in Table 4 require considerable information flow to be managed successfully. These processes are the activities that produce a specific output of value to the customer. According to Cooper et al. (1997), the communication system is a key to success. The kind of information passed among the business partners and the frequency of information updating has a strong influence on the efficiency of the supply chain.

Platform based collaboration model

Figure 4 illustrates the future platform-based operation model in supplier network management. It is an imagination of the possible future collaboration model.

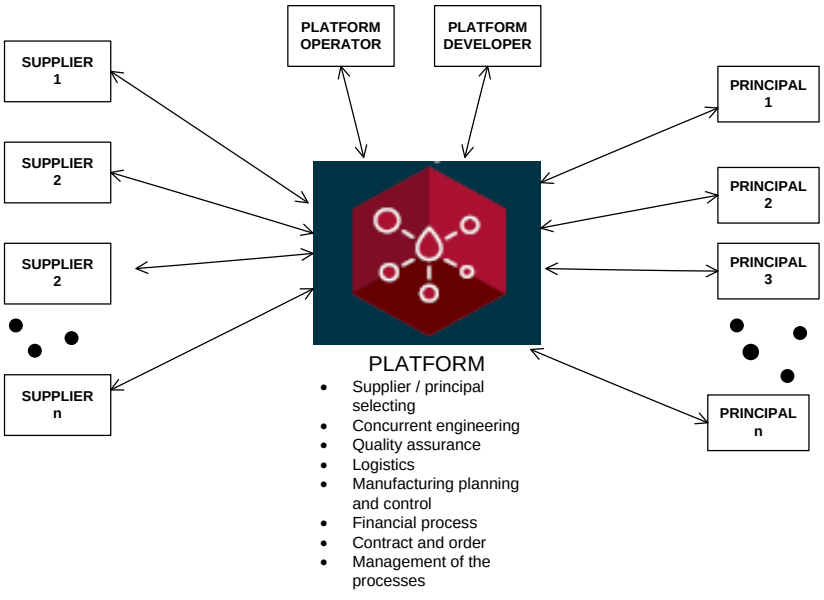


Figure 4: Platform-based operation model

The model in Figure 4 seems to be simple, but there are a number of open questions concerning the model. Some of the practical questions are:

- Who are the platform operator and platform developer?
- How is security and data integrity managed?
- Can the platform eliminate companies' extranet and possible other applications?
- How is the data movement between the companies' ERP thought to be?
- What kind of functionality does the platform have (data transfer, data storage, information creation, intelligence, etc.)
- Is it possible that the platform can help managers make better business decisions?
- How are the technical questions managed?
- Is the platform based on open or closed architecture?

Those open practical questions are only a small set of possible problems. And so the platform idea offers a very interesting area for academics and practitioners.

Thinking through the possible R&D issues

The different kinds of information flows between business partners need to be discovered. These information flows are the main base for platform conceptualisation. Some of the possible research issues could be:

- What are the possible use cases to be supported by the platform?
- What kind of APIs and equipment are used in every use case?
- What amongst the information flows are suitable for the platform?
- What kind of intelligence could the platform have?
- Is there a possibility to create a new kind of supplier selection method by using the platform?
- Is it possible for the new supplier candidates to join the game?
- Are there new kinds of possibilities for the companies to increase joint development collaboration?

Transaction theory is a strong basis for future research. Distinguishing the transaction costs and production costs form each other is important. Because of the globally distributed production networks, the management of the transaction costs is becoming an increasingly more important issue. That is why we think that transaction cost theory-based cost calculation models need to be developed for the networked operation model.

Finally

There is a gap in the scientific discussion in this area. The platform idea is quite new in supplier network management and so it needs more academic attention. The practitioners have only limited opportunities to develop platform-based operation models without academic research.

In practice, we can imagine very many new operation models, but they are only products of our imaginations. After the real pilot cases, there is more evidence to see the real possibilities of the platform models.

The traditional Supply Chain Management concept is possibly reaching the next development stage. There is an adage "Supply chains compete, not companies",[7] which needs to be analysed and challenged more in the future. The platform idea may mean a new kind of supply chain configuration and dynamics between business partners.

[7] E.g http://www.martin-christopher.info/publications/logistics-and-supply-chain-management

References

- Accenture Technology Vision 2016, https://www.accenture.com/t20160804T100550__w__/us-en/_acnmedia/Accenture/Omobono/TechnologyVision/pdf/Technology-Trends-Technology-Vision-2016.pdf#zoom=50
- Cooper, M., C., Lambert, D., M., Pagh, J., D. (1997), ' *Supply Chain Management: More Than a New Name for Logistics*', International Journal of Logistics Management, Vol. 8 (1), pp. 1-14.
- Gonzales-Benito, J. (2002), 'Effect of the characteristics of the purchased products in JIT purchasing implementation'*, International Journal of Operations & Production Management*, Vol. 22 (8), pp. 868–886.
- Häkkinen, K. (2008), 'Managerial approach to subcontract manufacture co-operation in the metal industry', VTT Publications 676/2008. 131 p. Dissertation. http://www.vtt.fi/inf/pdf/publications/2008/P676.pdf
- Kraljic P. (1983), 'Purchasing Must Become Supply Management', *Harvard Business Review*, September/October, pp. 109–17.
- Rao, P., K. (2003), 'The Economics of Transaction Costs; Theory. Methods and Applications'. New York: Palgrave Macmillan, 197 p.
- Svenson, A. L. (1968), 'Subcontracting and Management of 1970's', *Journal of Purchasing*, Nov, pp. 13–22.
- Williamson, O. E. (1985), 'The economic institutions of capitalism', The Free Press. 450 p.

CAN SUPPLY CHAIN COOPETITION ENABLE SMALL ENTERPRISES TO COMPETE WITH LARGE ENTERPRISES AND MEET CONTEMPORARY CHALLENGES: EVIDENCE FROM THE IRISH WHISKY SECTOR

Janet Kavanagh[1] **and Nikolaos Valantasis-Kanellos**[2]
[1]*Lily O'Briens Chocolates, Green Rd. Newbridge, Co. Kildare, Ireland*
[2]*National Institute for Transport and Logistics, Dublin Institute of Technology, D01 K822, Dublin, Ireland*

Introduction

Recognising that there are higher levels of knowledge and expertise in established Irish Whiskey companies, Bord-Bia (the Irish Food Board) suggests co-opetition as a strategy to support sectoral growth. They state that large enterprises (LE) should support smaller whiskey producers with adverse business challenges (e.g. limited access to capital, resource shortages), as it is in their best interest to secure sectoral growth (Bord-Bia, 2013). To support this vision, the Alcohol Beverage Federation of Ireland (ABFI) introduced a Mentor Program to address sector issues and support knowledge-sharing (ABFI, 2016). Given the substantial success and market share held by Scotch Whisky, this research aims to discover if there are opportunities to gain competitive advantages for the Irish Whiskey sector through Supply Chain Collaboration (SCC) and Co-opetition. To achieve this aim, this paper critically evaluates how Supply Chain Management (SCM) is applied within the Irish Whisky sector and explores the possible effects of SCC and the use of shared services to create a positive impact on the outputs of the sector. The application of a SCM lens demonstrates the benefits to be gained and the contextual adaptation of the "Buy-Make-Move-Store-Sell" framework identifies how competitive advantage can be improved.

Literature review

It is well known that SCM can be used to leverage the inherent knowledge of customers and suppliers to drive competitiveness (Fawcett et al. 2008). Adding to this, Simatupang and Sridharan (2015) and Lambert and Enz (2017) argue that SCM enables organisations to move beyond reducing costs and increasing asset utilisation, to achieve differentiation and competitive advantage by closely managing relationships with key customers and suppliers and creating customer value. Through collaboration organisations can create mutually beneficial relationships. These relationships are reciprocal in nature, interdependent, based on a long-term view, and can be instrumental in igniting new growth (Littunen, 2000). SCC extends to relationships internally to breakdown functional barriers and align objectives holistically. Each element of the "Buy-Make-Move-Store-Sell" system contains opportunities to strengthen SC links to ensure it is stronger than competitors' SCs. The integration of the relationships along the "Buy-Make-Move-Store-Sell" system in the distribution channel from supplier to customer forms the philosophy of successful SCM (Sweeney et al., 2007, Braziotis et al., 2013).

As research and practice expand our knowledge, it is evident that management is far more complex than it was at the century's turn. Organisational growth, changes in the trading environment, and technological advances have added complexity, people and intense competition on an international level. With these dynamics at play it is unrealistic to expect longevity or sustainable profits from traditional managerial practices (Cao and Zhang, 2011). SCM provides a framework to engage and drive each SC element (internally and externally) to share knowledge and collaborate, to increase profits, drive economic growth, and mitigate market risks. Within the Irish Whiskey sector, the evaluation of SCM implementation, collaboration and co-opetition is relevant to each individual company, but as the industry has a collective aim it is also relevant to how the industry behaves as a holistic unit in supporting growth through collaboration and knowledge sharing.

SCC has been established as a philosophy with proven best practice processes to create agility, reduce costs and create a source of additional knowledge (Soosay et al., 2008, Cao and Zhang, 2011). Each party in the collaborative process has a strong core competency, thus, eliminating the need for an

organisation to provide these resources itself. Improved flows of information, enabled by technology and close relationships, aid material flows and reduce cash requirements; thus, releasing for more value adding activities (Spekman et al., 2002, Gunasekaran et al., 2008).

The challenge to remain competitive has intensified and all participants in a network must engage at a higher level to remain viable (Ibrahim, 2015). The process of introducing and enabling collaboration requires willingness to breakdown existing barriers and leverage information available within the network, to transform business processes (Horvath, 2001). Where collaboration exists across supply and demand networks, SCM efficiencies result in revenue growth for all SC partners (Fawcett, et al., 2008). Effective collaboration cross-functionally and cross-enterprise is essential to achieve these goals (Kampstra, et al., 2006), and common goals connect organisations for successful collaboration (Sang Chin et al., 2008). In their study of British SMEs, Haddoud et al. (2017) propose that there is a link between network collaboration and Government agencies in improving exports by improving organisations' relationships quality. This point will be developed further in empirical research investigating the role that Ireland's Government agent, Bord-Bia, has within the co-opetition strategy for the sector. However, barriers to implement SCC exist. These can be categorised as: difficulties to implement the necessary culture change from functional management to strategic SCM for the development of trust and information sharing, difficulties for integrating firms to become a cohesive team, the need for common technological interfaces to align processes across function, customers, and suppliers, and volatile forecasting (Fawcett et al., 2008, Simatupang and Sridharan, 2015, Anand and Walsh, 2016).

The process of collaboration ultimately involves integration (Sundram et al., 2016), whether at arm's length or very closely depending on the importance of the network actors. Effective horizontal collaboration and network integration is required so all entities can actively participate and achieve the desired goals but it is contended that alignment is difficult to achieve, infrastructure is lacking, and trust is not always evident (Kampstra, 2006). Fawcett et al. (2008 p. 67) propose that "integration fosters the collaboration needed to turn a set of independent firms into a cohesive team". Collaboration, co-operation and co-ordination are key to enhanced performance, and highly productive relationships enhance value across the entire network (Braziotis et al., 2013, Pinho et al., 2014). Co-opetition cannot occur without collaboration and this research intends to illustrate how collaboration with a SC lens can strengthen an organisation's performance and identify the opportunities that can be gained from collaboration, internally and externally, and increase co-opetition within the Irish Whiskey sector.

Collaboration is not limited to specific elements of the SC but should be aligned across all areas. Table 1 demonstrates how collaboration can add value across the areas of "Buy-Make-Move-Store-Sell". Sweeney (2007) describes the "Buy-Make-Move-Store-Sell" elements as the micro or internal SC. He identifies five core elements found in most companies, and states that traditionally these operate in isolation and that SC thinking means crossing boundaries, bridging barriers and bringing each closer together to enable and improve flows of information, materials and finance. Across the five key elements found in most organisations there are also de-coupling points with suppliers and customers. Integration and alignment should extend from end to end across the SC. To do this, relationships must be built, knowledge shared, and a culture of system-wide continuous improvement fostered for the mutual gain of all parties and to reduce the elements of risk for all.

Knowledge Sharing and Co-opetition

Knowledge sharing strengthens the combined knowledge base within a network of engaged participants through the creation and management of a process (Dyer and Nobeoka, 2000). This will improve organisational performance, maximise the benefits within the organisation and across its boundaries, will generate efficiencies, support agility and increase value for customers and stakeholders (Capó-Vicedo, et al., 2011, Chevallier et al., 2016). Willingness to participate and share is noted as essential (Anand and Walsh, 2016) but as knowledge is proprietary, sharing can be difficult if

the environment is not supportive and empowering (Durmusoglu, et al., 2014). The relative size of co-opeting partners is a critical factor for the success of the collaboration, as LEs tend to have greater resources available and more mature markets established, whereas SMEs face difficulties such as lack of internal resources, financial constraints and market knowledge (Soppe et al., 2014). In a study of the wine sector, co-opetition was recognised as critical to success, especially for smaller companies where the efforts of the whole are greater than what was possible individually (Golicic et al., 2017).

The Irish Whiskey sector consists of both LE's and SME's and there is an apparent lack of research into how knowledge is transferred between different entities in the sector, or if this is more successful when there is a shared market objective. A mentor programme has been established to facilitate the transfer of knowledge, but the sector has a stated goal to grow the Irish Whiskey market. Using the well-known market brands provides a gateway for new brands to capitalise on the established market share but there is huge knowledge within established industries that could be shared to fast-track the performance of SMEs. The successful transfer of knowledge between entities can be difficult. A learning culture must be present and encouraged, and a process for sharing must be created and managed with suitably aligned end to end goals to generate efficiencies, agility and value for all stakeholders. Where competitiveness is introduced within a sector, knowledge sharing can be diminished, but if the sector has a strategic goal and is willing to behave collaboratively for the common benefit, the rate of knowledge sharing in a co-opetitive manner can be successful. The whiskey producers in Ireland wish to work together to grow the Irish Whiskey brand to capture a larger share of the global market, sharing knowledge and experience especially from the larger more established companies to the emerging brands to grow the total market capability. A mentor programme seems to be the route suggested by Bord-Bia and adopted by the sector to develop and build the resources needed and sustain growth and challenge the Scotch and Bourbon markets. Empirical research aims to investigate the strategies underlying this route and establish if they could be aided or improved through the lens of SCM.

	SCC opportunities between LEs and SMEs	**Contextual adaptation**
BUY	Strengthening the limited power of SMEs; granting access to technological information and finance; assistance in purchasing materials or equipment; SC risk mitigation through intelligent vendor choice, negotiation, management and integration; assistance in supply availability; material and information flows management; inventory management; value identification and continuous improvement.	In the context of the stated sector objective of co-opetition, there may be opportunities to implement shared services across procurement i.e. sector collaboration to improve competitiveness.
MAKE	Improvement of the speed and accuracy of planning information (demand driven rather than forecast driven); processes re-engineering to deliver agility; reducing contingency inventory across external and internal SC with information and material decoupling points; assistance to implement Lean Manufacturing, JIT inventory, and pull systems; use of SCOR model and Lean Six Sigma to implement, measure and monitor progress for continuous improvement.	Extended collaboration between Irish SME companies and market leading brands has the potential for more opportunities for process improvement, if that is not excluded due to competitiveness but fostered under the sector vision to present an Irish Whiskey market strategy.
MOVE	Assistance to identify and resolve SCM challenges; assistance to develop strategic partnerships with 3PLs/4PLs for the holistic coordination of material flows internally and across the network with an outlook to international markets for efficient material movement.	The mix of established and new LE's and SME's within the Irish Whiskey sector, the relative proximity of manufacturers in Ireland and similarities in raw

STORE	Facilitation of a SCM view at every storage point across the SC to remove waste and add agility; Strategic partnerships with 3PLs/4PLs for the use of integrated systems for increased global visibility and systemic improvement in speed, accuracy, reliability, customer service, and cost efficiency.	materials, packaging and finished goods create opportunities to consolidate deliveries and collections and for deeper collaboration in transport and warehousing, by the shared use of a 3PLs/4PLs specifically for the sector as a shared service.
SELL	Use of CRM for enhanced understanding of customer needs, building of deep customer relationships focused on co-creation and delivery of value to market for long-term profitability; increased delivery reliability and invoice accuracy; facilitation of cross-functional integration, streamlined information flows, shared knowledge; assistance.	In the Irish Whiskey sector there is a shared objective to collaborate to sell the provenance of the sector to develop the Irish Whiskey brand awareness to develop its market strength.

Table 1: SCC collaboration along the "Buy-Make-Move-Store-Sell", source: authors' own

Methodology

In order to gather detailed data that enhance the understanding of how SCM is implemented within a particular context, and address the research question, this exploratory study employed a mixed methods research design. A Mixed Methods research design utilises both qualitative and quantitative tools, thus, rejecting a dichotomous either-or approach, and overcomes narrow-view based additions to knowledge. This allows an increased range of research options, to enhance the trustworthiness of the research strategy, select the best techniques to answer the research questions, and balance participant bias (Golicic and Davis, 2012). Additionally, a mixed method design and the subsequent use of multiple data collection techniques allows for triangulation, which increases the validity of evaluation and credibility of research findings, because one data collection method alone will not adequately cover the complexities of social realities (Yeasmin and Rahman 2012). Secondary data were used for triangulation and give a balanced overview of how the sector behaves in its environment.

The contemporary nature of the present study, and the need to understand managerial behaviour but not to have control over it imposed the use of case study research strategy (Marshall and Rossman 1995). The chosen case study focussed on a national sector (Irish Whiskey) which aims to grow through co-opetition, influenced by both natural competition (to grow individual market share) and co-operation (to develop an international brand recognised under the umbrella of Irish Whiskey) to compete with other globally recognised brands such as Scotch or Bourbon whiskeys. As such the unit of analysis for this study is the Irish Whiskey sector. The case study design followed a Linear-Analytic structure (Yin 2014). The primary data collection utilised two approaches. Initially, a questionnaire was developed to identify the levels of SCM implementation, and any potential collaboration and co-opetition of the Irish Whisky sector along the "Buy-Make-Move-Store-Sell" domain. To elaborate the findings of the questionnaire and to understand in-depth the current perceptions of the sector and its future a structured interview phase with industry experts was introduced. Following the primary data collection, a secondary data stage was introduced to provide a greater view of the sector, and to ascertain if current and future practices support co-opetition.

Data analysis

Primary data analysis

To address the research aim, initially, a questionnaire was distributed among 25 Irish Whisky distillers. A number of senior managers and operations managers from 5 distillers, all with over 10 years' experience in the sector completed the questionnaire. The first section of the questionnaire aimed to identify the level of SCM implementation among Irish Whiskey Distillers. Data analysis revealed that only two of these have a SC Manager employed, indicating that a SC strategy is prevalent. However, it

is not known if these are LEs or SMEs. Concerning the level of SC implementation, the results derive only from the 2 distillers that have SC Managers. Data analysis reveals that their levels of SCM implementation are high as both implement cross-functional strategies among Marketing, Sales, Operations, and Finance functions, and liaise with vendors and customers to re-engineer and optimise the SC and manage the team. However, there is room to improve as evaluation and implementation of ICT solutions, and monitoring and managing SC performance and capability metrics where identified only in one organisation. The second section of the questionnaire aimed to identify the levels of internal and external SCC along the "Buy-Make-Move-Store-Sell" elements. For the 5 participating distillers data analysis showed positive results for internal collaboration, indicating strong cultures of sharing knowledge. However, it was identified that most cross-functional collaboration occurs tactically rather than strategically or as standard operating procedure, thus, there are limits to integration and alignment. External collaboration is strong and government agencies and the sector association are key influencers. The analysis of the data indicated that there are strong opportunities for further collaboration across the "Buy-Make-Move-Store-Sell" elements, illustrating that shared services and collaboration are not optimised. Overall, the analysis of the questionnaires showed that the perception of SCM utilisation is low in the sector, and that there are opportunities for deeper collaboration and higher use of shared services across the sector.

Regarding the evaluation of the perceptions of key stakeholders within the Irish Whiskey sector on collaboration and co-opetition, interviews with industry experts were conducted. The analysis of the qualitative data identified that the LE of the research sample has a strong utilisation of SCM and collaboration is strong internally and externally. The LE displayed efficient and effective access to markets through other products but behaves competitively rather than co-opetively.

Secondary Data Analysis

To triangulate the findings of the primary data, an extensive review of secondary data from government agencies was conducted. The analysis of these documents shows that Bord-Bia as the primary Government Agency developing Ireland's Food and Drink export markets is in a unique position to create a collaborative environment and to establish methods to increase co-opetition. The positioning of the Irish Whiskey sector first and individual brand second will enable a cohesive approach to the sector. The establishment of the Irish Whiskey Association is another step to build collaboration and co-opetition in the sector and the close involvement of ABFI unites all members in its goals. Benchmarking against the Scotch and Bourbon industries and creating an Irish Whiskey Trail again solidifies collaboration and the co-opetitive nature of driving growth for the entire sector.

Summary of findings

SCM utilisation is low in the sector, however, it is not identified if SCM utilisation is equal amongst companies regardless of their size. LEs have advantages in the strong adaptation of a SCM strategy, processes and alignment when compared to SMEs. There are LEs involved in the IWA Mentor Programme and it would be expected through the sharing of knowledge that SMEs could improve their position. However, there is room for greater integration and alignment evident from this study, so the sector could benefit through applying a SCM strategy. While there is evidence of internal and external collaboration it appears to be based on traditional management strategies. In some instances, collaboration exists at a higher frequency in some functions but not across all, thus, there are levels of dis-integration. A SCM strategy would raise collaboration across all elements and integrate and align better to create greater competitive advantages for the individual organisations and for the sector as it will drive co-opetition. Government agencies can foster the creation of a collaborative environment and help establish methods to increase co-opetition. While there are opportunities for increased collaboration and co-opetition it is prudent to remember the re-generation of the Irish Whiskey sector is at an infant stage, but this is also an opportunity to integrate a strong holistic SCM strategy across the sector to gain competitive advantage early on.

Discussion and conclusions

SCM is often misunderstood and has generated a reluctance to embrace within industry. This is often more evident in mature organisations where custom and practice make change difficult. Functions may be siloed and reluctant to trust and share knowledge. However, SCM is a management strategy and must be promoted from the top-down and integrated from the bottom-up. It takes time to fully understand how all partners work, and to identify and change processes and practices, but these need to be enabled and encouraged by managers across the organisation. There is an opportunity for new businesses to embrace this strategy early on and create the right culture, systems and process, to cultivate a knowledge learning and collaborative environment. Literature also reveals notable differences in the implementation of SCM, and that LEs benefit due to a higher rate of implementation. This is due to the higher level of complexity in large, multi-national companies. It is pertinent to note that SMEs experience lower levels of complexity and may not need to implement SCM to the same degree at this stage of maturity, but this may become more relevant as organisations grow and complexity increases. In the case of the Irish Whiskey sector a growing number of SMEs exists, which hope to grow sales and contribute to the common goal. Increasing their size and complexity will be inevitable; implementing a SCM strategy early on can mitigate some of the highlighted risks.

Literature explores the differences in traditional management and SCM and illustrates how a SCM strategy creates greater competitiveness. It also identified that SCM is usually more prevalent in larger organisations. The case study concurred with this although most of the respondents were from established multi-nationals, so the result was skewed to favour this to a degree. However, although owned by multi-national LEs, the most prominent Irish brands were independently owned before acquisition. These brands originated as traditional family-managed organisations with their own cultures and strategies before being integrated into the parent company. The parent companies are often more developed and the difficulties in aligning corporate cultures are widely discussed in academic research. Horizontal mergers and acquisitions are often concerned with value created through brand acquisition and have interest only in the sources of revenue to be gained through already well-managed brands (Vũ et al., 2009). If this is the case for the top Irish Whiskey brands it may explain why stronger SCM indicators such as end-to-end integration are not evident. The sector decision to create a Mentor Programme to facilitate knowledge sharing between LEs and SMEs indicates that SCM practices instead of traditional management will more likely be developed.

Literature also depicts foundations of SCM such as collaboration, knowledge-sharing and internal and external integration and the case study sought to identify how evident these were in the Irish Whiskey Sector. The results showed some evidence of collaboration, driven by ABFI and Bord-Bia to enable sector-wide knowledge sharing. This supports co-opetition and indicates newly established programs to support and develop this strategy. This is still in early stages of development as the sector renaissance is relatively recent and can improve. Some areas highlighted in the case study illustrate that SCM is seen as an operational or crisis management tool and not an 'end to end' holistic system. Adding a SCM strategic lens to an entire organisation can yield greater benefits and offer the competitive advantages the sector needs to become a leader by 2030.

This research also aimed to identify further opportunities to develop collaboration and co-opetition across the "Buy-Make-Move-Store-Sell" and to investigate if shared services could add benefits to the sector. The case study confirms that there are further opportunities for collaboration and co-opetition and these should be developed to gain benefits. The areas investigated were only some of those available and sector participants may be able to identify more through their inherent knowledge. Literature also notes the positive influence a Government Agent can have on a sector. It was noted that Bord-Bia developed a strategy and shared this with the sector. It is in any government's interest to develop and grow export markets and the Irish Whiskey sector, which was once a global dominator, had diminished severely over the last century. The Scotch market has flourished and has grown to be a world leader. Famed for its single malt, the sector is supported by a high number of SMEs in addition

to multi-national owners with access to global markets. Bord-Bia noted new market demand for less age statements and more provenance, for brands who could bring diversity to complement Ireland's well-known brands, the emergence of consumers who wanted to experience mixology and variety of flavour capturing a young and modern attitude, and the new middle-class growth in Eastern and Southern markets. All of these, provided an opportunity to develop new markets rather than compete head to head with a traditional possibly staid Scotch or Bourbon market and more typified the image Ireland has across the world as creative, multi-cultural, emerging but with a sense of history, unspoilt landscape and world class ingredients. Another element captured was tourism, which is an industry very important to Ireland as a revenue generator. Learning again from successes in Scotch and Bourbon markets, collaboration to promote tourism and Whiskey together illustrating the rich heritage, beautiful scenery and the social nature of people is a natural marriage. Multi Government agencies collaborate across their respective industries to mutually grow each area leveraging benefits from each other. Table 2 highlights key points from literature and findings from empirical research.

Theoretical	**Empirical**
Traditional vs SCM strategy	Both are evident across the investigated organisations
SCM is more prevalent in LEs than SMEs	SCM more prevalent in LEs, although more LEs responded
Reluctance to embrace SCM	Evidence that SCM is not deployed holistically
Collaboration, Knowledge sharing, Integration	Evidence of collaboration and knowledge sharing, driven by co-opetition
Differences in levels of implementation of SCM	Variances of implementation even across LEs
SCC opportunities across the "Buy-Make-Move-Store-Sell" functions	Opportunities for competitive advantage were identified
Positive influence of Government Agencies on a sector	Several Government Agencies and IWA are key influencers

Table 2: Key points identified in literature and empirical research, source: authors' own

Implications for Policy and Practice

Having a collective goal brings a natural synergy as members aim to collaborate to improve the sector's performance for neither the exclusion or benefit of any single participant. Traditional collaboration in this sector has occurred in legislation or lobbying. To bring the sector forward and compete aggressively in the global whiskey market, the key influencers have adopted a co-opetition strategy to use the knowledge and experience of established actors to assist new entrants. In addition, new entrants will provide diversity of brands to capture new markets and the Irish Whiskey Trail will support the promotion of Irish Whiskey with its rich traditions, diverse flavours, high quality ingredients and the imagery of Ireland. The findings of this study indicate that there are levels of collaboration evident but as the sector has only recently begun to implement its strategy it is expected these levels will increase. The IWA Mentor Program will develop collaboration and knowledge sharing across the sector as more distilleries come through the planning process. Currently few new distilleries have opened, but this is set to increase rapidly. From the SME perspective, there is a lot to learn from established actors and it is in their interest to learn from established collaborators. Research has also shown that using a SCM strategy can drive competitiveness over a more traditional management strategy. Utilising shared services, especially in a sector based in close proximity to each other and using similar materials and distribution channels can offer economy of scale benefits which aid financial performance. Other industry sectors could review this case study to identify if any benefits could be applied to them to gain competitive advantages. While the Whiskey sector is prominent as closely identified with Ireland historically, Bord-Bia's Origin Green campaign might develop similar pathways for other industries.

References

- ABFI (2016) 'Irish Whiskey Association launches landmark new Irish whiskey mentoring programme' [Online] Available at: http://www.abfi.ie/Sectors/ABFI/ABFI.nsf/vPagesWhiskey/Media~Newsroom~irish-whiskey-association-launches-landmark-new-irish-whiskey-mentoring-programme!OpenDocument
- Anand, A. & Walsh, I. (2016), 'Should knowledge be shared generously? Tracing insights from past to present and describing a model', *Journal of Knowledge Management,* 20 (4), pp. 713-730.
- Bord-Bia (2013) '*The Future of Irish Whiskey'* [Online] Available at: https://www.bordbia.ie/industry/manufacturers/insight/publications/bbreports/Documents/The%20Future%20Of%20Whiskey.pdf
- Braziotis, C., Bourlakis, M., Rogers, H. & Tannock, J. (2013) 'Supply chains and supply networks: distinctions and overlaps', *Supply Chain Management: An International Journal,* 18(6), p. 644-652.
- Cao, M. & Zhang, Q. (2011) 'Supply chain collaboration: Impact on collaborative advantage and firm performance', *Journal of Operations Management,* 29(3), p. 163-180.
- Capó-Vicedo, J., Mula, J. & Capó, J. (2011) 'A social network-based organizational model for improving knowledge management in supply chains', *Supply Chain Management: An International Journal,* 16(5), p. 379-388.
- Chevallier, C., Laarraf, Z., Lacam, J., Miloudi, A., & Salvetat, D. (2016) 'Competitive intelligence, knowledge management and coopetition: The case of European high-technology firms', *Business Process Management Journal,* 22(6), p. 1192-1211.
- Durmusoglu, S., Jacobs, M., Nayir, D., Khilji, K., & Wang, X. (2014) 'The quasi-moderating role of organizational culture in the relationship between rewards and knowledge shared and gained', *Journal of Knowledge Management,* 18(1), p. 19-37.
- Dyer, J. & Nobeoka, K. (2000) 'Creating and Managing a High-Performance Knowledge-Sharing Network: The Toyota Case', *Strategic Management Journal,* 21(3), p. 345-367.
- Fawcett, S., Mangan, G. & McCarter, M. (2008) 'Benefits, barriers, and bridges to effective supply chain management', *Supply Chain Management: An International Journal,* 13(1), p. 35-48.
- Golicic, S. & Davis, D. (2012) 'Implementing mixed methods research in supply chain management', *International Journal of Physical Distribution & Logistics Management,* 42(8/9), p. 726-741.
- Golicic, S., Flint, D. & Signori, P. (2017) 'Building business sustainability through resilience in the wine industry', *International Journal of Wine Business Research,* 29(1), p. 74-97.
- Gunasekaran, A., Lai, K. & Cheng, T. (2008) 'Responsive supply chain: A competitive strategy in a networked economy', *Omega,* 36(4), p. 549-564.
- Haddoud, M., Jones, P. & Newbery, R. (2017) 'Export promotion programmes and SMEs' performance: exploring the network promotion role', *Journal of Small Business and Enterprise Development,* 24(1), p. 68-87.
- Horvath, L. (2001) 'Collaboration: the key to value creation in supply chain management', *Supply Chain Management: An International Journal,* 6(5), pp. 205-207.
- Ibrahim, H. Z. T. (2015) 'A content analysis of global supply chain research', *Benchmarking: An International Journal,* 22(7), pp. 1429-1462.
- Kampstra, R., Ashayeri, J. & Gattorna, J. L. (2006) 'Realities of Supply Chain Collaboration', *The International Journal of Logistics Management,* 17(3), p. 312-330.
- Littunen, H. (2000) 'Entrepreneurship and the characteristics of the entrepreneurial personality', *International Journal of Entrepreneurial Behaviour and research,* 1(3), p. 213.
- Lambert, D. & Enz, M. (2017) 'Issues in Supply Chain Management: Progress and potential', *Industrial Marketing Management,* 62, p. 1-16.
- Marshall, C. & Rossman, G. B. (1995) *Designing Qualitative Research.* 2nd edn. Thousan Oaks: SAGE

- Pinho, N., Beirao, G., Patricio, L. & Fisk, R. (2014) 'Understanding value co-creation in complex services with many actors', *Journal of Service Management,* 25(4), pp. 470-493.
- Sang Chin, K., Chan, B. & Kit Lam, P. (2008) 'Identifying and prioritizing critical success factors for coopetition strategy', *Industrial Management and Data Systems,* 108(4), p. 437-454.
- Simatupang, T. & Sridharan, R. (2015) 'An integrative framework for supply chain collaboration', *The International Journal of Logistics Management,* 16(2), pp. 257-274.
- Soosay, C., Hyland, P. & Ferrer, M. (2008) 'Supply chain collaboration: capabilities for continuous innovation', *Supply Chain Management: An International Journal,* 13(2), p. 160-169.
- Soppe, B., Lechner, C. & Dowling, M. (2014) 'Vertical coopetition in entrepreneurial firms: theory and practice', *Journal of Small Business and Enterprise Development,* 21(4), p. 548-564.
- Spekman, R., Spear, J. & Kamauff, J. (2002) 'Supply chain competency: learning as a key component', *Supply Chain Management: An International Journal,* 7(1), p. 41-55.
- Sundram, V., Chandran, V., & Bhatti, M. (2016) 'Supply chain practices and performance: the indirect effects of supply chain integration', *Benchmarking: An International Journal*, 23(6), pp.1445-1471
- Sweeney, E. (2007) 'Supply Chain Integration', In: Sweeney, E. ed. *Perspectives on Supply Chain Management and Logistics.* Dublin: Blackhall Press.
- Vũ, D., Shi, Y. & Hanby, T. (2009) 'Strategic framework for brand integration in horizontal mergers and acquisitions', *Journal of Technology Management in China,* 4(1), p. 26-52.
- Yeasmin, S. & Rahman, K. (2012) 'Triangulation' Research Method as the Tool of Social Science Research', *BUP,* 1(1), p. 154-163.
- Yin, R. (2014) *Case Study Research: Design and Methods.* 5th ed. Thousand Oaks: Sage Publications Inc.

EXPLORING THE ENVIRONMENTAL SUSTAINABILITY AND PERFORMANCE IN GLOBAL LOGISTICS HUBS

Sandy Hassan[1], Alessandro Creazza[1], Sarah Shaw[1] and David B. Grant[1, 2]
[1]Hull University Business School, Hull, UK
[2]Hanken School of Economics, Helsinki, Finland

Introduction

Globalization has had different effects on the world since the concept emerged. Globalization impact on supply chains and logistics has revolutionized global trade. It has resulted in new levels of speed, efficiency, effectiveness and endless options. With the concept of globalization applied in supply chains and logistics, it has resulted in the emergence of global logistics hubs. Global logistics hubs have many advantages and are the base for global trade nowadays and they are a crucial link in global supply chains. Without the facilitations that global logistics hubs bring to the table, it is nearly impossible to carry on global trade with the same standards we see today. Global logistics hubs are massive composition of activities, offering all types of transportation modes, light manufacturing and added-value logistics services, and handling global amounts of products. This agglomeration of activities as much as it helps in keeping the global trade system going smoothly, it has immense environmental externalities, affecting the local communities and the rest of the world. Scholars, governments, and NGOs' increased interest in the sustainable development and the environmental impact of organizations since the Rio Summit in 1992. This brings our attention to the effect of the agglomerated activities of global logistics hubs and how it is measured and managed. Since sustainability has multiple dimensions, such as people, culture and institutions (O'Riordan, 2014), it is interesting to explore how stakeholders affect and are affected by environmental sustainability in global logistics hubs as well. This paper is based on an ongoing PhD research that aims to explore the holistic model of global logistics hubs and their environmental sustainability and measurement, in addition to the stakeholders and their influence on environmental sustainability.

Ports and port clusters

By reviewing the literature, the term global logistics hub seemed ambiguous and used loosely and interchangeably with other similar terms but none of which has a clear framework in the scholarly articles. Some scholars attempted to define the term but still the definition is a general idea of the function of a global logistics hub. The lack of a known framework of global logistics hubs has contributed to the vagueness of the term. Additionally, it was also found that it is confusing to use the terms port, port cluster and similar terms to global logistics hubs in the same context. Therefore, in order to clear this, the research attempts to clarify the difference between ports, port clusters and global logistics hubs.

Maritime ports have been evolving since the 1960s due to the changes in the market and the requirements of trade nowadays. The UNCTAD (1999) defined four generations of ports and Flynn and Lee (2010) coined the fifth-generation port evolution. According to Notteboom (2011) after the 1990s port generations were influenced by globalization and the change that happened to the global trade scene. Ports went from offering simple exchange of transport services to complex systems of sophisticated operations and integration (Beresford et al., 2004). Thus, ports became central nodes to global trade activities (Wan et al., 2014). The importance of the link that ports offer to the global trade made it a good base for global logistics hubs. Fourth and fifth-generation ports are the generations that are considered advanced enough to be a base for global logistics hub, since they can be integrated horizontally and vertically (Zang & Lam, 2013) in the global logistics chain. A main differentiating point between fourth and fifth-generation ports is the operation viewpoint, where fourth-generation ports aim to improve internal profit, but fifth-generation ports aim to improve customer satisfaction and consider stakeholders in their decisions (UNCTAD, 1999, Flynn & Lee, 2010).

The objectives of this research align with the fifth-generation ports to be the base for global logistics hubs

operations. By connecting and integrating with the system where it exists, in this case under the global logistics hub umbrella, and involving stakeholders in their operations, fifth-generation ports will facilitate exploring the environmental sustainability of the port and the global logistics hubs as a whole and the influence of stakeholders. A port is perceived as one entity of interrelated activities and connections to offer the best service to its customers (UNCTAD report, 1999; Flynn and Lee, 2010), however, a global logistics hub is a more complex system requiring a strategic location, a concrete infrastructure to be able to receive huge numbers of products and offer services to sustain global trade and provide a smooth flow of products for global supply chains, have strong multimodal connections and routes to the feeder network connected to it, in order to serve the region surrounding the global logistics hub.

A port cluster is another concept that was found confusing in the literature with global logistics hubs because of the agglomeration of activities in both. Haezendonck (2001, p.136) defines a port cluster as "a set of independent firms engaged in port related activities, located within the same port region and possibly with similar strategies leading to competitive advantage and characterized by a joint competitive position vis-à-vis the environment external to the cluster". A port cluster is a concentration of similar activities and infrastructures serving several ports located around a geographical region to avoid intensified competitions between ports that adversely affect regional economies, encouraging ports to cooperate rather than compete (Zhaoliang et al., 2009; Lam et al., 2013). Port clusters, in addition to the port operations of maritime transportation, cargo handling, and logistics activities, include manufacturing and trade activities such as shipbuilding, oil refining, specialized suppliers to port industries (Haezondonck and De Langen, 2012). Therefore, the purpose behind developing a port cluster is different from developing a global logistics hub and both concepts include a port as part of their operations. This also shows that they require specific activities to serve their operation's aim.

Figure 1 illustrates the position of a port and the position of a port cluster. This figure is missing the position of a global logistics hub and what is its layout, and thus one of this research's objectives is to find out where a global logistics hub would lie in this image and what would its borders encompass.

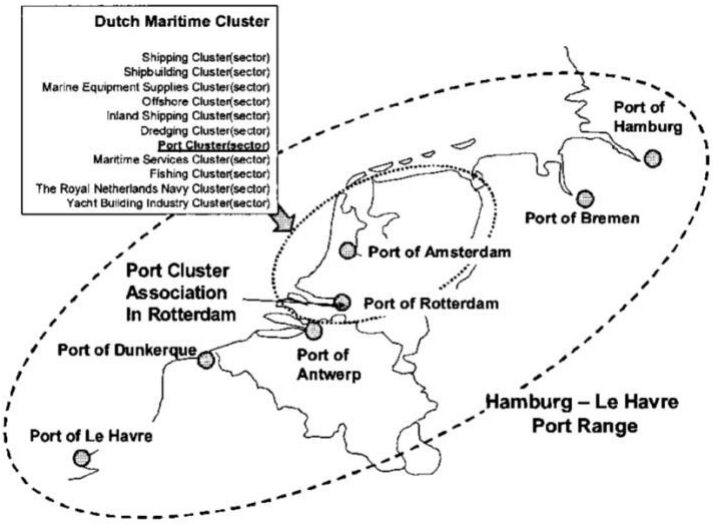


Figure 1: Illustrating Maritime Cluster, Port Cluster and Port Conceptual Model to North Western Europe Region (Source: Roh, 2006, p. 75)

Global logistics hubs

The emergence of global logistics hubs resulted from the dispersion of supply chain operations all over the world and the agglomeration of the global manufacturing output in certain parts of the world (Sheffi, 2012). With customers of global supply chains located in different parts of the world, it is a challenge for supply chains to deliver their products to their customers in high quality with low costs to achieve high customer satisfaction. Global logistics hubs help them achieve this by offering a strategic location to act

as a centre for consolidating the huge number of products transported to a certain region in the world, offering value-added services and logistics services, acting as a hub to the feeder network where the deconsolidation happen to distribute the products through the network using the multimodal facilities offered through the global logistics hub. Yang and Chen (2016, p.181) defines a global logistics hub as "a port in a strategic geographical location at the intersection of major trunk and feeder systems, and which possesses a logistics park or free trade zone in the port hinterland providing integrated value-added logistics services in addition to conventional import, export, and transit cargo operations". This helps supply chains in providing a smooth flow of products to their customers, decrease the risks that is associated with having the manufacturing operations across the world, take advantage of the economies of scale, decrease costs, and improve responsiveness.

Several authors addressed the lack of conceptualization and the ambiguity of the concept of global logistics hubs. As much as they added to the knowledge, proposing a framework of the terminologies and classification of logistics hubs (Notteboom et al., 2017), highlighting different types of global logistics hubs (Sheffi, 2012), or describing a global logistics hub concept through a specific case study (Yang & Chen, 2016), they either failed to incorporate the transportation viewpoint, or to identify the stakeholders of global logistics hubs, they also didn't take into account ownership, governance or economic development position that would be different in each global logistics hub. Global logistics hub framework and definition would not be the same mold for all of them if all aspects are taken into consideration.

A port is one entity of interrelated activities serving the purpose of maritime transportation and cargo handling and is the base for both port clusters and global logistics hubs. A port cluster is an agglomeration of associations not an entity (De Langen, 2004), it includes activities to enhance regional economy and benefit the competitive position of ports in the same geographical region. A global logistics hub buffers some of the risks associated with global supply chains and provides a smooth flow of products for a specific region. In addition to a fourth or fifth-generation port, a global logistics hub must have a strategic geographical location, a strong physical infrastructure to accommodate global capacity of products, Free Trade Zone, a well-connected multimodal network (e.g. rail, road, inland waterway, seaports, airports).

Even though a global logistics hub is a crucial link in the global trade operations and support global supply chains, they have immense adverse impact on the environment. According to Rondinelli and Berry (2000) logistics and transport operations have major environmental impacts such as green space displacement, soil and sediment contamination, air, water and noise pollution, lost habitat, and wetlands destruction. In global logistics hubs, transport, logistics and other services are immensely present and agglomerated to serve global trade operations, which intensifies and increases the adverse environmental impacts. These environmental externalities result in a challenge to balance between the financial and economic benefits and the environmental sustainability of global logistics hubs.

The large amount of activities carried out under the umbrella of a global logistics hub connects a large number of stakeholders. Different types of stakeholders are identified by using stakeholder theory and it is also used to manage stakeholders' responsibilities (Lavassani and Movahedi, 2010). Stakeholder theory (Freeman, 1984) has been used as an organization management framework to understand business operations and solve problems in micro and macro contexts. Alam (2013) explains that organization's activities affect stakeholders in a direct and indirect way and are also affected by them. In the context of this research, it is essential to explore the stakeholders involved in global logistics hubs' and their effect on the environmental sustainability. The involvement and influence of stakeholders are essential to take into consideration when exploring the environmental sustainability in a holistic manner, since it will reveal their relative prominence to the environmental sustainability of global logistics hubs as well as the potential cooperation that might help in managing it. Additionally, identifying global logistics hubs' stakeholders will help develop a more accurate framework for global logistics hubs.
Figure 2 illustrates a theoretical framework of stakeholders involved in a global logistics hub.

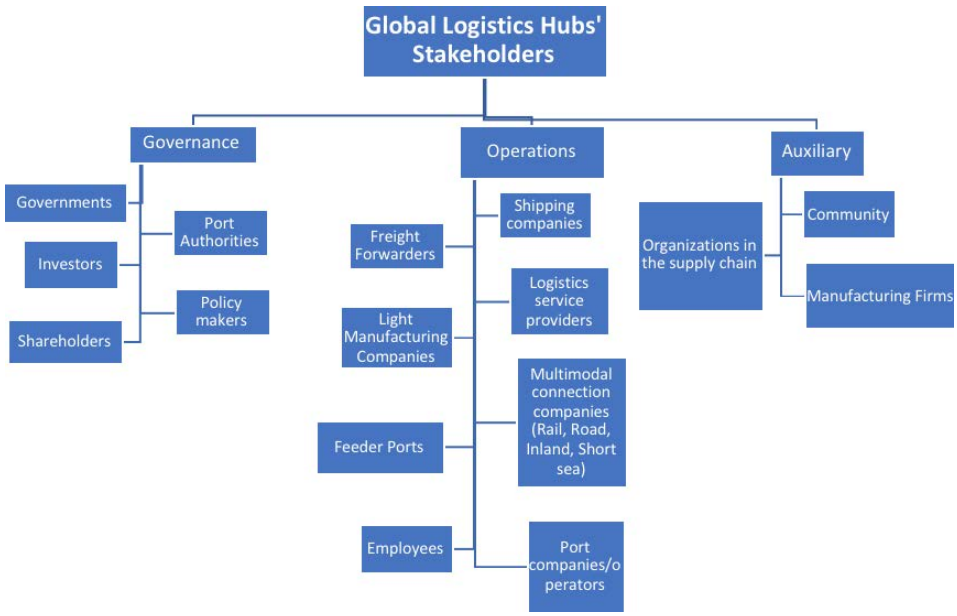


Figure 2: Global Logistics Hub's Stakeholders Theoretical framework (Source: author)

Through the literature review on global logistics hubs it was found that the studies were mainly concerned with the economic aspect of developing a global logistics hub (Veldman et al., 2005; Lee et al., 2009; Xiao & Liu, 2017) and there was a lack of interest regarding the organizational responsibility or the environmental sustainability of global logistics hubs. To address the environmental sustainability and environmental performance measurement in global logistics hubs, a literature review was conducted through Scopus and Web of Knowledge to reveal the environmental sustainability position of the constituents of global logistics hubs since literature on global logistics hubs is relatively insufficient.

Environmental sustainability and environmental performance measurement in global logistics hubs

Sustainability encompasses environmental, economic, and social aspects (Carter & Rogers, 2008), however this research is focusing on the environmental aspect of sustainability in global logistics hubs and its measurement. With the increasing interest of scholars, governments and NGOs with the environmental impact of organizations, it is important to understand the environmental impact and sustainability strategies of the agglomeration of activities that take place in global logistics hubs.

According to Defra (2011) the environmental impact is manifested through 4 key areas: emissions to air, water, land and resource use. However, through the literature review it was found that scholars mainly concentrate on air pollution and the carbon footprint of operations such as the study by Lee and Wu (2014). Furthermore, by reviewing the literature, it was found that the maritime transport sector environmental sustainability exists, however there is a lack of unity in the measurement frameworks and that is because of the diversity of sizes and functions in maritime ports. Additionally, in the logistics services sector, the studies addressing the sustainable development are rare (Evangelista, 2014), and even the studies addressing the environmental impact of the logistics services are shallow and do not reveal the interrelation between the different modes or the stakeholders.

Other constituents of global logistics hubs must have their own individual environmental sustainability strategies; however, they are not reflected in the literature. This shows that scholars are treating global logistics hubs' constituents in a standalone manner and there is a lack of integration in the literature within the various parts of a global logistics hub, which makes it difficult to view the holistic position of the environmental sustainability and measurement in global logistics hubs. The holistic approach would benefit the efficiency of environmental sustainability of global logistics hubs, since it would eliminate the duplication of measurement and enhance the integration of the system, which in turn would help more parts of the global logistics hub, regardless of their size or impact, be involved in the environmental

sustainability measurement and management. Thus, improving the overall environmental sustainability of the global logistics hub, facilitate implementing any environmental management system and benefit the global logistics hub's stakeholders.

Methodology

This research is looking into exploring the holistic view of global logistics hubs' operational model and their environmental sustainability and measurement, an inductive approach is appropriate since theory on global logistics hubs is scarce, therefore, the theory is developed from observation of empirical reality, thus moving from the specific to the general (Collis & Hussey, 2013). Furthermore, according to the research questions, the research method can be selected (Ellram, 1996). Given this research questions a case study methodology is found appropriate to implement and will provide a holistic and in-depth exploration in a real-life setting (Ellram, 1996; Yin, 2013). Additionally, Yin (2013) recommends the multiple case study strategy to overcome the vulnerability of the single case study. Moreover, by using a multiple case studies strategy in this research, it will help the research to study different cases of existing global logistics hubs to define the activities and operations considered under the authority of global logistics hubs and explore the environmental sustainability situation in each setting, that is to address the heterogeneity of global logistics hubs and the different characteristics that could be found in their different governance, ownership, and developmental settings which will affect the case study selection as well. Unstructured interviews are being considered as the primary data collection method due to the rarity of literature and ambiguity of the global logistics hub concept. Easterby-Smith et al., (2012) explain that unstructured interviews are used as a general area exploration with the aim of in-depth understanding. It will allow the interviewees the opportunity to further illustrate the concept and the environmental sustainability measurement and management and the stakeholders' influence without affecting the answers or imposing the researcher's thoughts on the outcome.

Findings

Global logistics hubs have an essential role in the global trade, but they also adversely impact the environment. By reviewing the literature on the research topic, gaps were revealed that requires addressing in order to achieve the research objectives. The literature review showed that global logistics hubs have no clear operational or conceptual model in the literature. Previous scholars who studied global logistics hubs failed to address their heterogenous nature, since they usually have different ownership and governance settings, economic development levels, operation systems, sustainability approaches, or market to serve, which in turn will have an effect on developing a clear, inclusive and holistic definition and framework. Additionally, the vagueness of the responsibilities of global logistics hubs' environmental sustainability and the influence of stakeholders regarding this issue is another aspect that is not addressed in the literature. It will help the research in viewing the issue holistically, especially that stakeholders' interest is the motive behind sustainable development of organizations. Furthermore, several constituents of global logistics hubs are environmentally aware of their impact and have sustainability strategies and management tools in an individual organization's efforts. However, they are not integrated to address the environmental sustainability of the global logistics hub as a whole or as a system of agglomerated activities. By integrating the environmental sustainability and measurement of global logistics hubs constituents, it will result in a more efficient and effective management of the environmental externalities and will unveil possibilities that will affect the management of these externalities

To address the research gaps, the following questions are going to direct the research towards the research objectives:

- What are the constituents of a global logistics hub?
- Who is responsible for the environmental sustainability of global logistics hubs? And who would manage the integration of the environmental sustainability of global logistics hubs constituents?
- How would the stakeholders be involved and affect the integration and how would they come together and integrate?

- What are the drivers and barriers that face global logistics hubs when integrating their environmental sustainability measures?
- What are the environmental externalities resulting from global logistics hubs' agglomerated activities that are additional to that of a seaport or a port cluster?

Conclusions

Environmental sustainability has attracted much attention lately. Global logistics hubs are important links in the global trade network and they have a lot of advantages for the regions hosting them. However, they still affect the environment immensely with the agglomeration of transport and logistics activities. The activities and operation model of global logistics hubs as a whole are not clear in the literature, which makes exploring their environmental sustainability and measurement difficult. Even the existing literature discusses the individual attempts of the constituents of global logistics hubs in managing their environmental sustainability. Additionally, the literature is lacking the stakeholders position or influence on the environmental sustainability of global logistics hubs. While it is beneficial that individual organizations are concerned with their environmental sustainability, the integration of these constituents under a holistic system to measure and manage the environmental sustainability would improve the efficiency of the system, reduce duplication, include all parts of the global logistics hubs whether they have a small impact on the environment or they are just a small organization that their impact would be overlooked. By exploring the stakeholders effect on the environmental sustainability, it will improve the understanding of the macro and micro setting of the global logistics hub operation. Furthermore, this paper is reporting an ongoing research and it is mainly presenting the preliminary findings of reviewing the literature through the gaps found and the questions that are going to be addressed in the next steps. These questions are going to explore the scene through an inductive approach on global logistics hubs and their environmental sustainability. The following steps would be to select the pertinent case studies to explore the real-life situation, create the interview structure and specifying the interviewees.

References

- *Alam, S. A. (2013), 'Evaluation of the potential locations for logistics hubs: A case study for a logistics company'.*
- *Beresford, A.K.C., Gardner, B.M., Pettit, S.J., Naniopoulos, A. and Wooldridge, C.F., (2004). 'The UNCTAD and WORKPORT models of port development: evolution or revolution?' Maritime Policy & Management, 31(2), pp.93-107.*
- *Carter, C. R. & Rogers, D. S. (2008). 'A framework of sustainable supply chain management: moving toward new theory'. International journal of physical distribution & logistics management, 38(5), 360-387.*
- *Collis, J. & Hussey, R. (2013) 'Business research: A practical guide for undergraduate and postgraduate students'. Palgrave macmillan.*
- *De Langen, P.W., (2004). 'The Performance of Port Clusters'. Journal of International Logistics and Trade, 2(1), pp.47-56.*
- *DEFRA (2011) 'Environmental Key Performance Indicators'. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69281/pb11321-envkpi-guidelines- 060121.pdf [Accessed August 2017].*
- *Easterby-Smith, M., Thorpe, R. & Jackson, P. R. (2012) 'Management research'. Sage.*
- *Ellram, L. M. (1996). 'The use of the case study method in logistics research'. Journal of business logistics, 17(2), 93.*
- *Evangelista, P., (2014). 'Environmental sustainability practices in the transport and logistics service industry: An exploratory case study investigation'. Research in Transportation Business & Management, 12, pp.63-72.*

- *Flynn, M. and Lee, P.T.W., (2010). 'Customer-Centric and Community Ports as the Next Step on the Port Ladder: The Fifth Generation Ports'. In The 8th Asia Pacific Transportation Development Conference, Tainan, Taiwan, May (pp. 27-30).*
- *Freeman, R. (1984) 'Strategic management: A stakeholder theory'. Journal of Management Studies, 39(1), 1-21.*
- *Haezendonck, E., (2001). 'Essays on strategy analysis for seaports'. Leuven, Garant.*
- *Haezendonck, E. and de Langen, P.W., (2012). 'Ports as cluster of economic activity'.*
- *Lam, J.S.L., Ng, A.K. and Fu, X., (2013). 'Stakeholder management for establishing sustainable regional port governance'. Research in Transportation Business & Management, 8, pp.30-38.*
- *Lavassani, K. M. & Movahedi, B. (2010). 'Critical Analysis of the Supply Chain Management Theories: Toward the Stakeholder Theory', POMS 21st Annual Conference, Vancouver.*
- *Lee, K. L., Huang, W. C. & Teng, J. Y. (2009). 'Locating the competitive relation of global logistics hub using quantitative SWOT analytical method'. Quality & Quantity, 43, 87-107.*
- *Lee, K. H. & Wu, Y. (2014). 'Integrating sustainability performance measurement into logistics and supply networks: A multi-methodological approach'. British Accounting Review, 46, 361- 378.*
- *Notteboom, T. (2011) 'An application of multi-criteria analysis to the location of a container hub port in South Africa'. Maritime policy & management, 38(1), 51-79.*
- *Notteboom, T., Parola, F., Satta, G. & Risitano, M. (2017,) 'A taxonomy of logistics centres: overcoming conceptual ambiguity'. Transport Reviews, 37(3), 276-299.*
- *O'Riordan, T. ed., (2014). 'Environmental science for environmental management'. Routledge.*
- *Roh, H.S., (2006). 'A Conceptual Model of Port Clusters and Related Assemblages'. Journal of Navigation and Port Research, 30(2), pp.145-150.*
- *Rondinelli, D. & Berry, M. (2000). 'Multimodal transportation, logistics, and the environment: managing interactions in a global economy'. European Management Journal, 18(4), 398-410.*
- *Secretariat, U.N.C.T.A.D., (1999).' Technical note: Fourth-generation port', Ports Newsletter, 11, pp.9-10.*
- *Sheffi, Y. (2012), 'Logistics clusters: delivering value and driving growth'. MIT press.*
- *Veldman, S. J., Bückmann, E. H. & Saitua, R. N. (2005). 'River depth and container port market shares: The impact of deepening the Scheldt River on the West European container hub-port market shares'. Maritime Economics and Logistics, 7, 336-355.*
- *Wan, Z., Zhang, Y., Wang, X. and Chen, J., (2014). 'Policy and politics behind Shanghai's free trade zone program'. Journal of Transport Geography, 34, pp.1-6.*
- *Xiao, X. & Liu, N. (2017). 'Container hub port competition and cooperation in Northeast Asia'. International Journal of Shipping and Transport Logistics, 9, 29-53.*
- *Yang, Y.-C. & Chen, S.-L. (2016). 'Determinants of global logistics hub ports: Comparison of the port development policies of Taiwan, Korea, and Japan'. Transport Policy, 45, 179-189.*
- *Yin, R. K. (2013) 'Case study research: Design and methods'. Sage publications.*
- *Zhang, W. and Lam, J.S.L., (2013). 'Maritime cluster evolution based on symbiosis theory and Lotka–Volterra model'. Maritime Policy & Management, 40(2), pp.161-176.*
- *Zhaoliang, L., Xu, Z. and Baoyi, Z., (2009), August. 'Study on the relationship between port cluster and regional economic development with SD'. In Automation and Logistics, 2009. ICAL'09. IEEE International Conference on (pp. 1800-1805). IEEE.*

EVALUATION OF THE USE OF PUBLIC SPACE IN CITIES: A PILOT-STUDY OF COMPETING USES INCLUDING URBAN LOGISTICS

Alena Brettmo[1], Henrik Ringsberg[2] and Michael Browne[1]
[1]University of Gothenburg, School of Business, Economics and Law, Sweden
[2]University of Borås, School of Engineering, Sweden

Introduction

On September 25th 2015 the United Nations launched 17 goals for sustainable development of societies based on a mutual cooperation between authorities, the industrial sector, civil society and residents (United Nations, 2018). In addition, the number of residents in cities is expected to grow by 60 percent until 2030 (United Nations, 2016). Development of cities based on an expected increase of residents is addressed in UN sustainable goal 11 sustainable cities and communities, which emphasize sustainable development of services, energy, transportation, and housing for all city stakeholders (United Nations, 2018).

To enhance development of sustainable urban freight transport, city-logistic systems have been implemented in European countries such as The Netherlands, United Kingdom, and Portugal (Vaghi, 2013; Leonardi et al. 2014; Rooijen & Quak 2010). Published studies reveal that transport in urban environment is mostly operated by road (London Freight Data Report, 2014). In addition, residents in urban environments have become increasingly aware of factors that positively affect their standard of living, but require PS in the urban environment (Broere, 2016). It ought also to be noted that the PS used for speed reduction facilities to ensure safety for residents has increased as a result of concern about recent terrorist attacks (SvD, 2018).

Stakeholders in urban environments have different interests in city-logistics and interests may contradict with one another (Ballantyne, Lindholm & Whiteing, 2013). Because of this improvement of transport within urban environment requires involvement of all stakeholders (Lindholm & Blinge, 2014), and understanding of different stakeholder interests (Stathopoulos, Valeri & Marcucci, 2012). Further, the use of public space (PS) in the urban environment is linked to interests of administrators (i.e. local authorities), suppliers (i.e. distributors), carriers (i.e. transporters) property owners, receivers (i.e. business owners), residents and visitors. Despite numerous published papers on city- logistics, there is still a lack of studies which evaluate stakeholders' interests in PS within urban environments. To fill this gap, this paper presents a conceptual framework to evaluate the stakeholder interest and rights to influence the use of PS in urban environment, in accordance with the following formulated research question:

How should the use of public space be evaluated based on different stakeholder interests?

To answer the research question, the paper begins with a review of scientific papers on urban freight transport, city-logistics, and the use of PS in urban environments. Based on the literature review, a conceptual framework, to evaluate the use of PS based on stakeholders' interests and rights to influence the use PS in urban environment is proposed (Section 2). Next, the methodology and a case study of a street attached to a city-logistics system are presented (Section 3). To evaluate use of PS in an urban environment, the paper adopts the presented framework (Section 4). The paper ends with a results and discussion, managerial implications and suggestions for further research (Section 5).

Literature review

Stakeholders in city-logistics

Ballantyne, et al. (2013), define stakeholders in city-logistics are "all that have an interest in the system of urban freight transport (individuals, groups of people, organisations, companies, etc.); whereas actors are those that have a direct influence on the system. Therefore, all actors are stakeholders, but not all

stakeholders are actors." (Ballantyne et al. 2013, p. 98). Published research proposes that main stakeholders in city-logistics consist of:

- Administrators refers to local authorities who create opportunities and regulations to sustain attractive development of the urban environment.
- Suppliers, refers to actors involved in the shipment of goods increasing their efficiency and competitiveness.
- Carriers, refers to transporters who focus on to enhance efficiency and reduction of transport costs.
- Receivers, refers to offices, stores, restaurants, cafés, and end-customers who has a common interest in reliable transport of goods with a minimal impact on the urban environment. Large goods receivers in the cities are retailers and offices on the high streets.
- Residents, visitors, refer to individuals whose interest is a well-accessible, comfortable and lively city centre with reliable access to goods but who may be adversely affected by goods transport. (Ballantyne et al., 2013; Urban Freight Initiative, 2016; Quak & Tavasszy, 2011)

Published research shows that stakeholders in city logistics have different interests and goals and this complication result in adverse impacts for the development of city-logistics initiatives (Ballantyne et al., 2013; Anand et al., 2012). For example, Anand et al., (2012) addresses severe impacts on decision making due to stakeholder goal conflicts. Stathopoulos et al., (2012) mention that the large number of stakeholders with different interests creates problems in city-planning, supported by Lindholm & Blinge (2014) who highlight the importance of including all stakeholders in plans to improve urban freight. In addition, published research shows that while public space is important for urban logistics activities so too is private space such as that used for warehouses and distribution centres (Hesse & Rodrigue, 2004). As a result it is important to recognise that the use of space in the urban environment is linked to ownership, market values, level of profitability, and user interests and rights.

The use of PS in the urban environment

The use of PS in the urban environment is affected by commercial interests and public interests. However, public interests in the use of PS such as for roads, curbs, pavements, are owned and managed by administrators, (i.e. local authorities) and used to enhance accessibility, safety and service in the urban environment. Because of this, PS is often taken for granted, sometimes with poorly defined and unclear rights to use them based on previous actions and practices.

Commercial interest in the use of PS

The review of published literature reveals that the commercial interest in the use of PS in the urban environment is used for out-door seating, loading zones for goods deliveries, and advertisement signs.

Outdoor seating: Restaurants and cafés provide outdoor seating for their guests especially during high season. This allows them to increase the productive space for accommodation of an increased number of customers (Heo, 2013). However, local regulations about outdoor seating differ between municipalities.

Loading zones: Efficient goods deliveries in urban areas require the presence of loading zones for loading and unloading of goods (Russo & Comi, 2010). The accessibility to loading zones in commercial areas decreases the total delivery time as well as dwell time of the vehicles by providing the space for parking during loading/unloading of goods. There are public loading/unloading zones, but also private loading zones and loading bays, which are designated only for the loading/unloading activities for certain goods receivers (Dezi et al., 2010; Giron et. al., 2018).

Advertisement signs: Receivers (i.e. shops, offices, restaurants and cafés) sometimes occupy the public space with advertisement signs to attract visitors and customers. Published research also shows that the use of advertisement do not adversely affect road safety, since drivers must cope with a load of information from other vehicles, traffic- and direction signs, shop labels, and pedestrians (Yannis, et al., 2013). The advertisement signs may however impede pedestrian and traffic accessibility, pedestrian and traffic movement and visibility.

Public interests in interest in the use of PS
Public interests include the use of PS to enhance accessibility, safety and service in the urban environment.

PS to enhance accessibility
PS used in the urban environment to enhance accessibility includes the use of roads, pedestrian streets and pavements.

Roads: Due to competition from several stakeholders and spatial resource limitations roads in the urban environment are often heavily congested (Allen et al., 2014). This traffic impedes people and goods movement dramatically, impairs economic development and results in negative impacts on urban the liveability of cities (Browne et al., 2017). To decrease congestion in the urban environment, some cities have implemented congestion charging or road tolls. It ought however to be noted that road tolls reduce the congestion caused by private car users and not by goods transport (Holguín- Veras & Sánchez-Díaz, 2015).

Pavements: Pavements in the urban environment are mainly used for walking by pedestrians but also for parking of bicycles and transport vehicles during loading and unloading of goods. Due to the infrastructural design of cities the PS for parking of vehicles, to enhance accessibility of transports, and availability to pavements is limited. In addition, accessibility to PSs for loading or unloading of goods is often not taken into consideration in city- planning. Many municipalities also try to regulate PS used for parking of transport vehicles in busy areas (Giron et. al., 2018).

Pedestrian streets: In Europe there is a growing trend to pedestrianize the streets in the urban environment (Ballantyne, et al., 2013). This contributes to the liveability of the cities, making them more accessible and friendly for the visitors, increase retailers turnover, shop occupancy and value of the properties (Soni & Soni, 2016). To comply with interests of carriers due to pedestrian streets, goods transport are allowed to use parallel streets and then the final distance is made by foot or delivery vehicles are allowed to drive in during certain hours and/or to certain areas (Verlinde, Kin, Strale, & Macharis, 2016). Furthermore, regulations concerning the use of PS on pedestrian streets are still often unclear which contributes to conflicts between stakeholders' interests and misunderstandings in the usage of the pedestrian street.

PS to enhance safety
Due to recent terrorist attacks, the management of PS within European cities has received increased attention in order to find speed reduction mechanisms such as medians, pinchpoints, chicanes, vertical speed humps, lane shifts, and roundabouts. One of the measures successfully used by municipalities to ensure safety is using several speed reduction mechanisms (NACTO, 2018).

PS used to enhance service
PSs used to enhance service for residents and visitors in urban environment include customer parking and municipal service.

Customer parking: The availability of customer parking is considered to be an important service that creates an added value for visitors. Because of this receivers emphasize to have the PS used for customer parking close to their premises (Soni & Soni, 2016). However, research has been published which show that the availability of customer parking attracts additional visitors (Kumar & Ross, 2006). It ought also to be noted that customer parking is a source of financial income for municipalities.

Municipal service: PS used in the urban environment to provide municipal service that improve residents' quality of life (Hourie, et al., 2015), such as public waste collection points, and entry points to water and sewerage system. Allocation of the PS is conducted in compliance with regulations on safety and waste management. In addition, to provide safety and security as an added value for visitors, PS is used for tourist information signs (WTO, 1996).

A conceptual framework for evaluation of stakeholder interests in PSs

Evaluation of PS usage in urban environment is complex issue since interests and influence of stakeholders must be considered (Ballantyne et al. 2013). From the literature review, it emerged that the use of PS is linked to commercial and/or public interests. According to published literature, public interests linked to use of PS has an indirect impact on the commercial interests (Figure 1) due to creation of added values for residents and visitors (e.g. customer parking, municipal service, accessibility)

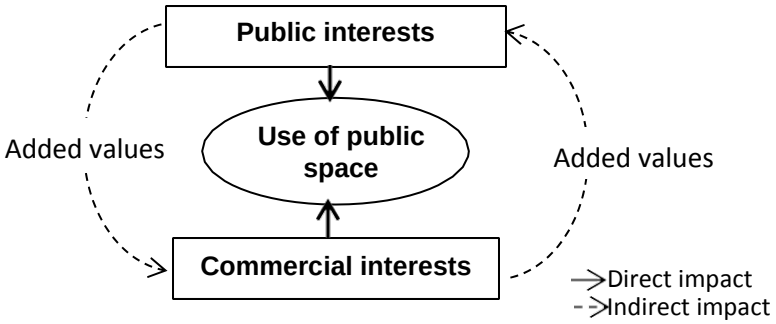


Figure 1: Conceptual framework for evaluation of stakeholder interests in public spaces

Methods

The objective of this paper is to evaluate stakeholder interest in the use of PSs in the urban environment. To comply with the objective, an iterative matching process between a developed conceptual framework, empirical data sources and analysis according to system combining has been applied (Dubois & Gadde, 2014). The conceptual framework was developed based on a literature- review of peer-reviewed papers published during 10 years (i.e. 2008 and 2018) in logistic and transport journals. Peer-reviewed papers were identified through a literature search based on the use of the keywords “city logistics”, “urban logistics”, “spaces”, “stakeholders” and a combination of the mentioned keywords in the titles, keywords and abstracts of peer-reviewed papers found in databases at Emerald (www.emeraldinsight.com), Wiley (www.wiley.com), Science Direct (www.sciencedirect.com) and Taylor and Francis. In addition to search in databases at publishing firms google scholar was used. The search ended up in an initial selection of 36 peer-reviewed papers. Next, duplicates in the initially selected papers were removed, which narrowed down the total amount of papers to 23. The peer-reviewed papers in the initial selection were then read to determine whether or not they matched the objective of the present paper. If the selected peer- reviewed paper matched the objective of this paper, it was selected for a final analysis. In total 11 peer-reviewed papers were selected for final analysis to be used as frame of reference and in development of the conceptual framework.

To evaluate stakeholder interest in the use of PS based on the developed framework, empirical data was collected from single casestudy (Yin, 2009) which consisted of a pilot study of a street attached to a city-logistics system. According to Dubois and Gadde, (2002), single-case studies are appropriate if the research problem includes interdependent variables. Since public interest in PS affect commercial interests, empirical data was collected from a single case study (Yin, 2009). The single case study included owners of restaurants/cafés with outdoor seating facilities, retailers (store managers) and managers employed at property owners and at the local authority (Table 1).

Stakeholder category	Stakeholder	Distributed questionnaires (No.)	Completed questionnaires (No.)
Receivers	Property owners	2	2
	Store	9	5
	Restaurant/café	3	2
Total:		14	9

Table 1 Stakeholders and questionnaires included in the study.

A questionnaire containing 12 semi-structured questions was used as source of empirical data. Structured questions focused on interest in the use of PS, and rights to use it in the urban environment based on the location of business and residents within buildings (i.e. ground floor; second floor; third floor; and fourth floor). In addition, the influence of the local authority, transporter, property owner, carriers and visitor interests was evaluated. Likert-scales ranged between 1 (i.e. low) to 5 (very strong) according to Trochim et. al., (2016) was used in used in evaluation of stakeholder interest and influence of stakeholder interests. Open-ended questions in the questionnaire included stakeholder opinions (Trost & Hultåker, 2016) about city-logistics, and estimation of revenues and costs linked to the use of PS. In total, the questionnaire was sent out to 14 respondents with a return of questionnaires from 9 respondents. In addition, empirical data from participant observations were used as an empirical source of evidence as suggested by Yin (2009).

Results and discussion

This paper presents a conceptual framework to evaluate stakeholder interests in the use PSs in the urban environment. The results show that stakeholders' interests are linked to commercial interests and public interests in the use of PSs. Analysed results from the questionnaire and participant observations reveal that PSs in the urban environment are used for:

- Outdoor seating at restaurants and cafés: the PS is mainly used during April to October. During this period outdoor seating may act as a barrier to urban goods deliveries (both in access to establishments and in terms of finding spaces to unload).
- Loading zones: Loading zones: surprisingly, results from analysed questionnaire shows a lack of interest to use PS for loading zones. This is because stakeholders included in the study consider usage of PS for loading zones to be an issue for transporters.
- Advertisement signs: PS for advertisement signs should be considered on a year round basis. The use of advertisement signs is however sometimes a barrier for urban goods transport. This result was confirmed by one of the store owners who mentioned: "Our advertisement signs have been run-over several times by the transport companies, so we decided to place them on the building instead" (Owner, store 3).

Further, the results from analysed questionnaires retrieved from commercial business owners' shows a high interest the use of roads, pavements and pedestrian streets, followed by an average interests linked to the use of PS for municipal service, and an average or low interest in the use of PS to enhance security. Surprisingly, the results also show a low interest to use public spaces in the urban environment for customer parking and thus contradict research presented by Soni & Soni, (2016). One explanation for this is, however that the shared public space is very limited in the street under study resulting in limited interest from the stakeholders customer parking. This contradicts with the results from analysed questionnaires filled in by the property owners which show a high interest in the use of public space for customer parking.

The questionnaire also sought responses about the views of the selected stakeholders on which stakeholder should have the right to influence the use of public space. Results from the evaluation show that restaurants and cafés with outdoor seating, followed by stores located on the ground floor felt that they should have the greatest rights to influence the use of public space (presumably as such use has a direct business impact). The results also showed an interest from stakeholders to maintain a lively street with reliable access for visitors and residents. The analysis of the questionnaires indicated that the participating stakeholders considered that residents should have little or no right to influence the use of PS. This especially regards to residents on level 3 and level 4. This result requires special attention since the market price of residential city apartments in Sweden increases proportionally with the higher floor level of the apartment. Thus, a resident who owns an expensive apartment may face a view that they should have no or little right to influence the use of the PS outside the building in which they live. The study showed that the participating stakeholders felt that administrators, carriers and suppliers should have very limited influence on the use of PS, while visitors should have no influence. However, according to analysed questionnaire results from the receivers, property owners should have great opportunities to influence the

use of PS, and to decide how such space should be managed. This is an interesting result, since the streets are public spaces and thus should be managed by local authorities.

This paper targeted a limited amount of receivers and property owners on a single street in Sweden, hence, generalization is not appropriate. In addition, local authorities, carriers, and residents were also excluded as stakeholders in the study. Future research will be carried out to widen the representation to all categories of stakeholders and also to consider other streets and other cities. Finally, another avenue for future research relates to understanding costs and revenues linked to stakeholder maintenance responsibilities, and use of PS in the urban environment.

References

- Allen, J., Browne, M., & Woodburn, A. (2014), *London freight data report: 2014 Update*. Technical Report. Transport for London, London.
- Anand, N., Quak, H., van Duin, R. & Tavasszy, L. (2012), "City Logistics Modeling Efforts: Trends and Gaps - A Review", *Procedia - Social and Behavioral Sciences,* Vol. 39, pp. 101-115.
- Ballantyne, E. E. F., Lindholm, M., & Whiteing, A. (2013), "A comparative study of urban freight transport planning: addressing stakeholder needs". *Journal of Transport Geography, Vol. 32*, pp. 93-101.
- Broere, W. (2016), "Urban underground space: Solving the problems of today's cities",
- *Tunnelling and Underground Space Technology*, Vol. 55, pp. 245-248.
- Browne, M., Macharis, C., Sanchez-Diaz, I., Brolinson, M., & Billsjö, R. (2017), "Urban traffic congestion and freight transport: A comparative assessment of three European cities". In: Proceedings of the Interdisciplinary Conference on Production, Logistics and Traffic, Darmstadt, Germany.
- Dezi, G., Dondi, G., & Sangiorgi, C. (2010), "Urban freight transport in Bologna: Planning commercial vehicle loading/unloading zones", *Procedia - Social and Behavioral Sciences, Vol. 2, No.* 3, pp. 5990-6001.
- Dubois, A. & Gadde, L.-E. (2002), "Systematic combining: an abductive approach to case research", *Journal of Business Research*, Vol 55 No. 7, pp. 553-560.
- Giron, G., Goodchild, A., Ivanov, B., Kim, H. & Machado, J. (2018), "The Final 50 Feet Urban Goods Delivery System", Supply Chain Transportation & Logistics Center, University of Washington, Seattle, USA.
- Heo, C. Y. (2013), "Restaurant revenue management", *Revenue management for hospitality and tourism. Woodeaton, Oxford: Goodfellow Publishers ltd*.
- Hesse, M., & Rodrigue, J.P. (2004), "The transport geography of logistics and freight distribution". *Journal of Transport Geography,* Vol. 12, No. 3, pp. 171-184.
- Holguín-Veras, J. & Sánchez-Díaz, I. (2016), "Freight Demand Management and the Potential of Receiver-Led Consolidation programs", *Transportation Research Part A: Policy and Practice*, Vol. 84, pp. 109-130.
- Hourie, E., Malul, M. & Bar-El, R. (2015), "The social value of municipal services", *Journal of Policy Modeling*, Vol. 37, No. 2, pp. 253-260.
- Kumar, S., & Ross, W. (2006), "Effects of pedestrianisation on the commercial and retail areas: study in Khao San road, Bangkok". *World Policy and Practice*, Vol. 13, No. 1.
- Kvale, S. (2007), *Doing Interviews*. Thousand Oaks, CA, Sage Publications.

- Leonardi, J., Browne, N., Allen, J., Bohne, S. & Ruesch, M. (2014), "Best Practice Factory for Freight Transport in Europe: Demonstrating How 'Good' Urban Freight Cases are Improving Business Profit and Public Sectors Benefits". *Procedia - Social and Behavioral Sciences,* Vol. 125, pp. 84 - 98.
- Lindholm, M. E. & Blinge, M. (2014), "Assesing knowledge and awareness of the sustainable urban freight transport among Swedish local authority policy planners", *Transport Policy*, Vol. 32, pp. 124 - 131.
- NACTO, (2018). *Speed Reduction Mechanisms* [online]. National Association of City Transportation Officials. Available from: https://nacto.org/publication/urban-street-design- guide/design-controls/design-speed/speed-reduction-mechanisms/ [Accessed 14 June 2018].
- Rooijen, T. & Quak, H. (2010), "Local impacts of a new urban consolidation centre – the case of Binnenstadservice", *Procedia - Social and Behavioral Sciences,* Vol. 2, p 5967-5979.
- Russo, F. & Comi, A. (2010), "A classification of city logistics measures and connected impacts", *Procedia Social and Behavioral Sciences,* Vol. 2, pp. 6355-6365.
- Soni, N., & Soni, N. (2016), "Benefits of pedestrianization and warrants to pedestrianize an area", *Land Use Policy,* Vol. 57, pp. 139-150.
- Svenska Dagbladet, (2018), "Nu vaktar nya betonglejon Drottninggatan", Available from: https://www.svd.se/nya-betonglejon-vaktar-drottninggatan [Accessed 19 May, 2018].
- Stathopoulos, A., Valeri, E. & Marcucci, E. (2012), "Stakeholder reactions to urban freight policy innovation", *Journal of Transport Geography*, Vol. 22, pp. 34-45.
- Trochim, W.M., Donnelly, J.P. & Arora, K. (2016), *Research Methods- The essential knowledge base*, (2nd edn). Boston, US, Cengage Learning.
- Trost, J. & Hultåker, O. (2016), *Enkätboken*, (5th edn). Lund, Sweden, Studentlitteratur.
- United Nations (UN), (2018), "Sustainable development goals, 17 goals to transport our world", Available from: https://www.un.org/sustainabledevelopment/sustainable- development-goals/ [Accessed 19 May, 2018].
- United Nations (UN), (2016), "The World's Cities in 2016", Data booklet, Available from: http://www.un.org/en/development/desa/population/publications/databooklet/index.shtml [Accessed 19 May, 2018].
- Urban Freight Initiative (2016), "Why goods movement matters", Available from: http://goodsmovementmatters.org/ [Accessed 20 May, 2018].
- Vaghi, C. (2013). "Cityporto – Last mile deliveries in Padua", Available from: http://www.bestfact.net/category/urban-freight/, [Accessed 3 April, 2018].
- Quak, H. & Tavasszy, L. (2011), "Customized Solutions for Sustainable City Logistics: The Viability of Urban Freight Consolidation Centres", *Transitions Towards Sustainable Mobility* pp 213-233.
- World Tourist Organisation, (1996), *Tourist Safety and Security: Practical Measures for Destinations*, Available from: https://www.e-unwto.org/doi/pdf/10.18111/9789284401529 [Accessed 19 June, 2018].
- Yannis, G., Papadimitriou, E., Papantoniou, P. & Voulgari, C. (2013), "A statistical analysis of the impact of advertising signs on road safety", *International Journal of Injury Control and Safety Promotion*, Vol. 20, No. 2, pp. 111-120.
- Yin, R. (2009), *Case study research: design and methods*, (4th edn.). Thousand Oaks, CA: Sage Publications.

THE MAIN FACTORS DETERMINING POSITION OF WOMEN IN CONTEMPORARY LOGISTICS AND SUPPLY CHAINS

Danuta Kisperska-Moroń
Department of Business Logistics, University of Economics in Katowice, Poland

Introduction

Human factor is one of the most important issues of supply chain and logistics, it is subject to essential transformation concerning a profile of skills and competencies. The view that human capital in supply chain management needs to be given far more attention today than ever before is gaining more and more support (*Success Factor*…, 2004). Research indicates that making the best use of the human capital will be the essential success factor in supply chain management. The leading companies invested 44% more into their work force than their competitors. They have more sophisticated human resource management and they have more flexible labour force (Kisperska-Moroń, Klosa, 2017).

All over the world businesses increasingly face the challenge of managing a more diverse workforce. That twenty-first century trend was indicated already long time ago (Nelton, 1995). One of the most important profile of such diversity is the growing number of working women. In terms of changes across time, the female labour force participation rate today is higher than three decades ago. Around the world men tend to participate in labour markets more frequently than women, however, there are huge differences across countries (Ortiz-Ospina and Tzvetkova, 2017). The female-to-male ratio of labour force participation rates, differs from 20% to 110%. In 2015 in countries such as Syria or Algeria, the ratio was below 25%. At the same time in Laos, Mozambique, Rwanda, Malawi and Togo, the relationship was close to, or even slightly above 100%, indicating that there was a gender parity in labour force participation or even a higher share of women participating in the labour market than men. The highest women participation rates were typical for the poorest countries within Africa and the richest European countries (Ortiz-Ospina and Tzvetkova, 2017).

A large part of female employment around the world takes place in the informal economy, and particularly in many low and middle income countries, the vast majority of women engaged in paid work are in the informal economy. The share of women employed in various sectors of the economy (e.g.in the US) differs also between industries (Figure 1).

The debate on discrimination against women in the labour force is still very much an open topic, and one that affects all economic sectors and positions/levels of responsibility. In certain industries such as logistics and transportation, the difference in gender representation is so large that it denies any statistics that could indicate a trend of improvement (Mateu, 2017). Therefore, women are easily overlooked as a significant part of the logistics industry.

The purpose of this study is double fold. First of all it aims at exploring potential career-related concerns and problems among female logisticians and supply chain decision makers. Secondly, it suggests potential career patterns of females who currently are or might be involved in logistics and supply chain disciplines.

In order to achieve these goals the following research questions have been formulated:
RQ1: What logistics disciplines offer actual good conditions for women's employment?
RQ2: How do women in logistics perceive selected career-related opportunities and issues?
RQ3: What factors contribute to successful career patterns experienced by female logistics professionals?

All these issues deserve additional studies since despite some research contributions reaching even the year 1990, many aspects have not been investigated yet and not well implemented in practice.

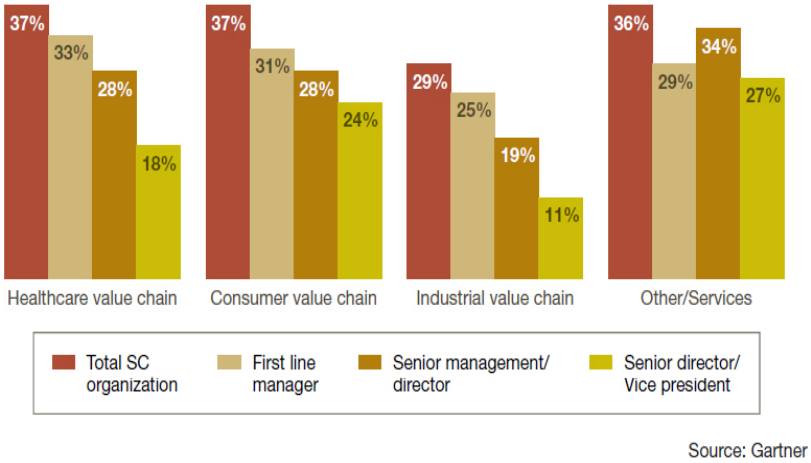


Figure 1: Participation of women varied by industry
Source: Survey Analysis: Women …, 2016

The role of women in the logistics and supply chain sector

Logistics sector has traditionally been associated with physical work and, consequently, considered a masculine sector. Jobs involving a considerable amount of physical work such as machine operators and storage technicians are very much male-dominated. However, qualifications required today in logistics operations reach far beyond physical work and requirements for physical strength are not essential for all types of supply chain management positions. Despite that, there's still a huge gap between the number of women and men working in the sector. Women made up 46.8% of the US labour force in 2015. However, in the US Transportation & Utilities sector, women constitute only 22.6%, even if according to the US Bureau of Labour Statistics, the trade, transportation, and utilities industry is the second largest employer of women, after manufacturing. In 2016, the industry registered a 3.9% increase of women employment from 2006 (Mateu, 2017).

Some EU statistics concern the share of women in transport in the European countries. In the transport industry in Poland the proportion is 20% women and 80% men (Eurostat Labour Force Survey, 2018). The largest share of women in transport industry is typical for such countries like Cyprus (31%), France (27%) and Czech Republic (26%). On contrary, the lowest share was noticed in Luxembourg (12%), Greece and Slovenia (in each of them - 16%).

In supply chains collaborative skills are especially important (Pateman, Cahoon, Chen, 2016). The ability to effectively negotiate and work with multiple stakeholders—whether this is internally among marketing, engineering and supply chain, or externally between trading partners—is key to smooth and efficient supply chain management.

The study completed by Danish consultancy, Innovisor in 2012 , based on a survey of around 1,000 people from more than 30 countries, found that irrespective of their cultural origin, women are keener than men to collaborate to achieve a common goal. They often will take the role of bringing about collective success even if it comes at their own expense in terms of recognition and advancement. Moreover, women expressed "a clear desire to collaborate even more than they already do today – a desire that men don't appear to share" (Amble, 2012). What is also interesting, people are far more inclined to cooperate with others of the same sex.

Despite such a clear merit connected to female operations and management style, practice of the share of women in the management staff does not confirm any extend use of collaborative abilities of female managers. Gartner, Inc. shows that the share of women in management drops down at higher managerial levels (Figure 2).

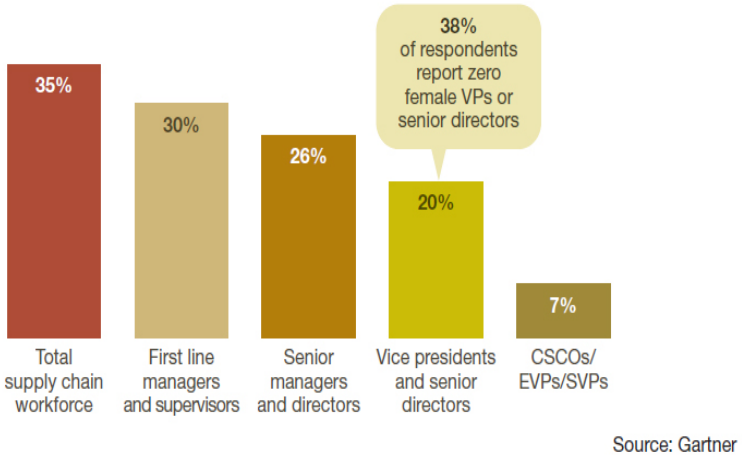


Figure 2: Women in supply chains 2016
Source: Survey Analysis: Women …, 2016

APICS research conducted in 2018 (Supply Chain Compensation… , 2018) indicates that there is a gender gap between men and women in salaries in the supply chain field. Male respondents of the survey reported average salaries that are 15,8% higher than those reported by female respondents. The disparity increases with the number of years of employment in the field. There is also a gender difference in position level with a significantly higher proportion of men in upper position levels. At the staff/associate level the share of women is slightly larger than the share of men. At higher hierarchical levels the share of men is much larger and in particular reaches the 2-to-1 ratios at director and vice president levels, and even 4-to-1 at executive level. However, field tenure appears to be similar between the two groups.

A study of Fortune 500 companies, completed by Catalyst, a global nonprofit corporate membership research and advisory organization, found that companies with the highest representation of women in leadership positions experienced a 35% greater return on equity and 34% higher return to shareholders. Fortune 500 companies with at least three women board directors experienced a 66% higher return on invested capital, a 42% higher return on sales and a 53% higher return on equity. Women leaders play an important role in understanding and addressing customer needs, since roughly 50% of the population are women and 80% to 85% of all consumer decisions are made by women (Wilson, 2017). „Smart companies appreciate that diversifying their boards with women can lead to more independence, innovation, and good governance and maximize their company's performance." (*Companies With More Women*..., 2004).

Besides financial aspects some studies indicate that women are more likely to make ethical choices than men and years of women's experience in their jobs is correlated with higher level of ethical behaviour (Glover et al, 2002). Such results might have some implications for rethinking gender differences in logistics and supply chain leadership and management.

Methodology

The paper presents an exploratory approach to female positions in logistics and supply chain. After detailed literature studies the main potential problems faced by the female staff in logistics disciplines were identified. Basic information and data was obtained from the reports on empirical analyses conducted by professional agencies and corporations reported on numerous internet portals. Several interviews with logistic professionals were also conducted in order to support publicly published information. Basic empirical quantitative data deals with the US logistics sector since in that country such information has been widely published on different web pages.

Career prospects for women in logistics and supply chains

The quality of operations within the supply chain depends on people who make decisions and take actions based on their abilities and habits, their motivation and natural talents. Professional qualifications and personal qualities are particularly important for effective logistics operations in terms of both practical experience in logistics operations and high-level education are important (*Employment and Qualifications …*, 2005). Here are some of the most important items shaping the whole picture of SCM qualifications:

- The logistics manager has to negotiate the often-conflicting interests of the different employees, sections and departments, in the context of an integrated process. Having identified the actual cause-and-effect relationships in the logistics system and its environment a logistician will develop and propose solutions based on compromise between the conflicting elements.
- Logistics personnel have to become members of operating teams and exhibit an exceptional capability of adaptation. In addition, logistics managers need to acquire the ability of non-standard thinking, and they must be able to critically examine the options for improving their performance. They have to acquire the ability to look from the specific perspective of logistics management.
- Clearly enough, communication skills are becoming crucial, since logistics managers have to be very persuasive when announcing their compromise proposals.
- The *kaizen* principle of constant learning – should organise rotate training in order to obtain an in-depth knowledge of all company departments and of the links with other organizations and institutions.
- Logistics management has changed dramatically with advancing computerisation (e.g. the computerised processes of product dispatch, satellite systems, radio systems for inventory management, and the Internet). Working in a fully automated logistics requires super-standard skills.

The future working environment will demand even higher flexibility and adaptability, decision-making skills, creation of professional links, and sensitivity to corporate culture. It is for these reasons that the demand for well-educated personnel is still increasing, even at the operational level of order fulfilment (Ozment, Keller, 2009). Requirements for those skills, quite often typical for well educated female personel, should lead to more equal employment rates between men and women. This is a desirable objective for any company, but such a movement is even more vital for the logistics sector, where the gap between men and women is so large and completely unjustified in the contemporary business.

Many business nowadays change their operations and strategies due to dynamic markets and constatntly evolving customer requirements. Several trends relating to the career progress of women transport and logistics managers can be identified in terms of businesses restructuring themselves all the time (Simpson and Holley, 2001):

1) Restructuring is generally associated with negative work aspects, especially and in the private sector and in the case of large-scale restructuring. Employed women have to take to account such forms of negative implications as longer hours, increased work loads, job insecurity and performance pressures. Competitive and performance pressures are likely to be greater in the private logistics sector, mainly due to small impact of trade unions and stronger market constraints. However, such issues more and more often appear also in the public sector, influencing women careers also there. It creates a conflict for women between demands of home and work pressure. Less opportunity to work at home may cause the high incidence of stress and health problems is a possible outcome of these pressures. Quite often work is taken home.
2) Senior women seem to feel more positive about business restructuring, experiencing greater levels of motivation and company loyalty than less senior women. Senior women seem to accommodate and accept changes resulting from restructuring, perhaps partly due to their greater involvment in

decision making and strategy formulation. Business restructuring may create more opportunitites for senior women in terms of new positions and managerial jobs.

3) Senior women are more likely to identify attitudinal barriers in their careers than junior women (Lynagh et al., 1999; Holley, 1998) but business restructuring may positively influence women's careers through reduction of barriers and improvement of attitudes towards women managers within the organisation, particularly prejudice of colleagues and sex discrimination.

Women have held support jobs in transportation and warehousing for many decades, most of the careers in these fields have been so male-dominated that they don't even sem to accesible for women. "Schools and society don't move women toward those jobs," says Deborah Cutler-Ortiz, director of National Programs and Policy for Wider Opportunities for Women (Aaron, 2018). Some research results argue that most female employees in the transport and logistics industry are in administrative positions such as human resources, finance and data processing and not in high-profile operations positions (The Unseen Gender…, 2010). For example, nontraditional occupations for women in transportation and warehousing include road repair, mechanic, forklift operator, warehouse supervisor, logistics manager, and, even drivers. These jobs may offer also much better financial conditions for female employees.

Determinants of women employment in logistics and supply chain field

Women's careers in logistics sector, as in many other fields, are affected by the social structure of their surrounding environment (Ng and Chow, 2009; Reskin et al., 1999). In the cross-national study, Charles et al. (2001, p. 385) assert that "individual decision making and economic behavior can only be understood with attention to the broader social environment in which they occur". Generally all over the world, women spend more time than men on unpaid care work activities (Ortiz-Ospina and Tzvetkova, 2017).

Gender in supply chain is subject to several structural constraints (Volpe and Murphy, 2011):

- *Organisational demography* in terms of basic attributes such as age, sex, race, and educational level may cause that being in the minority has negative effects on individuals' affective experience in the workplace. It can have serious implications for women's access to information, attitude formation, and for interpersonal interactions.
- *Occupational demography* where the rigid structure of training and advancement in some logistics occupations disadvantages women during their childbearing years.
- *Sociopolitical context* represents structural barriers due to sexism and facilitative factors such as the women's rights movement. These conditions put working women at a disadvantage both in terms of objective rewards for their labor and subjective rewards of work recognition and satisfaction.
- *Ethnic or national culture **w***hich can be measured by "gender gap index," which illustrates gender inequality in 134 countries on the basis of four measures: economic participation and opportunity, educational attainment, political empowerment, and health and survival (Hausmann et al., 2010). Nordic countries (Norway, Finland, Sweden, and Iceland) rank highest overall due to their more liberal societies. Pakistan, Chad, and Yemen rank the lowest with the widest gaps between women and men. Across the 134 countries, over 93 percent of the global education gap and 96 percent of the health gap has been closed, whereas only about 60 percent economic participation gap has been closed

The main factors contributing to female labour supply in logistics field can be classified as biological types of factors (maternal health and fertility), childcare and other family-oriented policies, social norma and culture and economic factors connected to structural changes in the economy and delivery of labour-saving consumer durables (Ortiz-Ospina and Tzvetkova, 2017). The various aspects related to maternity impose a substantial burden on women's time, also that one spent in job performance. Lower rates of fertility can free up a significant amount of women's time, hence allowing them to enter

Professional careers more easily. Having children is very time consuming even when enjoying perfect health. Childcare and other family-oriented policies make employment compatible with childbearing, and thus broaden the professional choices available to women.

Social norms and culture indicate the extent to which it is possible or desirable for women to become engaged in professional work. Despite considerable persistency of social norms, more and more often they can be sometimes largely and even suddenly changed. With sustained development, women gain educationally and the value of their time devoted to professional activities increases. Also the demand-side pull from growing service sector (including logistics services) attracts more women to work. In high income countries, the rise in female labour supply is characterized by women gaining the option of moving into paid, often white-collar work.

The best promotion of gender equality in logistics and supply chains should be based on the following policies directed towards actual and potential female labour force:

- Support career progression by businesses through providing ongoing assistance with career planning, advocacy and general job support.
- Promoting work/life balance by offering parents of either gender reasonably long leave.
- Quotas understood as specific numerical targets like some companies e.g. Mars, Cisco or Deutsche Telekom that have set targets (40% is typical) for women in leadership positions; they are most likely needed to really make change happen.

Conclusions

The study presented in this paper revealed some interesting results related to the abilities and position of women in the field of logistics and supply chain. When answering RQ1: *What logistics disciplines offer actual good conditions for women's employment?* one may conclude that currently there are no real limitations for the potential jobs to be offered to female employees in the field of logistics. Technically, due to technological development, the majority of operational tasks can be performer by women and womens' educational achievements allow them to act at all organisational levels of management. Analysis of reports addressing RQ2: *How do women in logistics perceive selected career-related opportunities and issues?* suggests that their qualifications are the most important issue here. Supply chain and logistics sec tors require specific qualifications and demand for well-educated personnel is still increasing, even at the operational level of order fulfilment. Therefore female logistics personnel understands the role of education, training and experience in shaping their professional careers. Finally, analysis concerning RQ3: *What factors contribute to successful career patterns experienced by female logistics professionals?* indicates that womens' professional choices, also in logistics sector, should be considered within the context of broader social environment in which they occur. The most important factors (drivers) in that respekt concern biological types of factors (maternal health and fertility), childcare and other family-oriented policies, social norms and culture and economic factors connected to structural changes in the economy and delivery of labour-saving consumer durables.

This paper offers useful information for benchmarking to women currently working in the field of logistics and supply chain management. In addition, the findings could be valuable for establishing teaching and training programs to facilitate successful education for women currently employed in logistics as well to those who plan to develop their career in the logistics disciplines. Also, the study presents realistic advice to logistics and supply chain female professionals, aiming at providing a better understanding of what room for improvement exists in the discussed field.

References

- Aaron, S., (2018), **'**Transportation and warehousing jobs women don't consider', Monster Worldwide, Inc., https://www.monster.com/career-advice/article/transportation-warehousing-jobs-women
- Amble, B. (2012), 'Collaboration and gender', *Management Issues*, June 01, https://www.management-issues.com/news/6495/collaboration-and-gender/
- Charles, M., Buchmann, M., Halebsky, S., Powers, J.M. and Smith, M.M. (2001), 'The context of women's market careers: a cross-national study', *Work and Occupations*, Vol. 28, pp. 371-96.
- *Companies With More Women Board Directors Experience Higher Financial Performance*, 2004, Catalyst Bottom Line Report, http://www.catalyst.org/media/companies-more-women-board-directors-experience-higher-financial-performance-according-latest
- *Employment and Qualifications in Logistics: from national realities to an European approach* (2005), AFT-IFTIM-IPTL, Monchy Saint Eloi.
- *Eurostat Labour Force Survey* (2018), https://ec.europa.eu/transport/facts-fundings/scoreboard/compare/people/women-public-transport_en
- Glover, S.H., Bumpus, M.A., Sharp, G.F., Munchus, G.A., (2002) 'Gender differences in ethical decision making', *Women in Management Review*, Vol. 17 Issue: 5, pp.217-227
- Hausmann, R., Tyson, L.D. and Zahidi, S. (2010), The Global Gender Gap Report, World Economic Forum, Geneva.
- Holley, D. (1998), `Corporate woman: moving on and moving up?', working paper, University of North London, September.
- Kisperska-Moroń, D., Klosa, E. (2017), *'*Comparison of self-assessment and usefulness of qualifications of logistics personnel in companies of different sizes*',* paper presented at the Logistics Research Network Conference 2017, 6-8 September 2017, Southampton Solent University**.**
- Lynagh, P., Murphy, P. and Poist, R. (1999), 'Career perspectives of women in distribution: congruency or contrast?'', *International Journal of Physical Distribution & Logistics Management*, Vol. 29, No. 3, pp. 192-206.
- Mateu, A. (2017), 'Why should women work in logistics*?', Logistics Management*, September 25, https://www.logisticsmgmt.com/article/why_should_women_work_in_logistics
- Nelton, S. (1995), 'Nurturing diversity'', *Nation's Business*, Vol. 83 No. 6, pp. 25-7.
- Ng, I. and Chow, I.H. (2009), 'Cross-gender networking in the workplace: causes and consequences', *Gender in Management*, Vol. 24 No. 8, pp. 562-76.
- Ortiz-Ospina E., and Sandra Tzvetkova (2017), 'Working women: Key facts and trends in female labor force participation'*, Our World In Data*, October 2016, https://ourworldindata.org/female-labor-force-participation-key-facts
- Ozment J, Keller S.B (2009), 'Research on personnel issues published in leading logistics journals. What we know and don't know', *The International Journal of Logistics Management*, Vol. 20 No. 3, pp. 378-407.
- Pateman H., Cahoon S., Chen S.L. (2016), 'The Role and Value of Collaboration in the Logistics Industry: An Empirical Study in Australia', *The Asian Journal of Shipping and Logistics*, Vol.32, Issue 1, pp. 33-40
- Reskin, B.F., McBrier, D.B. and Kmec, J.A. (1999), 'The determinants and consequences of workplace sex and race composition', *Annual Review of Sociology*, Vol. 25, pp. 335-61.
- Simpson, R., Holley,D., (2001) 'Can restructuring fracture the glass ceiling? The case of women transport and logistics managers', *Women in Management Rev*iew, Vol. 16 Issue: 4, pp.174-182
- *Success Factor "People" in Distribution Centres* (2004), Results of the ELA/KSA Study, European Logistics Association, Kurt Salmon Associates, Brussels.
- *Supply Chain Compensation and Career Survey Report 2018,* Developed by APICS, research@apics.org

- *Survey Analysis: Women in Supply Chain Survey*, 2016, Gartner, Inc., https://www.gartner.com/doc/3302218/survey-analysis-women-supply-chain
- 'The Unseen Gender In Transport and Logistics', (2010), The Women In Supply Chain (WISC), https://twfhk.org/sites/default/files/u21/TheUnseenGenderInLogisticsAndTransport.pdf
- Volpe, E.H., Murphy, W.M., (2011) 'Married professional women's career exit: integrating identity and social networks, *Gender in Management: An International Journal*, Vol. 26 Issue: 1, pp.57-83
- pp.57-83,Wilson V.P. (2017), 'Why Women-Led Businesses Outperform Their Peers'**,** *Huffington Post*, Feb 18, https://www.huffingtonpost.com/valerie-plame-wilson/why-womenled-businesses-o_b_9263478.html?guccounter=1

THE SIGNIFICANCE OF CYNEFIN FOR COMPLEX INFRASTRUCTURE PROJECTS

Mohamed M. Naim*[*], Jon Gosling[1] and Bill Hewlett[2]
[1]Cardiff University, UK
[2]Costain Ltd.

Introduction

There is a recognition in supply chain management research that there is a spectrum of supply chain types and that there is no 'one size fits all' for the best logistics and management approaches (Christopher et al., 2006, de Leeuw and Fransoo, 2009). Engineer-to-order (ETO) systems, of which infrastructure projects are an example, have distinct logistics attributes when compared to ship-to-stock (STS), make-to-stock (MTS), assemble-to-order (ATO) and even make-to-order (MTO) environments (Gosling and Naim, 2009, Yang, 2013). ETO supply chains are recognised as having customised products, often as 'one-offs' in the form of unique 'projects' or 'programmes', higher degrees of uncertainty and relatively long lead-times. These characteristics call for the adoption of appropriate project management approaches; where inappropriate approaches are used, for instance due to lack of preparedness, capability and capacity, such ETO activities typically run over planned time and / or budget.

Yet, often in supply chain research, we find that there is an assumption that the contextual environment is relatively well ordered and structured. With much research undertaken in ATO and MTS environments, such as the electronics, automotive and food sectors, it is valid to categorise them as such as many organisations have 'leaned' their operations to reduce uncertainty and complexity so that the material flows are ordered and simple. In more MTO environments, such as the aerospace sector, where there is some supply chain research, the system is more complicated, with a wide range of components and subassemblies coming from many different vendors in dispersed geographical areas creating products to prescribed lead-times. We find that research on engineer-to-order (ETO) supply chains, such as in infrastructure project management, is far more limited but where it does exist there is a predominance of the translation of 'lean' techniques (e.g. Tezel et al., 2017). As Flyvberg et al. (2003, p. 73) noted with respect to megaprojects,

"too many…. studies…. of megaprojects assume projects to exist in a predictable Newtonian world of cause and effect where thing go according to plan. In reality, …things happen only with a certain probability and rarely turn out as originally intended."

Challenging the assumptions that it is always possible to order the world around us, the Cynefin framework (Kurtz and Snowden, 2003) is a phenomenological framework that provides a classification system that allows us to understand the nature of the 'habitat', or 'cynefin' (a Welsh word) within which the project exists. The Cynefin framework classifies contexts in terms of order (simple and complicated) and un-order (complex and chaotic), highlighting the need for different managerial approaches for each of the four domains.

Given the multifaceted nature of ETO we question the tendency to 'force' the same form of managerial interventions as found in complicated or simple environments onto complex infrastructure projects. Hence, we aim to *ascertain the relevance of the Cynefin complex domain's recommended managerial approaches to major infrastructure project supply chains*.

A cooperative enquiry approach is utilised by which the authors from academe and practice contemplate the value of the Cynefin framework, citing its referencing and / or exploitation in relevant previous research, and reflect on its meaning for the construction industry. We contextualise the different approaches from each domain and then determine how to frame expectations for the industry's project managers. Cynefin's validity is tested by interrogating various complex infrastructure case studies according to their characteristics.

The nature of ETO systems

Recent research has questioned whether there is a homogenous grouping of project based supply chains called ETO. Wikner and Rudberg (2005) note that, for MTO to MTS supply chains the product design is decoupled from production and distribution, and is actually operating as a 'make-to-stock'

process. Hence, this relates to the fact that in those environments the design is a separate new product introduction or development process separate from the product delivery process, while in an ETO context the product design and material flow execution are part and parcel of the same process.
Using the decoupling principle, Wikner and Rudberg (2005) then go on to surmise that two distinct ETO types exist, with a third that lies in between. The first ETO type, termed 'engineer-to-stock' is associated with the BTO context where, prior to an actual customer order being received, there are product designs ready-made, waiting in 'stock' for a customer order. Alternatively, the pure ETO situation is where a design of a product, and its associated production, is not initiated until there is an actual customer order placed. Sitting in-between these two extremes we may find existing design being modified in an 'adapt-to-order' situation.

Wikner and Rudberg's (2005) thesis was extended, enhanced and empirically tested in the construction sector by Gosling et al. (2017). Figure 1 shows the resulting categorisation of ETO types, namely, Research, Codes and Standards, and Existing Designs. While Wikner and Rudberg's (2005) proposition was based on the conceptual extension of the decoupling concept from production to engineering through a process of logic, Gosling et al. (2017) motivated their study from the perspective of project complexity, uncertainty, risk and mitigation approaches, such as through varying contractual arrangements or degree of innovation. Nevertheless, Gosling et al. (2017) summarised their findings as Figure 1 that utilises the degree to which the customer, or client, engages with the ETO process visualised via the order penetration point.

In 'existing designs' previous designs from other project will be available as if 'in-stock' to be utilised 'as-is' (completed design), or various elements or components from various existing designs are integrated into a new design (finalised design), or an existing design is adapted (adapted design). Here we find relatively low levels of uncertainty and standard solutions being offered to customer requirements. In the 'codes and standards' category, designs are developed from formal codes of practice exemplified by British Standards, Eurocode guidelines or those published by institutes such as the American Concrete Institute. A 'new design' would result from using established codes, standards and principles to develop new designs. In 'integrate codes', the design is a result of the development of new codes integrated with established codes. This will require a formal process of either seeking a "departure" from the existing code or the rewriting of the appropriate code. In 'develop codes' new codes are established based on 'engineering research'. Hence, in 'code and standards' the level of uncertainty is higher when compared to 'existing designs' so that there is some innovation required to exploit existing 'engineering research' and/or code and standards. There is some degree of customisation for the client.

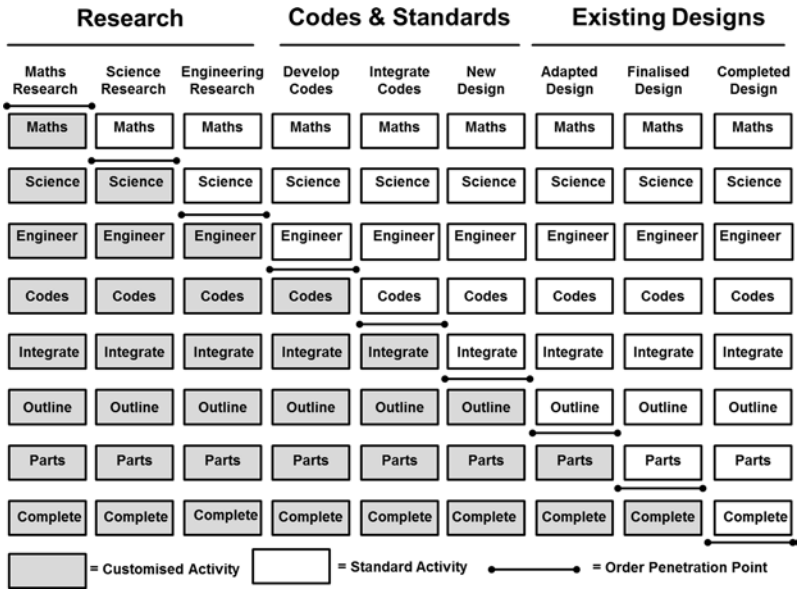


Figure 1: Continuum of Engineering Categories and Subclasses (Gosling et al. 2017)

Within the 'research' category designs require fundamental research or research development to be undertaken on a 'to-order' basis. For 'Engineering research', the testing of materials, principles or applications is necessary, while in 'science research' the theoretical grounding may exist but the application is uncertain. For 'mathematics research' the theoretical principles are unclear and may not exist at all. In this category we will find the highest degree of uncertainty, and hence risk, associated with developing a fully tailored and highly innovative solution.

Cynefin and its application to construction and ETO systems

The Cynefin framework, which we sometimes refer to simply as Cynefin, the Welsh word for habitat, was developed as a phenomenological construct to provide a sense of the nature of the world we live in (Kurtz and Snowden, 2003, Snowden and Boone, 2007). Figure 2 provides the visual representation of the Cynefin domains, Known, Knowable, Complex, Chaos and Disorder, as described by Kurtz and Snowden (2003). While the descriptions and definitions of the various domains has been expanded and adjusted in later descriptions (e.g. Snowden and Boone, 2007) the overall tenor has remained the same.

Cynefin classifies contexts that we may find ourselves in, in terms of ordered, Known and Knowable (Kurtz and Snowden, 2003), later referred to as Simple and Complicated (Snowden and Boone, 2007) and unordered, Complex and Chaotic, advancing the need for different managerial approaches for each of the four contextual domains. In order to determine which domain we may find ourselves in usually requires an element of discussion, maybe discourse and ultimately agreement or consensus among different stakeholders. Hence, we may actually find ourselves in a fifth domain, wherein the discourse has led to disagreement and there is no shared understanding of which of the other four domains we are currently in. In this instance, a possible further (fifth) management approach is needed: finding consensus!

In the Known domain, cause and effect relationships are easily understood and statically modelled, it is relatively easy to predict the future and there is a dominance of standard operating procedures and benchmarking to determine best practices. Here, managers will exploit sense making, use classic classification techniques and then determine appropriate responses to events. We ourselves would suggest that classic industrial engineering tools and techniques come to the fore, with the use of such tools as Pareto or ABC analysis, fishbone diagrams and linear programming.

For the Knowable domain, cause and effect is still clearly visible and forecastable, but the sources and sinks of events are separated by time and space. Managers still exploit sensing strategies, evaluating and assessing gathered data, and determining response strategies for exploitation in any given readily predictable scenarios. Here, dynamic modelling may be utilised, such as systems dynamics management flights simulators, to 'play' with different scenarios.

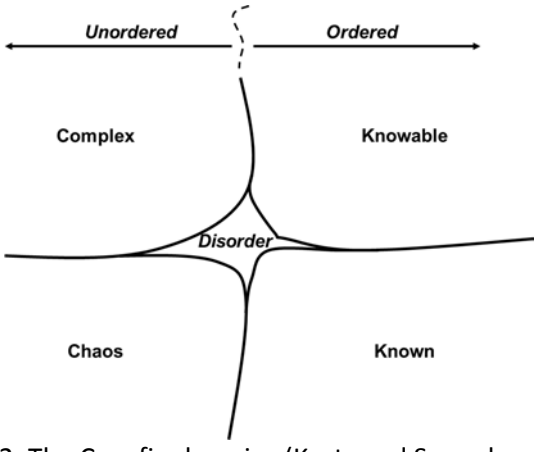


Figure 2: The Cynefin domains (Kurtz and Snowden, 2003)

Cause and effect in the Complex domain is only apparent 'after the event' and, while patterns of behaviour do emerge and may be understood, there is no perfect repetition. Classic quantitative / systematic approaches that we may exploit in the ordered domains are not useful here, nor in the Chaos

domain. We need to capture different perspectives of the same situation from different stakeholders, most likely in the form of narratives, to probe our environment in order to understand the situation we find ourselves in, which allows us to better sense and respond to events. Systems thinking approaches, such as soft systems methodology with 'rich pictures' tools and CATWOE analysis provide us with the means to manage our situation.

The primary approach in the Chaos domain is crisis management, such that actions are undertaken as a reaction to particular events as cause and effect is not discernible at all and there is no time to analyse a situation. So, the modus operandi here is to act first, then sense the outcomes of the actions in order to determine appropriate next-step responses. The Chaos domain may be undesirable, say, due to a catastrophic failure, or it may be created in order to instigate innovation.

Cynefin has found some traction in construction and engineering spaces, although rigorous, detailed and empirically based research is sparse. Koskela and Kagioglou (2005) give an expose of the Cynefin framework and briefly espouse its relevance for the construction sector as a whole and, in passing, indicate the potential of the Last Planner® tool, a production planning system, "to bring the process to the known domain" while acknowledging that, in order to do so, there is a need to explore the environment that a construction project may find itself in before doing so. Interestingly, Koskela and Kagioglou (2005), make no mention of the disorder domain.

In another article on the construction sector, with only a passing reference to the Cynefin framework, Rooke et al. (2007) again make the assertion that the aim of exploiting Cynefin is to understand which domain you are currently in but to enforce a form of order. Similarly, Tommelein (2014) promotes lean principles to drive all situations into, or to remain in, the Known domain.

In the more general ETO discipline, a notable contribution is by Vollmar et al. (2017), who relay their experience of the application of Cynefin in Siemens AG with inputs from engineers in the energy generation, energy transmission and high-speed train sectors. Vollmar et al. (2017) argue that Cynefin was originally developed for the management discipline and therefore needs translation for ETO environment. We do not agree with this argument, because our original point of reference with Cynefin was with the IBM Systems Journal (Kurtz and Snowden, 2003), which reads quite generically, while perhaps Vollmar et al. (2017) may have encountered Cynefin via the HBR paper (Snowden and Boone, 2007).

In any case, Vollmar et al. (2017), while ignoring the disorder domain, translate the Cynefin framework domains into four engineering scenarios, such that,

Known → Easy Engineering – engineering here exploits existing standardised designs and may include some simple and limited adaptations of existing solutions. This scenario works on repeatable processes dealing with limited complexity.

Knowable → Perfect Engineering – the focus is on the delivery of large scale projects, requiring integration of existing technological solutions with the aim of achieving 'optimum' solutions for the whole life-cycle of the artefact being delivered. There is a heavy reliance on engineers' experience.

Complex → Pioneer Engineering – this scenario is associated with a high degree of complexity involving implementation of 'first-of-a-kind' projects, defined as any aspect of the project that is new e.g. the client, brief or technological requirements.

Chaos → Crisis Engineering – this is presented as an undesirable state requiring a set of skills to cope with serious situations.

Vollmar et al. (2017) conclude that there is the danger that most ETO companies in Europe work on the assumption that only the 'Easy Engineering' scenario exists. Hence, complexity and unexpected events cause considerable disruption because the coping mechanisms do not exist via 'Easy Engineering' approaches.

Reflections

The Vollmar et al. (2017) scenarios has some analogue with our own perspective of Cynefin and synergy with the ETO categories proposed by Gosling et al. (2018). But we also have some criticism, which may be due to the different sectors that we are dealing with.

The notion that 'one-size-fits-all' creates performance and commercial dangers is particularly apposite, very much in line with our own thinking and criticism of modern industry. It is also synonymous with general logistics approaches, for example, as per Fisher (1997) and de Leeuw and Fransoo (2009). Also, we counter the claim from much of the lean construction literature, see for example from above, Koskela and Kagioglou (2005), Rooke et al. (2007) and Tommelein (2014), that the Known domain is the only desirable state as, with careful consideration of the significance of each domain, there are opportunities to be had in each one.

We believe there is a mapping of the ETO categories with the Cynefin framework, and hence with Vollmar et al.'s (2017) scenarios;

- The Existing Designs category may be seen as in the Known, where we utilise, or slightly adapt, as in 'Easy Engineering', existing design to deliver to the client brief. This category may be applied also to individual components within a more complex design. There needs to be a high level of certainty.
- In Codes and Standards there is similarity with the Perfect Engineering's 'optimum' integrated solutions development based on engineering experience, which has analogue with developing design based on code and practices, which is a collection of engineering know-how. A caveat, however, is that the operational environment needs to be pretty much fixed, for instance within a factory enclosure, or for construction engineering, where weather and other variables can either be predicted of will have little impact. We do not actually believe that 'Perfect' is entirely appropriate but, rather in line with the Cynefin 'knowable' terminology, here we could define the domain as 'perfectible', that is, where a striving for perfection is both realistic and worthwhile.
- The Pioneering Description, where 'first-of-a-kind' solutions are derived is in line in part with our Codes and Standards category, in this case where the operational environment brings considerable uncertainty, and overlaps with our Research category, where a particular situation warrants innovation or starting from first principles or the development of experimental testing to deal with situations that are total new or have not been encountered before.
- The Chaos description one hopes would be encountered only fleetingly, and might result from the manifestation of an unexpected outcomes or low frequency high impact risk, for instance, or from more creative sources, of which more below.

As can be seen from the above, the Vollmar et al. (2017) interpretation of the Cynefin does not necessarily correlate 100% with the ETO categorisation, which has been developed primarily for complex infrastructure projects and has a finer degree of granularity. Firstly, Vollmar et al. (2017) place large complex projects within the Perfect Engineering scenario, while our experience is that ETO categories find relevance in all of the Cynefin domains. Secondly, Vollmar et al.'s (2017) scenarios describe system 'states', which is a danger in itself, as Kurtz and Snowden (2003) point to, as Cynefin is a perception framework, not a definition of state. Perhaps when Vollmar et al. (2017) talk of Siemen AG's industry sectors they do so from the manufacturing aspects of the machinery rather than the civil engineering; in civil engineering the operating environment, for many reasons, contains uncertainty. Indeed, this might explain why major programmes, such as transport metros or HS2, can struggle as there is a cultural clash between Perfect (or Perfectible) Engineering, which is an expectation in the manufacturing engineers' domain, and Pioneering Engineering, where civil engineers see themselves as residing.

We believe the disciplinary boundaries are a prominent theme in infrastructure and built environment projects, where the various professional institutions, trades, and industry bodies have developed different traditions and worldviews over long time periods. For instance, in cases where some think the project should be 'perfectible' an old guard will defend 'pioneering' and espouse the management techniques that go with pioneering; this can lead to significant clashes and waste.

As we previously noted, Vollmar et al. (2017) rather step around Crisis Engineering, and seem not to embrace it as something that can be done much about. In line with Kurtz and Snowden (2003), we disagree. There is much that can be done to set up systems for early warning, be ready with reactions, prepare the team to keep positive and focussed, prepare people to be self-sufficient, set clear guidelines to support dispersed decision making, as will be needed if crisis strikes.

Also, we may wish to create a situation where we want to instigate innovation and, as Peters (1989) promoted, we may end up 'Thriving on Chaos'. For example, for situations where there are definite end goals but there is rightly an expectation that the course of action will need radical re-thinking, and getting the team out of its comfort zone. Another examples is where a project is reliant on (genuine) research (where the findings of the research are genuinely not foreseeable and could be highly variable) this might be the case. For instance, where a new type of solution is envisaged, but the new solution relies on a new technology which is yet to be proven, a completely different solution would need to be envisaged if the specific new technology did not work.

We also note that of the papers we have cited that refer to Cynefin none embrace the central Disorder domain. We believe this is an omission, as we need to heartily embrace the central zone and see it as a point of particular value in the Cynefin. On a project, if different parties disagree on the domain, the project is in 'Disorder' and disorder will certainly be the case. This will be manifested in misunderstandings, breakdown of teamwork, conflict and demotivation. This is a disaster for an ETO project, in our view worse than being in the 'wrong' domain.

Our interpretation of the Cynefin for complex projects

Relating ETO examples to the domains of the Cynefin requires some care, requiring consideration of both the work content itself and also of the variables that influence it, such as, location, regulations and legal frameworks, supply chain, weather conditions, what risks manifest / which do not, customer / client requirements, third party stakeholders, scale and interdependency of different elements, and unexpected results for experimentation and innovation, or unexpected condition of historic fabric once opened up during the works, and so forth. Add to this that all of these factors may change with time; for instance the client team might be substituted during a project and the new team bring a new interpretation, or neighbours might change their attitudes once they become aware of just what is going on 'over the hoarding'. Here are or thoughts:

Known / Easy: the components associated with speculative build housing, retail parks, and for the project as a whole only when the different influencing variables remain unchanged which in reality will be unlikely for any major construction project, other than at component level. Here we will find repeatability of designs with maybe some variations to accommodate local circumstances e.g. external cladding to fulfil planning regulations. There is the expectation that standard operating procedures govern the project management approach, exploiting various tools such as program evaluation and review technique (PERT) or critical path analysis (CPA). Hence we ensure certainty of quality, time and cost, making sure people strive for perfection, have thoroughly thought things through, spending time and money on prototyping, developing highly detailed engineering specifications, and enhancing efficiency though 'lean' techniques. This domain is fragile however. For instance, a specific supplier might go out of business, exchange rates or import constraints might vary. Unless we are prepared, the 'known and easy' suddenly becomes chaos.

Knowable / Perfectible: erection of a single span bridge of simple design, where the influencing variables show change but there is a perception that they are manageable and perfectible, and a perfect plan can and, importantly, should be formulated and enacted. In such a case, we still remain in an ordered domain and the problem at hand may be mastered, for instance, by comprehensive briefing with the client yielding no novel specifications, or geological ground testing confirming there are no unique circumstances about the location. Management here may utilise scenario planning, coupled with a traditional risk register, exploiting the project team's expert opinions to determine a number of different feasible designs for the client and highlighting potential hazards.

Complex / Pioneering: first of a kind work such as a London Rail Terminus rebuild, which includes multiple influences and stages of work, many stakeholders, as well as a long and protracted duration.

Here, we find the influencing factors are more unpredictable than in previous domains. Possible management techniques are to develop a robust plan with an emphasis on revaluation, renegotiation and responsiveness to changing circumstances to retain stability of the project as a whole, as well as ensuring a big picture perspective to ensure objectives are met and not to focus on cost. The management approach will be to establish a multidisciplinary integrated project team to ensure the breadth and depth of stakeholder involvement. Typically the project team tends to involve the 'experts' but representatives of all stakeholders, such as from the local populace, should be included. In this domain; the focus is on people, to build collaboration and trust. There is far less emphasis on immediate costs and there needs to be flexibility regarding budgets. The seeming paradox that a focus on cost reduction drives cost up is explained by considering how short term cost reduction undermines the ability of the team to respond to the emerging complexity; short term costs should be seen as investment, that will yield their return in due time: no investment, no return and we are poorer for it. As codified and procedural management approaches are inappropriate, instead "narrative techniques are particularly powerful in this space" (Kurtz and Snowden, 2003) where multiple stakeholders' perspectives are needed, including those of third-parties with significant risk exposure such as local communities, to aid decision makers i.e. the risk managers.

Chaos / Crisis Engineering: We envisage many types of scenario, but in all cases the project needs to Transform from Chaos into a more stable domain as rapidly as it can. In the safety realm, the Bow-tie approach (Zhang and Guan, 2018) gives equal weight to avoiding crisis as it does to managing the outcome; this approach is used where it is simply uneconomic to plan to avoid every conceivable negative outcome. In cases of structural collapse or earthquake for instance, immediate life safety is the priority and all else must cease. A second type of scenario is where a single 'project', or 'contract', within a broader programme suffers a radical change of priorities as a consequence of the changing climate in the whole programme. For instance, on a long metro system, each station starts as its own contract; in time opening the railway becomes the priority and the individual project priorities are subsumed; viewed from the perspective of the Project Manager for the individual station, this can be hugely chaotic. In this scenario we need to build resilience into the project, so that the team is ready for any disturbances, they can respond and recover. In another scenario there may be a small part of the project which becomes chaotic: perhaps an area of historic fabric is found to be unstable and cannot be incorporated into the final design as envisaged, needing a review both technically and with planning authorities. The strategy now is to box off this chaotic element, isolate a dedicated team to deal with it, and ensure good order is maintained elsewhere.

Based on our reflections, we also see a set of positive scenarios in the chaotic domain, as exemplified, for instance, in Thriving on Chaos (Peters, 1989), and we propose this as a stimulus for innovation. We are aware on an example from Gosling et al. (2017) involving the development of a new technique manufacture large scale optics. A project team were commissioned to undertake a feasibility study to provide the mirror component for a large scale telescope. The project made use of developments in nanotechnology in order to polish to extremely well-defined tolerances. Given the very experimental set-up it could be classified as residing in the Complex / Pioneering domain, bringing together scientists and bespoke technology. The polishing and smoothing process involved was unproven and hence a major risk. The client instigated an open brief, but with supporting structures to encourage innovation, which allowed for the impromptu instigation of different approaches to refine the process.

Discussion and conclusions

Something we would like to see more of is further consideration of management techniques aligned with each domain, especially if the project is in the Disorder zone. In the latter case, stopping the job to get alignment of thought, or at any rate acceptance of the legitimacy of different perspectives, thinking and management methods for different aspects of the project, is probably the right action. The management approach to disorder will likely be in the form of conciliation and arbitration, either achieving consensus or agreeing to disagree through the accommodation of worldviews. We should also note that the domain may define the management approach or vice versa. As highlighted in the literature review there has been advocacy of lean construction, which we then argue entails work in the ordered domains.

As a caveat, we would say that the appropriate domain is a function of component and timescale – a Complex project, like a live rail terminus rebuild might be Pioneering as a whole, but will have aspects which are Easy / Known, Perfect / Knowable and Crisis / Chaos in parts. While 'a part' in this context might be defined against certain criteria, in reality it amounts to what management technique is appropriate. Our point is that a wide range of approaches and attitudes are likely to be needed even in a single project. We advocate a need for new ways of risk assessment and de-risking with respect to Complex / Pioneering types of projects, in which narrative forms guide project teams, who must hear the voices of all stakeholders, and will need to embrace a wide palate of management techniques in response, varying with timeframe, scale (component vs. the project as a whole) and what risks manifest, what do not. Existing risk registers are based on simple one-to-one relationships between cause and effect and often miss the interconnectivity between different causes and different effects. Hence, existing risk management approaches, where the assumption is that the projects is 'ordered', are susceptible to cross suddenly into the 'chaos' if patterns of behaviour deviate from the 'risk register model' norm. The Cynefin framework enlightens our thinking, and the concept of journeys through the Cynefin, as responses are developed and are enacted, changing their domain as this happens, in itself gives a narrative which is easily grasped and makes sense of the complex and emergent in a world which craves certainty.

References

- Christopher, M., Peck, H. and Towill, D. 2006. "A taxonomy for selecting global supply chain strategies", International Journal of Logistics Management, 17 (2), 277-287.
- de Leeuw, S. and Fransoo, J. 2009. "Drivers of close supply chain collaboration: one size fits all?", International Journal of Operations & Production Management, 29 (7), 720-739.
- Fisher, M. 1997. "What is the right supply chain for your product?", Harvard Business Review, March/April, 105-116.
- Flyvberg, B., Bruzelius, N. and Rothengatter, W. 2003. Megaprojects and risk: an anatomy of ambition, Cambridge University Press, Cambridge, UK.
- Gosling, J. and Naim, M. M. 2009. "Engineer-to-order supply chain management: A literature review and research agenda", International Journal of Production Economics, 122 (2), 741-754.
- Koskela, L. and Kagioglou, M. 2005. "On the metaphysics of production", 13th International Group for Lean Construction Conference, 19-21 July, Sydney, Australia, 37-45.
- Kurtz, C. F. and Snowden, D. J., 2003. "The new dynamics of strategy: Sense-making in a complex and complicated world", IBM Systems Journal, 42 (3), 462-483.
- Peters, T. J., 1989. Thriving on chaos: handbook for a management revolution, Pan Books, London, UK. Rooke, J., Molloy, E-M., Sinclair, M., Koskela, L., Kagioglou, M., Siriwardena, M. and Siemieniuch, C., 2007. "Models and Metaphors: Some Applications of Complexity Theory for Design, Construction & Property Management", CIB World Building Congress, 14-17 May, Cape Town, South Africa, 2764-2775.
- Snowden, D. J. and Boone, M. E., 2007. "A Leader's Framework for Decision Making", Harvard Business Review, 85 (11), 68-76.
- Tezel, A., Koskela, L. and Aziz, Z. 2018. "Lean thinking in the highways construction sector: motivation, implementation and barriers", Production Planning & Control, 29 (3), 247-269.
- Tommelein, I. 2015. "Journey towards lean construction: pursuing a paradigm shift", Journal of Construction Engineering and Management, 141 (6), 04015005-1 - 04015005-12.
- Vollmar, J., Gepp, M., Palm, H. and Calà, A., 2017. "Engineering framework for the future: Cynefin for Engineers", Systems Engineering Symposium (ISSE), 2017 IEEE International, Vienna, Austria.
- Wikner, J. and Rudberg, M. 2005. "Integrating production and engineering perspectives on the customer order decoupling point", International Journal of Operations & Production Management, 25 (7), 623-641.
- Yang, L. 2013. "Key practices, manufacturing capability and attainment of manufacturing goals: the perspective of project/engineer-to-order manufacturing", International Journal of Project Management, 31 (1), 109-125.
- Zhang, Y. and Guan, X., 2018. "Selecting Project Risk Preventive and Protective Strategies Based on Bow-Tie Analysis", ASCE Journal of Management in Engineering, 34 (3), 04018009-1 - 04018009-13.

AUTOMATION IN PORT INDUSTRY AND ITS IMPACT ON PORT SUSTAINABILITY

Yilin Wang and Chukwuneke Okorie
Plymouth Business School, University of Plymouth, UK

1.0 Introduction

When discussing port terminal automation, reference is often made to the container terminals due to the unique characteristics of containers such as its uniform shape and size. Containerisation has revolutionised the method of carriage of goods by sea, and by 2018, nearly 90% of commodities (by volume) are transported by container ships (Ics-shipping.org, 2018). Also, technology-based strategy is needed in order to cope with the increasing size of the container vessels, where for example the largest container vessel OOCL Hong Kong has the capacity of 21413 TUE (Oocl.com, 2018). As a result of increasing ship sizes and growth of global trade volume, the amount of cargo flowing through container ports is increasingly high, thus the demand for better handling efficiency is higher (Voß, Stahlbock and Steenken, 2004).

In the past decade, research and policies on automated container terminal have gained attention from many stakeholders. Many governments, such as Singapore and Netherland (Port of Rotterdam) started automating their ports to enhance port performance (Nightingale, 2014). In the same vein, sustainability has become a major issue in for attention in all areas of human endeavours (Asgari et al., 2015), and definitely a crucial discourse in port management (Peris-Mora et al., 2012). To adapt, ports need an equilibrium between limited land, labour and development of technology (Lun, 2011). From a technological angle, it becomes important to intensify analysis of the current trends of developing automation in ports using the triple-bottom-line framework. Therefore the aim of study is to examine the automation of container terminals so as to improve operations and port sustainability.

2.0 Literature review

2.1 Port automation

According to (Martín-Soberón et al., 2014), port automation usually refers to a container port terminal that has the capability of automated movement of cargo in the yard and the dock-yard interchanges. This automated system is usually made up with equipment such as Automated Stacking Cranes (ASCs) and Automated Guided Vehicles (AGVs) which enable the system to operate without direct human interventions.

2.2 Container Port and terminal automation

Port terminal refers to an intermodal facility that facilitate the flow of arriving cargo from ships or departing goods delivered the port by land (Montfort et al.,2001). Automation of container terminals reduces costs associated with the involvement of humans in cargo operation, while striving to achieve set standard, efficiency and service level (Martín-Soberón et al., 2014). Port automation can be traced back to the 1990s when the Delta Terminal in Port of Rotterdam introduced the concept of automated container terminal, providing Automated Guided Vehicles (AGVs) to facilitate unmanned operations in the yard area (Evers and Koppers, 1996). After the success of Rotterdam, automated terminal gained global popularity. In Europe and Southeast Asia, policies made by authorities supported the development of automation (European Commission, 2007). Recently, the Singapore maritime industry received a budget approval of 100 million SGD (76.12 Million USD) from the Maritime Port Authority to further develop its automation for the future (Hwee, 2018).

2.3 General Level of Automation

Level of automation is an important issue when considering deployment of automation in container terminals, with associated implications on price tags and performance levels. Lyndon (2015) stated that many port terminals have automated systems that can be rated at 'level 3', offering the most efficient and flexible service in terms of movement of cargo and materials. The 'level 4' and above are not practicable in port industry, but mostly implemented in banking and finance industry. Hence, a

comprehensive automation index is needed in order to quantify the level of port automation to provide a tool for both the academia and maritime sector's practitioners.

Levels	Descriptions
5	Business system, strategy planning and corporation management
4	Plant level, production and programming, ERP, MRP and MES
3	Operation unit level
2	Machine/ process Automation level
1	Controller level
0	Sensor/ actuator level

Source: Figueiredo et al. (2015)

Table 1: Level of Automation

Figueiredo et al. (2015) summarised automation into five levels based on the ISA95 (International Standard for Automation) as shown in the Table 1.

2.4 Towards an Automation Index

After reviewing the literature regarding terminal operation process, such as (Kim and Nguyen, 2008; Branch, 2012; Alderton and Saieva, 2013; Paixao and Bernard, 2003), we select some key processes illustrated in Figure 1 and in line with the working principle of an automated terminal described in Phan and Kim (2012).

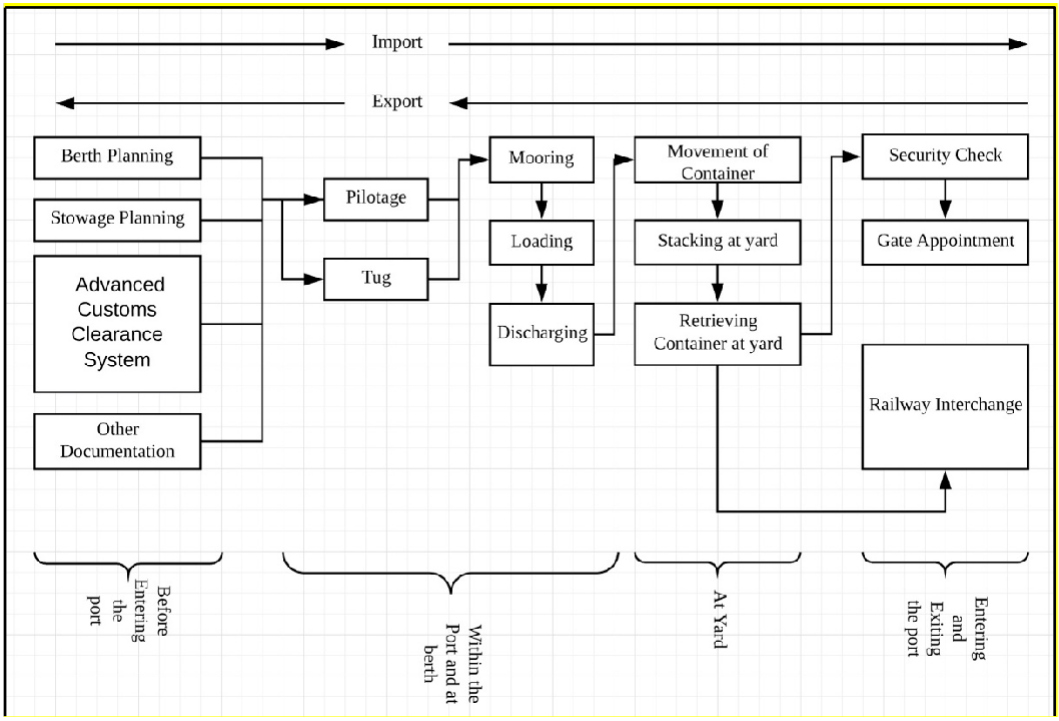


Figure 1. The basic process of port operation Source: Authors (2018)

The Figure 1 summarises key activities in general port operation, which from left to right represents the process of importing a container and from the right to left represents the process of exporting a container. By using the process summarised in Table 2, and in order to build a simple port automation index, each process will be evaluated to determine whether or not each individual process is automated. This evaluation and creation of a simple automation index is based on the compilation of findings from literature review and information available from ports. Each automated process will count as one point, and the total score is the number of counted automated processes.

	Ports	A	B	C	D	E
Before Entering the Port	Berth Planning	0	0	0	0	0
	Stowage Planning	1	1	1	1	1
	Advanced Customs Clearance System	0	0	0	0	0
	Other Documentation	0	0	0	0	0
Within the Port and at Berth	Pilotage	0	0	0	0	0
	Tug	0	0	0	0	0
	Mooring	0	0	0	0	0
	Loading	1	0	0	0	0
	Discharging	1	0	0	0	0
At Yard	Movement of Container	0	0	0	1	0
	Stacking at Yard	0	0	1	1	0
	Retrieving container at yard	0	0	1	1	0
Entering and Exiting the Port	Security Check	0	0	0	0	0
	Appointment System for trucks	0	0	0	0	0
	Gate	0	0	0	0	0
	Railway interchange	1	0	1	1	0
	Total Score	3	1	4	5	1

Source: Authors (2018)

Table 2: Simple Automation Index of five selected UK ports

Table 2 shows the calculation process of the simple automation index, and the result of the five selected UK ports, namely Ports of Tees and Hartlepool (A); Port of Grimsby and Immingham (B); Port of London-London Gateway terminal (C); Port of Southampton (D); and Port of Milford haven (E). Findings show that the Port of Southampton is the most automated port with 5 points, indicating relatively high level of automation. Movement of cargo in port-yard is fully automated, and the intermodal connection with railway transportation is automated. On the other hand, the least automated ports are Port of Grimsby and Immingham, and Port of Milford haven with only one point each on process automation, being at the early phase (stowage planning) due to the sizes and throughputs of the ports.

2.5 Automated terminal and semi-automated terminal

In (Martín-Soberón et al., 2014), classification is made of terminal automation into only two levels namely, Automated terminal and Semi-automated terminal. An automated terminal refers to automated movement of cargo in the yard and dock and points of interchange. One example of such terminal is the Pasir Panjang terminal in Port of Singapore. Semi-automated terminal refers to the use of remote controlled equipment within a terminal or only some of the operations in a terminal are automated (Martin-soberon et al., 2014).

2.6 Greenfield and Brownfield Automation Project

Automation of port terminal projects can be categorised into Greenfield and Brownfield projects. While Greenfield projects refer to developing new automated terminal, brownfield projects are conversion of existing terminals to automated terminals with implementation of partial or fully automated equipment. Decision on whether or not to build a terminal with automation technology is extremely important at the design phase (De Sousa, 2000), as the cost of later conversions to automation (semi-automated or fully automated) is considerably high. In addition, the installation of relevant equipment and the whole conversion process at a later stage will affect the service level of the terminal resulting in further economic impact to the port. To overcome the problem, carrying out

the conversion in phases, while keeping part of the terminal in operation, is a sensible approach. One example of Brownfield project is the Antwerp Gateway terminal where RMGs (Rail Mounted Gantry cranes) replaced the existing straddle carriers (Saanen, 2010).

2.7 Current trend and common implications of port automation

There are three common areas in a terminal where automation usually take place, namely the gate; yard and quay. Automated security check, data exchange and appointment systems at terminal gate are able to increase efficiency of truck driver's check-in process. Container yard is the most common area to have automation technology. As illustrated by Phan and Kim (2012) through Figure 2, the common processes of yard system automation are discussed. Firstly, containers are discharged from the vessel by quay cranes to AGVs (Automated guided Vehicles), then AGVs carry the containers to container yard, and finally a RMGs system or an automated straddle carrier system take these containers and stack them to their respective locations.

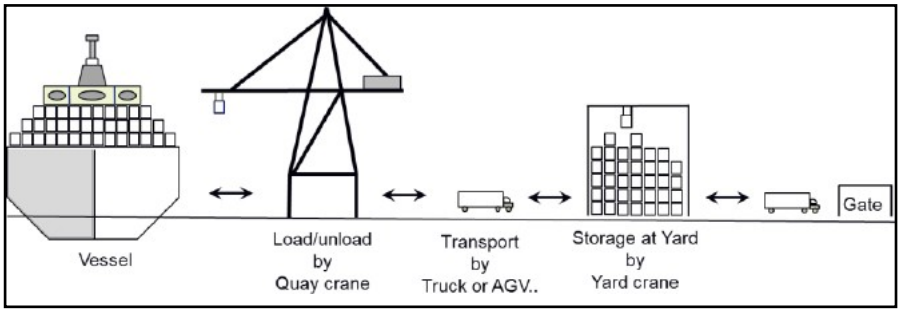


Figure 2: Working Principle of Automated Terminal. Source: (Phan and Kim, 2012)

The automation in Quay Crane in port terminal is by far the least developed due to the complexity of discharging and loading operations, with many stakeholders involved, higher risk for mistakes, and needing a 100% accuracy for smooth automation. Enormous effort is required to replicate the ability of a crane operator in terms of accuracy and flexibility (Zrnić, Petković, and Bošnjak., 2005). Prime-movers and normal straddle carriers are being replaced by for example Automated Guided Vehicles (AGVs) and Automated Rail mounted gantry crane systems (Ku et al., 2010), with common combinations such as Automated Straddle Carriers (ASCs) + AGVs; ASCs+ Automated lifting Vehicles (ALVs) or ASCs+ Automated shuttle Carriers (Martín-Soberón et al., 2014). As many ports consider these assortment of investments in automation, Zhu et al. (2010) assert that new container handling technologies such as twin 40-foot quay cranes, low bridge allocation system and twin 40-foot rail mounted gantry crane can increase the operation efficiency by about 50%.

2.9 Current Awareness of Port Sustainability

The concept of port sustainability can be broken down into three main area, firstly to be economically sustainable, secondly environmental preservation and lastly be socially responsible (Cheon and Dwakin, 2010). With the development of shipping industry, the function of port shifted from simply loading and discharging cargo/goods to an economic catalyst to a country and a link to international trade. The function of handling cargo remains but port also provide considerable amount of employment opportunity. Therefore, economic stability and social responsibility have been increasingly framed into port development plan and policy (Dinwoodie et al., 2012) which includes the development of automation in port industry.

2.10 Port Sustainability Goals

In relation the triple bottom line concept (Hall, 2011), sustainability has three core facets for attention, namely economic, social and the environment. While the environmental mainly seeks reduction in pollution (Adams et al., 2010), return on firm's investment and welfare of local communities are also crucial sustainability goals. Consequent upon recent increased sustainability awareness, industries now constantly develop policies, regulations and innovations (Cheon and Deakin, 2010), and ports not

left out in seriously seeking strategies to meeting their sustainability goals. Decision on automation and level of automation of port operations is important today in meeting sustainability goals, with authors such as (Martín-Soberón et al., 2014; Figueiredo et al., 2015), highlighting both the pros and cons of port automation.

3 Research gap and approach

Port sustainability has been widely studied (Denktas-Sakar and Karatas-Cetin 2012; Sidney 2010; Kim, and Chiang, 2014; Dinwoodie et al., 2012; Laxe et al. 2016; Sislian et al., 2016; Lu te al. 2012; Acciaro et al., 2014) and also port automation (Nelmes, 2006; Hong, and Ngo, 2009; Chao, and Lin, 2017; Reboll-o et al., 2000; Martin-soberon et al., 2014). However, there appears to be a limited number of studies that have given attention to examining both port sustainability and port automation together. The aim of this research therefore is to investigate the current trend of port automation and possible implications on port sustainability by deploying the content analysis approach. Hence, the study provides a basic framework to further understand the impact of automation in the port industry in meeting port sustainability goals. Firstly, a detailed literature review is conducted. Secondly, highlights of relevant key concepts (including the advantages of automation and drawbacks) are made for analysis. Thirdly, the triple-bottom-line of sustainability framework is used in analysing key findings and meeting the aim of the research.

4 Results, findings and discussions

Key concepts in implementing port automation, in terms of major drivers are compiled in Table 3.

	Automation key features
Operational performance	Better operational productivity
	Land space optimisation due to high yard density
	Better flexibility during high demand period
	Constant readiness, reduce respond time of human operator
	Achieve Resource utilisation
	Better control over operations, due to the fact of continues communication between control system and equipment, making decision making process easier in real time.
Safety and Security	Increase overall safety concern due to reduction of human involvement in operation
	Incorporation of security system
Environmental	Electric equipment reduces emission of Greenhouse gases
	Best use of current spaces (fewer extension)
Economical	Less variable operation cost
	Less maintenance operational cost

Source: Authors (2018)

Table 3: Major drivers for port automation

Table 3 presents a summary of the major drivers for port automation, representing key prospects for port management in the quest for sustainability in relation to the triple bottom-line.

4.1 Economic and flexibility perspective

The increased operational productivity due to the better efficiency by operating machines instead of human operators allows faster and smoother movement of goods within the terminal. Eventually, this will impact positively port revenue and economic prospects. However, automation could reduce

flexibility where unexpected situations cannot be processed and handled by the computerised systems, needing human intervention. The deployment of automation in port supports land-space optimisation, hence enhanced performance given limited land-space and high yard density. On the economical aspect, Greenfield automation project for instance, means less land is required to achieve the same level of performance as compared to a non-automated port. Hence less capital investment is required on purchase or leasing the land in the initial phase of a port project. Better flexibility during high demand period with automation allows the terminal to handle demand peaks smoothly and bring customer satisfaction and better performance. Terminal automation system also allows terminal to have constant readiness, reduced respond time of human operator. These will eventually enhance the service level of a terminal and bringing positive economic impact.

4.2 Human-engagement and social perspective

The implementation of port automation system reduces human labour required in the container-yard area. A bright social perspective is that it reduces the overall risk of injury and other safety issues. On the downside however, automation results in less employment opportunity for the local community. One can also argue that port-automation creates opportunity for high-tech ICT-related industry to support the implementation. As a result, there is a ripple effect in an increase in the demand of highly educated workforce, and a gradual displacement of those of lower skills.

4.3 Environmental perspective

By developing an automated port terminal, the installation of equipment that are powered by electricity such as AGVs will eventually reduce emission in the port region, hence achieving environment preservation goal of ports. To the surrounding community, electric-powered equipment also means lower noise levels as compared to traditional trucks and engine powered equipment. Additionally, less emission leads to positive social impact as local residents can be benefit from better air quality.

5 Conclusion

As a result of speed and overall efficiency gains from automation, ports make economic gains and the quest for extensive port-land expansion will be reduced. A resultant impact will be an environmental gain from low probability for land reclamation and related dredging operations, with an associated social benefit of local residents' rest of mind on possible relocation. Despite the advantages, it's crucial that port management analyses the needed capital cost of investment in automation equipment, which can only be recovered on long term basis.

Given advances in technology, the trend of developing automated terminal appears to be inevitable for most ports. Many leading ports such are port of Rotterdam and Singapore are already fully automated and still investing heavily in automation. This trend indicates that the policy of constructing a new terminal or upgrading an existing ones towards autonomy presents potential prospects. Although, automated terminals have some drawbacks in terms of sustainability, especially in the social aspect with machine-human displacement, its offers are compelling. In conclusion, automation in ports offers prospects for cleaner, faster, enhanced performance and support in the attainment of port's overall sustainability goals.

References

- Acciaro, M., Vanelslander, T., Sys, C., Ferrari, C., Roumboutsos, A., Giuliano, G., Lam, J.S.L. and Kapros, S., 2014. Environmental sustainability in seaports: a framework for successful innovation. *Maritime Policy & Management*, *41*(5), pp.480-500.
- Adams, M., Quinonez, P., Pallis, A. A. and Wakeman, T. H.,"Environmental Issues in Port Competitiveness", Working Paper 7, 2010, Centre for International Trade and Transportation. Online available at: http://www.dal.ca/faculty/management/schools_and_centres/centre-for–international- trade-and-transportation.
- Alderton, P. and Saieva, G., 2013. *Port management and operations*. Taylor & Francis.
- Branch, A., 2012. *Elements of port operation and management*. Springer Science & Business Media. Chao, S.L. and Lin, Y.L., 2017. Gate automation system evaluation: A case of a container number recognition system in port terminals. *Maritime Business Review*, *2*(1), pp.21-35.
- Cheon, S. H. and Dwakin, E., (2010) "Supply Chain Coordination for Port Sustainability," Journal of ransport Research Board, Vol.2166, No.2, 2010, 10-19.
- De Sousa, C., 2000. Brownfield redevelopment versus greenfield development: A private sector perspective on the costs and risks associated with brownfield redevelopment in the Greater Toronto Area. Journal of Environmental Planning and Management, 43(6), pp.831-853.
- Denktas-Sakar, G. and Karatas-Cetin, C., 2012. Port sustainability and stakeholder management in supply chains: A framework on resource dependence theory. *The Asian Journal of Shipping and Logistics*, *28*(3), pp.301-319.
- Dinwoodie, J., Tuck, S., Knowles, H., Benhin, J. and Sansom, M., 2012. Sustainable development of maritime operations in ports. *Business Strategy and the Environment*, *21*(2), pp.111-126.
- Evers, J.J. and Koppers, S.A., 1996. Automated guided vehicle traffic control at a container terminal. Transportation Research Part A: Policy and Practice, 30(1), pp.21-34.
- Figueiredo, A.E., Carvalhal, R.D.D., Hoeflich, S., Figueiredo, L., Pereira, S.L. and Dias, E.M., 2015. Port operation–increase of automated systems, decline of workforce jobs?. In Proceedings of 19th Hall, T.J., 2011. The triple bottom line: what is it and how does it work?. Indiana business review, 86(1), p.4.
- Hong, K.S. and Ngo, Q.H., 2009, October. Port Automation: modeling and control of container cranes. In *Inter. Conf. on Instrumentation, Control and Automation* (pp. 19-26).
- Hwee, T. (2018). Singapore Budget 2018: Maritime industry gets S$100m more to push for automated, digital future. [online] The Business Times. Available at: http://www.businesstimes.com.sg/transport/singapore-budget-2018/singapore-budget-2018-maritime-industry-gets-s100m-more-to-push-for [Accessed 15 Mar. 2018].
- Ics-shipping.org. (2018). ICS | Shipping and World Trade. [online] Available at: http://www.ics-shipping.org/shipping-facts/shipping-and-world-trade [Accessed 5 May 2018].
- Kim, H. and Nguyen, D. (2008). Allocation Model of Container Yard for A TC Optimal Operation in Automated Container Terminal. Journal of Navigation and Port Research, 32(9), pp.737-742.
- Kim, S. and Chiang, B., 2014. Sustainability Practices to achieve Sustainability in International Port Operations. *Economics*, *30*(3), pp.15-37.
- Ku, L.P., Lee, L.H., Chew, E.P. and Tan, K.C., 2010. An optimisation framework for yard planning in a container terminal: case with automated rail-mounted gantry cranes. OR spectrum, 32(3), pp.519-541.
- Laxe, F.G., Bermúdez, F.M., Palmero, F.M. and Novo-Corti, I., 2016. Sustainability and the Spanish port system. Analysis of the relationship between economic and environmental indicators. *Marine pollution bulletin*, *113*(1-2), pp.232-239.
- Lu, C.S., Shang, K.C. and Lin, C.C., 2012, May. Identifying crucial sustainability assessment criteria for international ports. In *International Forum on Shipping, Ports and Airports, Hong Kong* (pp. 27-30).
- Lun, Y. H. V.,"Green Management Practices and Firm Performance: A Case of Container Terminal Operations," Resource, Conservation and Recycling, Vol.,55, No.6, 2011, 559-566.

- Martín-Soberón, A., Monfort, A., Sapiña, R., Monterde, N. and Calduch, D. (2014). Automation in Port Container Terminals. Procedia - Social and Behavioral Sciences, 160, pp.195-204.
- Nelmes, G., 2006. Container port automation. In *Field and Service Robotics* (pp. 3-8). Springer, Berlin, Heidelberg.
- Nightingale, L. (2014). Rotterdam dockers unite in automation row. [online] Lloyd's List. Available at: https://lloydslist.maritimeintelligence.informa.com/LL048910/Rotterdam-dockers-unite-in- automation-row [Accessed 14 Mar. 2018].
- Paixao, A.C. and BernardMarlow, P., 2003. Fourth generation ports–a question of agility?. *International Journal of Physical Distribution & Logistics Management*, *33*(4), pp.355-376.
- Peris-Mora, E., Orejas, J.D., Subirats, A., Ibáñez, S. and Alvarez, P., 2005. Development of a system of indicators for sustainable port management. *Marine Pollution Bulletin*, *50*(12), pp.1649-1660.
- Phan, M.H.T. and Kim, K.H., (2012) Estimating the Cycle Time of Container Handling in Terminals. Department of Industrial Engineering, Pusan National University.
- Oocl.com. (2018). OOCL Hong Kong. [online] Available at: http://www.oocl.com/eng/ourservices/vessels/gclass21413/Pages/ooclhongkong.aspx [Accessed 26 Jun. 2018].
- Rebollo, M., Julian, V., Carrascosa, C. and Botti, V., 2000, October. A multi-agent system for the automation of a port container terminal. In *Autonomous Agents 2000 workshop on Agents in Industry* (Vol. 1, pp. 1-7).
- Saanen, Y. (2010). “Robotization for small and medium sized terminals - beyond the obvious”. In Terminal Operations Conference (TOC), 8-10 June 2010, Valencia
- Shih-Liang Chao, Ya-Lan Lin, (2017) "Gate automation system evaluation: A case of a container number recognition system in port terminals", Maritime Business Review, Vol. 2 Issue: 1, pp.21-35,
- Sislian, L., Jaegler, A. and Cariou, P., 2016. A literature review on port sustainability and ocean's carrier network problem. *Research in Transportation Business & Management*, *19*, pp.19-26.
- Voß, S., Stahlbock, R. and Steenken, D. (2004). Container terminal operation and operations research - a classification and literature review. OR Spectrum, 26(1), pp.3-49.
- Zrnić, N., Petković, Z. and Bošnjak, S., 2005. Automation of ship-to-shore container cranes: A review of state-of-the-art. FME Transactions, 33(3), pp.111-121.
- Asgari, N., Hassani, A., Jones, D. and Nguye, H.H., 2015. Sustainability ranking of the UK major ports: methodology and case study. *Transportation research part E: logistics and transportation review*, *78*, pp.19-39.

LONG-TERM FORECAST OF THE UNITED KINGDOM CONTAINER PORTS THROUGHPUT

Manuel Buitrago Moreno and John Preston
Transportation Research Group, Faculty of Engineering and the Environment, University of Southampton, UK

1. Throughput forecasting: a valuable tool for the strategic planning of the maritime transport sector of the United Kingdom within the current port governance models

Container ports act as the primary gateway for most of the United Kingdom (UK) trade (Eddington, 2006) and are key for the competitiveness of the UK's economy and its supply chains in a globalised, trade-dependent world. The ports of the United Kingdom handle around 95% of the total volume of UK trade and 71.87% of its value. (Department for Transport, 2016). Moreover, the port sector exerts significant economic influence in the UK. It is estimated that in 2016 the ports industry directly contributed approximately £22.6 billion in business turnover, £7.6 billion in gross value added (GVA) and supported 101,000 direct jobs (Cebr, 2017).

Port governance in the UK belongs to the Anglo-Saxon doctrine. This means that UK container ports are private service ports (Thomas, 1994) and the few companies who own the UK port infrastructure propose the development and enlargement of their facilities.

The addition of new infrastructure by expanding container port capacity has a tremendous economic and environmental cost. Liverpool2 container terminal is an example of the substantial financial commitment that the construction and equipment of a container terminal involves. This is the latest development of a container terminal in the United Kingdom. Situated in the port of Liverpool, the terminal cost in excess £400m (Peel Ports Group, 2016). Regarding the externalities caused by new container port development, the public opinion has contested expansion schemes in the United Kingdom in recent years, such the proposed new deep-water container terminal at Dibden Bay (Southampton).

The ultimate decision to grant permission for the expansion of container terminal capacity lies in the Government. Therefore, a country-level port development policy ought to be informed by models capable of forecasting future container throughput at country level and appraisal the current container terminal capacity of the container port system accurately. A better understanding of the UK container port system and the demand that it must accommodate in the next decades is a cornerstone step towards a clearer strategic port planning that will seek to enable container port capacity expansions when needed.

2. The UK range

The UK range is defined as the set of container ports (lo-lo) located in the UK (figure 1), which serve primarily the hinterland of Great Britain and to a lesser extent Ireland. In terms of throughput, the UK container port system is highly concentrated in the South East of the Isle of Great Britain, where the ports of Southampton, Felixstowe and London enjoy a privileged location, close to the maritime routes that flow from the Far East to Northern Europe across the English Channel (figure 1). The UK port range has seen during the last decade the considerable decline of some ports (in Thamesport, Tilbury and Tyne) as new deep-water capacity was built, such as London Gateway (2013) and the expansions at Southampton (SCT5, 2014) and Felixstowe (Berths 8&9, 2011). A detailed study of the dynamics within the UK port range can be found in Buitrago and Preston (2018). The degree of concentration of the UK container port system is high, but has been relatively stable during the last years and has only slightly increased.

3. Previous studies on container throughput forecasting

Since its first steps in the 1980s, container throughput forecasting research has considerably expanded. However, there has been no standardised methodology for the calculation of container port throughput yet. Maritime trade forecasting techniques can be divided in qualitative or

quantitative. Quantitative forecasting techniques can be classified into causal methods, time-series methods and nonlinear dynamic methods. (Abraham *et al.*, 1983). Time series models include exponential smoothing, autoregressive integrated moving average (Klein, 1996; Veenstra *et al.*, 2001; Amoako, 2002; Rashed *et al.*, 2017) seasonal autoregressive integrated moving average (SARIMA) (Schulze *et al.*, 2009), vector autoregressive (VAR) (Syafi'i *et al.*, 2005), decomposition (Peng *et al.*, 2009) and grey forecasting (Guo *et al.*, 2005; Zhang *et al.*, 2013; Twrdy *et al.*, 2016).

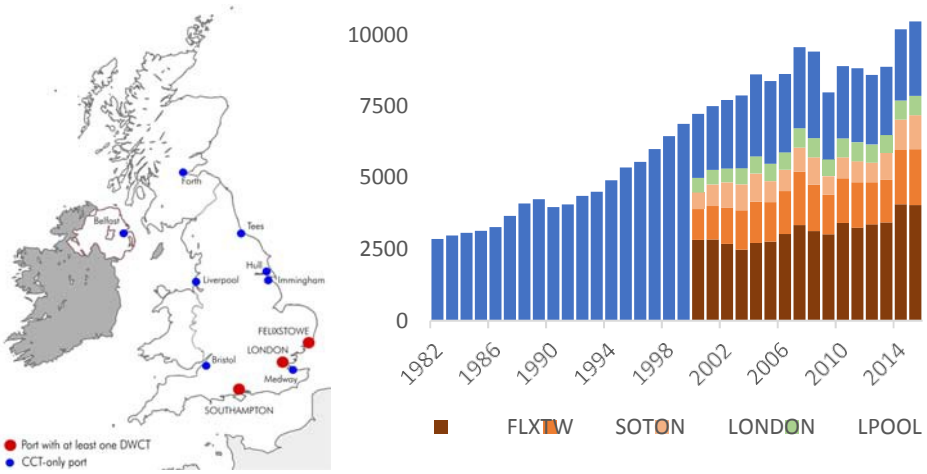


Figure 1: a) The UK container port system b) Throughput evolution in the UK container port system the UK (1982-2016) in kTEU. Data: Department for Transport, OECD

Causal models bind the container throughput with explanatory variables, using regression techniques and sometimes elasticity analysis. Normally, port authorities, consultants and transport departments explore the causal relations between the throughput and socio-economic indicators. Causal models have been applied to several geographical scopes. Seabrooke et al. (2003) forecast the traffic of the port of Hong Hong, Gosasang et al. (2011) analysed the volumes of the port of Bangkok, Patil and Sahu (2015) investigated the port of Mumbai, Chou, Chu and Liang (2008) dealt with the main ports of Taiwan and van Dorsser et al. (2012) computed a long-term forecast of the Hamburg – Le Havre range.

Finally, there has been a constant interest in the application of nonlinear dynamic models to port traffic forecasting. Under this category, neural networks is the most used technique (Gosasang et al., 2011; Ping et al., 2013; Mo et al., 2018). Other methods include genetic programming (GP) (Chen et al., 2010) and support vector regression (SVR) (Mak et al., 2007).

Manifold variables have been used in the literature as explaining variables for container throughput. A selection of variables includes: import prices (Coto-Millán et al., 2005), trade value (Seabrooke et al., 2003), population (Seabrooke et al., 2003; Gosasang et al., 2011) exchange, interest and inflation rates (Gosasang et al., 2011) or the production of oil (Patil et al., 2015).

The studies in container traffic forecasting can be further classified according to the time scale and the geographical scope. In the temporal scope, we can differentiate short-, mid- and long-term forecasting. Time series is mainly used in short-term forecasting (1 - 5 years). Causal methods establish an explanatory relationship between the response variable and the predictors (also called explanatory variables). Therefore, causal methods are applied to port throughput forecasting with a horizon year greater than 5 years (mid-term and long-term port traffic forecasts). The geographical scope of the previous forecasting studies varies considerably. Scholars have tried to forecast individual terminal or ports (Hui et al., 2004; Lam et al., 2004; Patil et al., 2015), a set of ports or a port region (Liu et al., 2011), the throughput in a specific country (S. Chen et al., 2010) or finally, a whole port range, which can be comprised in one country or extend between several (Langen et al., 2012; van Dorsser et al., 2012; Twrdy et al., 2016).

4. Methodology.

This paper presents a long-term country level forecast of the container throughput of the United Kingdom container port system up to 2050 by means of a several multivariate linear and non-linear regression models, which employ key macroeconomic predictors. These econometric models rest on the causality between the macroeconomic explanatory variables and the container throughput.

The predictors considered to predict the container throughput (TEU) were the UK gross domestic product (GDP), the energy cost (FC) and the UK population (POP).

The response variable (TEU) represents the aggregated container throughput in the UK, measured in twenty- foot equivalent unit (TEU). This is an inexact way of measuring cargo throughput for at least the following reasons:

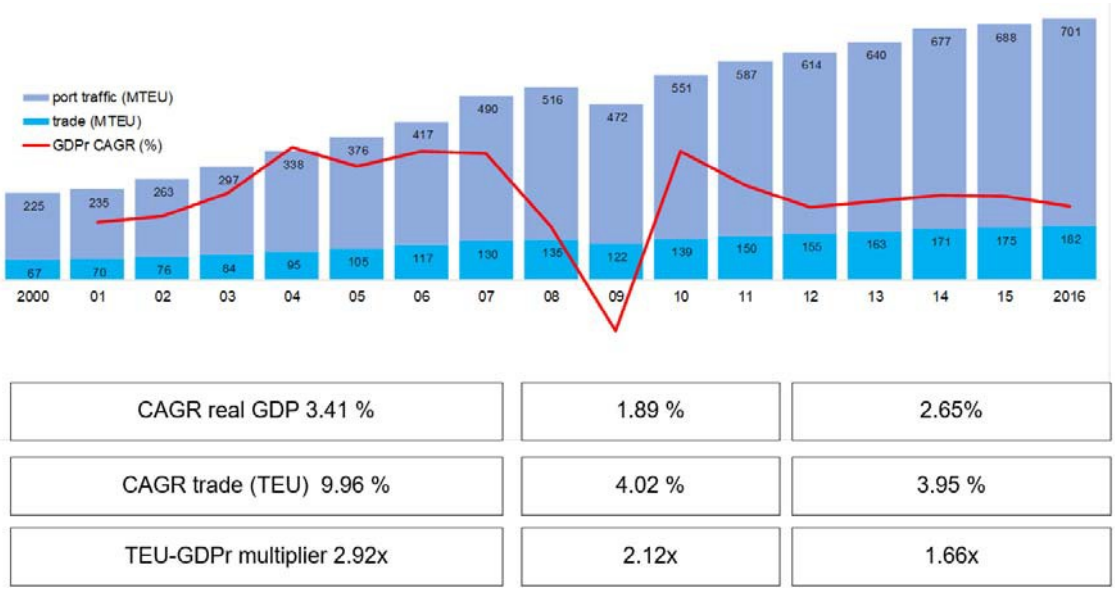
- Diversity of containers sizes. Container of several measures exist, being the most popular in maritime transport those of 20 and 40 feet. For containers of 40 feet, two TEU are accounted.
- Empty containers. The imbalance of trade between the economies of the Far East and Europe cause that a fraction of the containers handled at UK ports are in fact empty.
- Transshipment. Containers that are transferred to another maritime transport mode (including container feeder vessels and barges) are accounted two times for the throughput, as they are handled twice.
- It is suspected that port authorities aggregate container throughput data from roll on-roll off (RoRo) to lift-on/lift-off (LoLo) figures.

In the majority of forecasting models found in the literature, unitised traffic has mainly been expressed in tonnes rather than in units or TEU. However, TEU should be preferred to tonnes for reasons of statistical compatibility, as the methodology to account for tonnage differs from port to port (Coeck *et al.*, 1995). For the variable TEU, 45 years of aggregated container throughput data for the UK has been used, corresponding to the period 1971 – 2016 (Department for Transport, 2017; OECD, 2018).

Gross Domestic Product (GDP) is monetary appraisal (normally in US$) of the market value of all goods and services produced in a country during a year. There are three approaches to measure GDP: the production approach, the income approach and the expenditure approach. Most countries follow the System of National Accounts (European Commission *et al.*, 1993) as an international standard for measuring GDP.

There is a direct relationship between GDP and international trade. As freight transport is a derived demand, subsequently GDP and the transport of goods are correlated (Ickert *et al.*, 2007; Rijsenbrij *et al.*, 2011). GDP and international trade have a bidirectional relationship. However, it must be noted that GDP reflects wider changes in the domestic activity, which are not necessarily linked to the volume of imports and exports.

Frequently used in throughput forecasting, the so-called *GDP multiplier* is the ratio between the compound annual growth rate (CAGR) of global container trade and the CAGR of the global real GDP. The multiplier was 2.16 between 1985 – 1989, surged to 4.22 in the next decade as maritime trade enabled the second phase of globalisation and slowed down to 2.92 during the 2000s up to the Great Recession (2008-2011). Finally, we entered a new paradigm for the period 2012 – 2016 when the multiplier has been rather low (1.66) and even sank below 1.0 occasionally (figure 2).



CAGR real GDP 3.41 %	1.89 %	2.65%
CAGR trade (TEU) 9.96 %	4.02 %	3.95 %
TEU-GDPr multiplier 2.92x	2.12x	1.66x

Figure 2: Global port traffic and trade in MTEU (2000 - 2016). Data: Port traffic, GDP: World Bank; trade traffic: Alphaliner

Perhaps excessive importance has been placed in this multiplier when forecasting cargo. It must be observed that container trade represents trade flows, full containers moving from origin to destination. On the other hand, container port traffic includes every move of a box, whether import, export or transshipment. Port traffic is always a multiple of trade flows given that a container can be processed twice in one or several ports within the supply chain. Container trade increased globally in volume by 172% during the period 2000 – 2016, but the container port traffic did by 212%. The surge in container traffic was partially caused by a reshuffle of maritime shipping lines networks. The higher reliance of the supply chains on hub and spoke maritime networks increases the number of times a container is handled from origin to destination and the transshipment volumes. The demand growth is weaker than during the period 2001 - 2007, when global container port throughput grew at an impressive CAGR of 11.8%. Since then, a slower growth pace has become the new normal (~ 4%).

At the beginning, a better fit was obtained when GDP PPP (purchasing power parity) was used instead of real GDP. However, using GDP PPP for building the model would be problematic, as it would rely on the International Monetary Fund (IMF) projection, which only stretches until 2022, short of the desired forecasting horizon year. It became clear during the construction of the econometric model that it is necessary for throughput forecasting to use real GDP instead of nominal GDP, in order to avoid the effect of inflation. Furthermore, it is even more important to use GDP expressed in the national currency. This is crucial if big currency devaluations against the USD took place in the period of study.

Various organisations elaborate short-term and long-term projections for the GDP of the UK. There are numerous short-term GDP forecasts available. We computed the average of the UK GDP growth rate projected by Office for Budget Responsibility (OBR), Oxford Economics, Bank of England, European Commission, the National Institute of Economic and Social Research (NIESR), OECD and IMF for the period 2017 – 2022. The OBR's GDP long-term forecast was used for the period 2023 – 2050.

The variable fuel cost (FC) accounts for the energy price in the model. The Brent Oil spot price, which is the reference for the European markets, was chosen as the reference for computing the fuel cost. The data for both the historical data and the price projection have been extracted from the Annual Energy Outlook of the U.S. Energy Information Administration (EIA), (2017).

The variable population (POP) accounts for the mid-year population of the United Kingdom. This variable collects the statistical information about the population of the UK. Under neoclassic economic theory the population of country is an explanatory variable for the GDP calculation in the Solow-The

Solow–Swan model (Solow, 1956; Swan, 1956). Should the population of a country grow, there will be an increment of the labour hours, which will be translated into GDP growth. However, the relationship between population and GDP growth and has been challenged by Peterson (2017). In recent years, technological progress has enabled GDP increments without an increment of the labour factor. The variable POP was disregarded in the final models because it provoked multicollinearity, as GDP is highly linearly related to population. The correlation between the explanatory variable GDP and the dependent variable TEU for the period 1971 – 2016 is very strong (figure 3). Consequently adding more variables to the model yields a limited benefit in terms of increasing the explanatory power of model, while its complexity would increase. In the discussed models, one domestic variable (GDP) and one international commodity (fuel cost) were chosen as predictors.

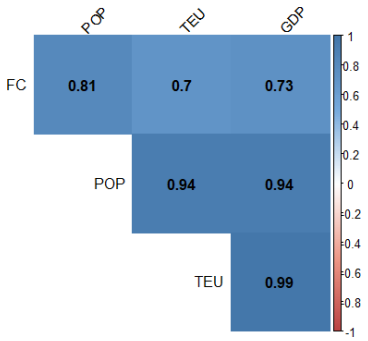


Figure 3: Correlation matrix of the studied explanatory variables

5. Regression models

The proposed multivariate regression models are:

$$\widehat{log\ TEU} = \hat{\beta}_0 + \hat{\beta}_1 \cdot log\ GDP + \hat{\beta}_2 \cdot log\ FC \text{ (model 1)}$$

$$\widehat{TEU} = \hat{\beta}_0 + \hat{\beta}_1 \cdot GDP + \hat{\beta}_2 \cdot FC^{0.5} \text{ (model 2)}$$

$$\widehat{TEU} = \hat{\beta}_0 + \hat{\beta}_1 \cdot GDP \text{ (model 3)}$$

Where:

- TEU is the container throughput in the UK container port system in a given year j, in TEU.
- GDP is the real gross domestic product of the UK in a given year j, in 2010 £m.
- FC is the average price of a barrel of Brent crude oil in a given year j, in 2017 USD/barrel.

Applying the model to the available set of data, the following regression coefficients where obtained (table 1):

	Model 1: $\hat{\beta}_i$	Model 2: $\hat{\beta}_i$	Model 3: $\hat{\beta}_i$
Intercept	-14.46507	-2.696E+03	-2.657E+03
GDP	1.65270	6.761E-03	6.364E-03
FC	-0.0636	-84.04	-
R^2	0.9883	0.9823	0.9805
RMSE	250.129	316.816	339.5416

Table 1: Regression coefficients

The model 1 has both the best adjusted R-squared and the minimum root-mean-squared error (RMSE).

Projections elaborated by reputed institutions are used to predict the throughput using the models. The GDP projection uses the estimated growth rate for two separated periods 2017 – 2022 and 2023 – 2050. The GDP growth rate of the period 2017 – 2022 was calculated as the average of the projections

provided by the Office for Budget Responsibility (OBR), Oxford Economics, Bank of England, European Commission, the National Institute of Economic and Social Research (NIESR), the OECD and the IMF. The OBR long-term GDP projection was used for the period 2023 -2050. The projection of the fuel cost, namely the cost of a Brent oil barrel was given by the forecast of the EIA (2018).

The projected values of the model one can be seen in figure 4:

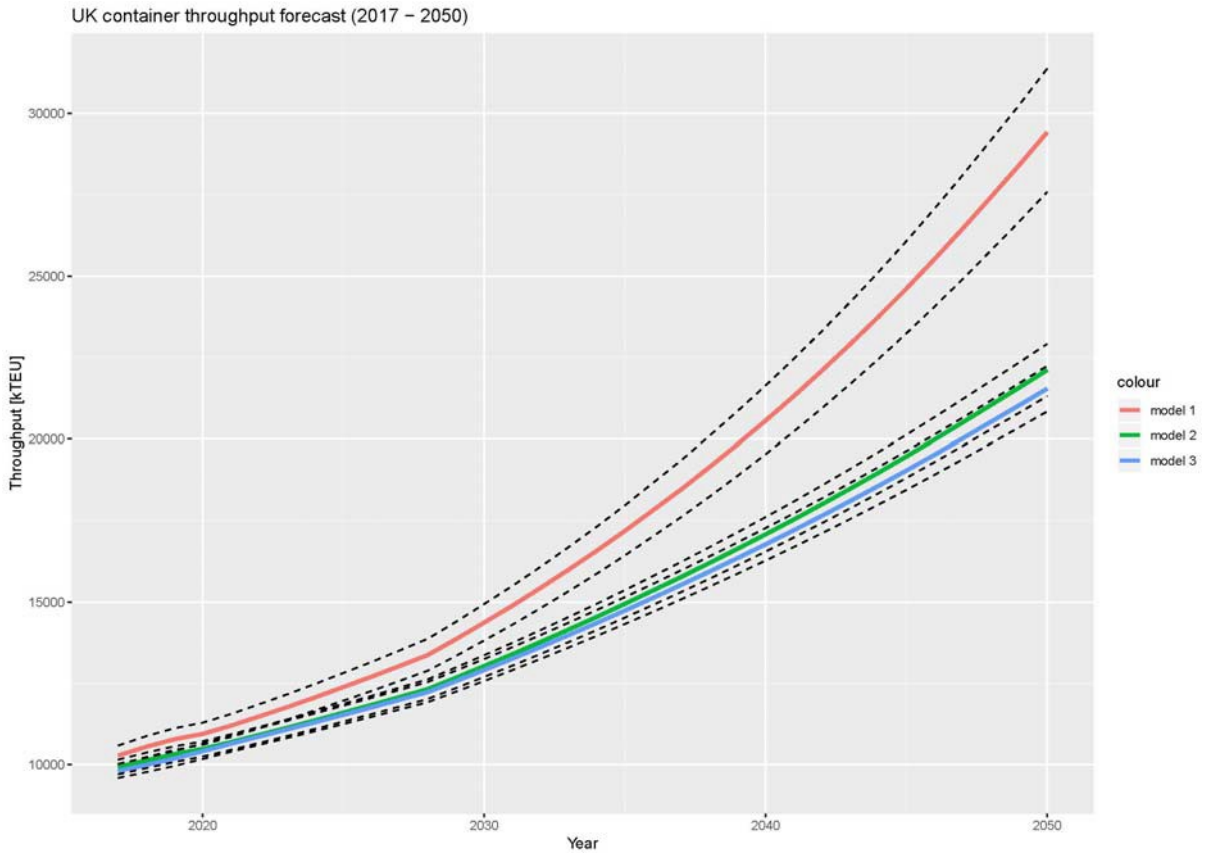


Figure 2: Projections (2017 -2050) of the models and the confidence intervals

Van Dorsser et al., (2010) suggested that apart from GDP, other variables should be included in the modelling of port throughput using regression methods.

Other variables that could be included in the model, as they could have a significant effect on the projection of container traffic, are:

a) Containerised commodities and goods factor, also known as *commodity effect.* This factor would reckon changes in containerisation ratio, as more commodities shifted to containers during the last decades and this trend may continue until it reaches a point of saturation.

b) Hinterland boundaries. It would reflect how the development of the hinterland infrastructure expands its boundaries, which affects the flows of cargo that go through the port.

c) Automation of ships – it could lead to an increase in capacity of containers ships as crew areas an certain machinery would not be longer needed.

d) Impact of the Chinese government-backed policy “One Belt One Road” (OBOR). The OBOR policy includes the further development of the maritime route between China and Europe. The impact of the OBOR could be twofold. It will generate a terrestrial alternative to the maritime route. This “New Silk Road” allowed freight trains to link for the first time in history the United Kingdom and China. The freight train took 17 days, which is significantly less than the maritime alternative. Secondly, the enhanced maritime route might increase the maritime trade worldwide, having a relative impact in the UK container flows.

e) New maritime routes. The opening of new maritime routes such as the Artic route or the Northwest Passage would reshuffle the cargo flows in North Europe affecting the number of calls and volumes at UK container ports.

f) Technological disruptions. The rise of additive manufacturing enabled by 3D printing technology would potentially reduce the amount transportation needed to deliver some goods to final consumers or other stages of the production chain. This implies that some production centres would be relocated back to Western countries if the manufacturing cost were substantially reduced. The location of manufacturing locations would be reshuffled and global trade patterns might substantially evolve. According to Ye (2015) the disruptive effect of 3D printing in global container throughput will be limited. Ye (2015) foresees a reduction of 0.511% of the total world throughput in 2035 compared to 2006 for the central scenario, with a maximum drop of 10.295% for a scenario that account for an extreme widespread use of 3D printing.

g) Resources. The resources of the world are being depleted at higher rates to fuel economic growth but Earth is finite. Better appraisal of GDP should take into account that the resources will be the limiting factor of never- ending over-optimistic exponential growth. Reviewed GDP forecast would have a dramatic impact in container throughput forecast (Galbraith, 2015).

h) Trade wars. A return to protectionism policies worldwide could sever trade at a global scale, and as result, it would lead to a lesser need for maritime freight transportation.

Prudence should preside over the assessment of future container flows and traffic volumes. Forecasting methods usually display an apparent mathematical rigour but they do not incorporate innovation and economic cycles (Notteboom *et al.*, 2009). Likewise, linear models cannot take into account external shocks (e.g. economic crisis, recessions, liberalisation or protectionism of trade) neither disruptive technologies and innovation. Furthermore, some developments driven by technological innovation could result in unforeseen side effects (Merton, 1936), what are not captured by the proposed model. Because of the above-mentioned reasons, it is common practice to complement and affect the results obtained by a linear model with qualitative data, often pulled together by a panel of experts. The qualitative assessment of exogenous shocks incorporates punctual macroeconomic-relevant events and help to identify structural breaks. However, the departure from quantitative forecasting methods comes at the price of introducing an undesired element of subjectivity in the traffic forecast. Several scenarios have been built (table 2) to reflect these uncertainties.

Scenario	GDP projection	FC projection	OBOR impact	3D printing
Central	Central	Central	From 2020 onwards	From 2030 onwards
Low GDP + High FC	Low	High	From 2020 onwards	From 2030 onwards
Hard Brexit	50% lesser immigration from EU	High	From 2020 onwards	From 2030 onwards

Table 2: Scenarios

6. Conclusions

This paper has introduced a novel method to forecast container throughput at a national scale, including for the first time a fuel cost variable. Shedding light into how the container volumes absorbed by the UK container port system may evolve in the future, a methodology has been presented, which permits to forecast the traffic throughput in the UK container port system up to the horizon year 2050.

The evolution of the demand of container traffic in the UK indicates that container traffic at UK seaports will grow steadily up to 2050, surpassing 20 MTEU in all the three models by the horizon year. It is reasonable to assume, looking at the historical trends and current trading patterns, that 70-80% of the total demand would be attended by a reduced number of deep-water capable ports. The projections elaborated provide a valuable tool for policy makers as it is possible to reconcile these

forecasts with the available capacity of the container system to evaluate the capacity margin, leading finally to a decision on when to grant permissions to add additional capacity.

Port infrastructure is costly in financial terms and lengthy in time to build and expand and better guidance is needed of when and where these key investments should be deployed (Meersman, Van de Voorde and Vanelslander, 2014). Even when the UK has a privatised container port system, the Government should monitor available capacity and develop independent container throughput forecasts. This paper provides a rationale on which to decide granting permission for future port development and might entice the UK's government to play a bigger role in the planning of container port infrastructure, helping to rationalise the bids for new container terminals in the future.

Acknowledgments

The authors would like the Southampton Marine and Maritime Institute (SMMI) of the University of Southampton and ITRC Mistral for funding this research.

References

- Abraham, B. and Ledolter, J. (1983) Statistical Methods for Forecasting. New York: Wiley.
- Amoako, J. (2002) 'Forecasting Australia's international container trade', *25th Australasian Transport Research Forum*. Canberra.
- Buitrago, M. and Preston, J. (2018) 'Forecasting the throughput of the United Kingdom container ports system up to 2050', in. Antwerp.
- Cebr (2017) *The Economic Contribution of the UK Maritime Sector*. London.
- Chen, S. and Chen, J. (2010) 'Expert Systems with Applications Forecasting container throughputs at ports using genetic programming', *Expert Systems With Applications*. Elsevier Ltd, 37(3), pp. 2054– 2058. doi: 10.1016/j.eswa.2009.06.054.
- Chen, S. H. and Chen, J. N. (2010) 'Forecasting container throughputs at ports using genetic programming', *Expert Systems With Applications*. Elsevier Ltd, 37(3), pp. 2054–2058. doi: 10.1016/j.eswa.2009.06.054.
- Chou, C. C., Chu, C. W. and Liang, G. S. (2008) 'A modified regression model for forecasting the volumes of Taiwan ' s import containers', *Mathematical and Computer Modelling*, 47(9–10), pp. 797–807. doi: 10.1016/j.mcm.2007.05.005.
- Coeck, C. *et al.* (1995) 'The unreliability of maritime trade statistics: an extension of results', *International Journal of Transport Economics / Rivista internazionale di economia dei trasporti*, 22(2), pp. 217–224.
- Coto-Millán, P., Baños-Pino, J. and Castro, J. V. (2005) 'Determinants of the demand for maritime imports and exports', *Transportation Research Part E: Logistics and Transportation Review*, 41(4), pp. 357–372. doi: 10.1016/j.tre.2004.05.002.
- Department for Transport (2012) *National Policy Statement for Ports*. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3931/nationa l- policy-statement-ports.pdf.
- Department for Transport (2017) 'UK Port Freight Statistics: 2016 final figures (Revised)'. London.
- Department for Transport (2018) *Maritime 2050: Call for evidence*. London.
- van Dorsser, C., Wolters, M. and van Wee, B. (2012) 'A Very Long Term Forecast of the Port Throughput in the Le Havre - Hamburg Range up to 2100', *European Journal of Transport and Infrastructure Research*, 12(1), pp. 88–110.
- van Dorsser, M. and Wolters, M. (2010) 'A Very Long Term Forecast for the development of the Cargo Flows in the le-Havre – Hamburg range', in *Port infrastructure Seminar 2010*. Delft. Available at: https://repository.tudelft.nl/islandora/object/uuid%3Ad3810cd0-b0ff-4daf-9341-4729b6148fc3.
- Eddington, R. (2006) *The Eddington Transport Study - the Case for Action*.
- European Commission *et al.* (1993) 'System of national accounts, 1993', *Journal of Government*

- *Information*, p. 814. doi: 10.1016/1352-0237(95)90103-5.
- Eurostat (2018) *What is the 'Rotterdam effect'?* Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/International_trade_statistics_-_background#What_is_the_.27Rotterdam_effect.27.3F (Accessed: 2 March 2018).
- Galbraith, J. K. (2015) *The End of Normal: The Great Crisis and the Future of Growth*. Simon & Schuster.
- Gosasang, V., Chandraprakaikul, W. and Kiattisin, S. (2011) 'A comparison of traditional and neural networks forecasting techniques for container throughput at Bangkok port', *Asian Journal of Shipping and Logistics*, 27(3), pp. 463–482. doi: 10.1016/S2092-5212(11)80022-2.
- Guo, Z., Song, X. and Ye, J. (2005) 'A Verhulst Model On Time Series Error Corrected For Port Throughput Forecasting', *J. of the Eastern Asia Society for Transportation Studies*, 6, pp. 881–891.
- Herfindahl, O. C. (1950) 'Concentration in the U.S. Steel Industry'. Colombia University Press, New York.
- Hirschman, A. O. (1945) 'National Power and the Structure of Foreign Trade'. Publications of the Bureau of Business and Economic Research. University of California Press, Berkeley.
- Hui, E. C. M., Seabrooke, W. and Wong, G. K. C. (2004) 'Forecasting Cargo Throughput for the Port of Hong Kong: Error Correction Model Approach', *Journal of Urban Planning and Development*, 130(December), pp. 195–203. doi: 10.1061/(ASCE)0733-9488(2004)130:4(195).
- Ickert, L. *et al.* (2007) *Abschätzung der langfristigen Entwicklung des Güterverkehrs in Deutschland bis 2050*. Basel.
- Klein, A. (1996) 'Forecasting the Antwerp maritime traffic flows using transformations and intervention models', *Journal of Forecasting*, 15(5), pp. 395–412. doi: 10.1002/(SICI)1099-131X(199609)15:5<395::AID-FOR628>3.3.CO;2-Z.
- Lam, W. H. K. *et al.* (2004) 'Forecasts and Reliability Analysis of Port Cargo Throughput in Hong Kong', *Journal of Urban Planning and Development*, 130(3), pp. 133–144. doi: 10.1061.
- Langen, P. W. De, Range, L. H. and Langen, P. W. De (2012) 'Combining Models and Commodity Chain Research for Making Long-Term Projections of Port Throughput: an Application to the Hamburg- Le Havre Range', 12(12), pp. 310–331.
- Liu, L. and Park, G. K. (2011) 'Empirical analysis of influence factors to container throughput in Korea and China ports', *Asian Journal of Shipping and Logistics*, 27(2), pp. 279–304. doi: 10.1016/S2092- 5212(11)80013-1.
- Mak, K. L. and Yang, D. H. (2007) 'Forecasting Hong Kong's Container Throughput with Approximate Least Squares Support Vector Machines.', *World Congress on Engineering 2007 (Volume 1)*, I, pp. 7–12. Available at: http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=32040347&site=ehost- live.
- MDS Transmodal (2016) *The value of goods passing through UK ports*. London.
- Meersman, H., Van de Voorde, E. and Vanelslander, T. (2014) *Port Infrastructure Finance*. Informa Law from Routledge.
- Merton, R. K. (1936) 'The Unanticipated Consequences of Purposive Social Action', *American Sociological Review*, pp. 894–904. doi: 10.2307/2084615.
- Mo, L. *et al.* (2018) 'GMDH-based hybrid model for container throughput forecasting: Selective combination forecasting in nonlinear subseries', *Applied Soft Computing Journal*. Elsevier B.V., 62, pp. 478–490. doi: 10.1016/j.asoc.2017.10.033.
- Notteboom, T. E. (1997) 'Concentration and load centre development in the European container port system', *Journal of Transport Geography*, 5(2), pp. 99–115. doi: 10.1016/S0966-6923(96)00072- 5.
- Notteboom, T. E. (2010) 'Concentration and the formation of multi-port gateway regions in the European container port system: An update', *Journal of Transport Geography*. Elsevier Ltd, 18(4), pp. 567–583. doi: 10.1016/j.jtrangeo.2010.03.003.
- Notteboom, T. E., Parola, F. and Satta, G. (2013) *Synthesis of the information regarding the*

container transshipment volumes.
- Notteboom, T. and Rodrigue, J. P. (2009) 'The future of containerization: Perspectives from maritime and inland freight distribution', *GeoJournal*, 74(1), pp. 7–22. doi: 10.1007/s10708-008-9211-3.
- OECD (2018) *Container transport (indicator)*. doi: 10.1787/26de63f3-en.
- Patil, G. R. and Sahu, P. K. (2015) 'Estimation of freight demand at Mumbai Port using regression and time series models', *KSCE Journal of Civil Engineering*, 20(5), pp. 2022–2032. doi: 10.1007/s 12205- 015-0386-0.
- Peel Ports Group (2016) *Official Opening of Peel Ports £400 million Liverpool container terminal*. Available at: https://www.peelports.com/news/2016/official-opening-of-peel-ports-400-million-liverpool-container-terminal (Accessed: 29 October 2017).
- Peng, W. Y. and Chu, C. W. (2009) 'A comparison of univariate methods for forecasting container throughput volumes', *Mathematical and Computer Modelling*. Elsevier Ltd, 50(7–8), pp. 1045–1057. doi: 10.1016/j.mcm.2009.05.027.
- Peterson, E. W. F. (2017) 'The role of population in economic growth', *SAGE Open*, 7(4). doi: 10.1177/2158244017736094.
- Ping, F. F. and Fei, F. X. (2013) 'Multivariant Forecasting Mode of Guangdong Province Port throughput with Genetic Algorithms and Back Propagation Neural Network', *Procedia - Social and Behavioral Sciences*. Elsevier B.V., 96(Cictp), pp. 1165–1174. doi: 10.1016/j.sbspro.2013.08.133.
- Rashed, Y. *et al.* (2017) 'Short-term forecast of container throughout: An ARIMA-intervention model for the port of Antwerp oa', *Maritime Economics and Logistics*. Nature Publishing Group, 19(4), pp. 749–764. doi: 10.1057/mel.2016.8.
- Rijsenbrij, J. . and Wieschemann, A. (2011) 'Sustainable Container Terminals: A Design Approach', in Böse, J. W. (ed.) *Handbook of Terminal Planning*. Springer.
- Schulze, P. M. and Prinz, A. (2009) 'Forecasting container transshipment in Germany', *Applied Economics*, 41(22), pp. 2809–2815. doi: 10.1080/00036840802260932.
- Seabrooke, W. *et al.* (2003) 'Forecasting cargo growth and regional role of the port of Hong Kong',
- *Cities*, 20(1), pp. 51–64. doi: 10.1016/S0264-2751(02)00097-5.
- Solow, R. M. (1956) 'A Contribution to the Theory of Economic Growth', *The Quarterly Journal of Economics*, 70(1), pp. 65–94.
- Swan, T. W. (1956) 'Economic growth and capital accumulation', *Economic Record*, 32(2), pp. 334– 361. Available at: https://doi.org/10.1111/j.1475-4932.1956.tb00434.x.
- Syafi'i, Kuroda, K. and Takebayashi, M. (2005) 'Forecasting the demand of container throughput in indonesia', *Memoirs of Construction Engineering Research Institute*, 47.
- Thomas, B. J. (1994) 'The privatization of United Kingdom seaports', *Maritime Policy and Management*, 21(2), pp. 135–148. doi: 10.1080/03088839400000030.
- Twrdy, E. and Batista, M. (2016) 'Modeling of container throughput in Northern Adriatic ports over the period 1990-2013', *Journal of Transport Geography*. Elsevier B.V., 52, pp. 131–142. doi: 10.1016/j.jtrangeo.2016.03.005.
- U.S. Energy Information Administration (EIA) (2018) *Annual Energy Outlook 2018*.
- Veenstra, A. W. and Haralambides, H. E. (2001) 'Multivariate autoregressive models for forecasting seaborne trade flows', *Transportation Research Part E: Logistics and Transportation Review*, 37(4), pp. 311–319. doi: 10.1016/S1366-5545(00)00020-X.
- Ye, M. (2015) *The impact of 3D printing on the world container transport [Master Thesis]*. Delft University of Technology. doi: 10.4172/2324-8777.1000163.
- Zhang, C., Huang, L. and Zhao, Z. (2013) 'Research on combination forecast of port cargo throughput based on time series and causality analysis', *Journal of Industrial Engineering and Management*, 6(1 LISS 2012), pp. 124–134. doi: 10.3926/jiem.687.

THE DEVELOPLMENT OF A SUSTAINABLE SUPPLY CHAIN PERFORMANCE MEASUREMENT FRAMEWORK IN THE OIL REFINING SECTOR

Dina E. Tamazin, Nicoleta S. Tipi and Saher Validi
Huddersfield Business School, Department of Logistics, Operations and Hospitality Management, The University of Huddersfield, UK

1. Introduction

Oil refining industry is a strategic industry, since it effects the economy of nations. That is, oil refining is a requisite to industrialized nations, as it serves as central part of many industries like transportation, power generation and petrochemical (Kojima, M., Matthews, W., and Sexsmith, F., 2010 and Sahebishahemabadi and Nickel, 2013). Hence, this paper reviews previous studies focusing on oil refining supply chain performance measurements (SCPMs) models from the sustainability theme. Thus, this paper attempts to develop a theoretical framework of oil refining SCPM model that incorporates the sustainability theme.

The reminder of this paper is organized as follows. The next section provides extensive literature review in oil refining SCPM through the sustainability scope. Section 3 develops a theoretical framework of oil refining SCPM model from the sustainability theme. Within section 4 the work is concluded, which identifies that there is still insufficient and inconsistent guidance for measuring the supply chain (SC) performance in oil refining sector from the sustainability prospect. Thus, this paper attempts to develop a theoretical framework of oil refining SCPM model that includes the sustainability theme.

2. Oil refining supply chain performance measurement through sustainability scope

Performance measurement systems play a vital role in enhancing the SC performance. Accordingly, companies should have an appropriate performance measurement system, to identify company's current status, progress and improvement opportunities to increase company's competiveness (Gunasekaran and Kobu, 2007 and Lin and Li, 2010). Therefore, this paper has been concerned to review the literature in the field of oil refining SCPM models to overview and understand the current performance measurements used to measure the SC performance in the oil refining sector. According to, Julka, Karimi and Srinivasan (2002), Stevans (2008) and Antonoio Martins, Felipe Scavarda and Hellingrath (2014) which focus on defining SCPM in the oil refining sector, these studies inferred that there is a limited number of papers that consider the oil refining SCPMs. This paper recognize that most of the previous studies like Varma, Wadhwa and Deshmukh (2008) and Nourouzi (2013) assign a widely used management tool such as the Balanced Scorecard model (BSC) to measure the SC performance in the oil refining sector. Practically, BSC application involves identifying the oil refining criteria under the four BSC's perspectives (financial, customer, internal and innovating and learning perspectives) to evaluate the performance of the oil refining company's supply chain on these criterias. Thus, this paper realizes the environmental aspect is considered an essential criteria to be measured in the oil refining sector, where this is not incorporated in the BSC model. In addition, the safety criteria is considered a desirable characteristics for the oil refining theme, where this is not present in the well-known models such as BSC and SC operations reference (SCOR) models. Hence, this paper observes that still there is restrained attempts to integrate the various oil refining criteria (i.e. these criteria reverse the oil refining characteristics which indicate the generic issues which oil refining SC faces) under the BSC and SCOR perspective. Considering, the oil refining SC have special characteristics which distinguish it among other kinds of process industries. Basically, any initiatives

to measure the oil refining SC performance will not be completed, unless having an appropriate SCPM model capable to consider or link the oil refining special characteristics to the assigned SCPM model.

On the other hand, in the last ten years there is growing awareness in the world heading towards sustainability. Consequently, this paper has been concerned to review the literature in the field of oil refining SCPM models that consolidate the sustainability theme. According to George, Siti-Nabiha, Jalaludin and Abdalla (2016), Pati, Wan, de and Tavasszy (2016) and Raut, Narkhede and Gardas (2017) which stated that in recent years there is an increasing awareness from the oil refining companies which realized that the crude oil will be scare and climate changes. Therefore many major companies have made outstanding progress by investing heavily to re-engineer their SC in order to meet sustainable measures and standards. Although, the preceding studies indicated that more efforts are needed to identify performance measurement indicators that can be used to measure the SC performance from the sustainability perspective. Although, SCOR (2017) announces some initiatives to attach the environmental sustainability perspective to be integrated to the SCOR model. However, the SCOR model still did not present any initiatives to integrate the economic and social sustainability perspective to the SCOR model. Besides, oil refining company's reports like PETRONAS (2014), BP (2015) and Eni (2016) which are reviewed, revealed that oil refining companies have not yet reached an advanced level of maturity with regards to sustainability. Thus, oil refining industry still did not reach an adequate scope to have consistent guidance for performance measurement capable to comprising the main characteristics of the oil refining industry and to coordinate the sustainability perspective. Therefore, more work is needed to develop a competent SCPM model which is able to incorporate all the sustainability aspects.

The development of theoretical framework of oil refining SCPM model from the sustainability theme

Subsequent to the previous discussions, this paper has great motive to attempt to develop a theoretical framework of oil refining SCPM model that incorporates the sustainability aspect. Thus, the theoretical model will be developed via 4 stages. Firstly, the model will comprises the main aspects of the oil refining industry which reflect the main oil refining characteristics. These aspects will be extracted from the analysis of previous studies in the area of oil refining. Secondly, extensive literature analysis is carried out to obtain key performance indicators (KPI) for each aspect. Thirdly, allocate each KPI under one of the three pillars of sustainability to assure that oil refining performance measurement model reverse the sustainability insight. Fourthly, provides measurement for each KPI, which are identified based on the previous literature review discussions, which end up with oil refining sustainable SCPM conceptual framework.

The development of the theoretical model follows a systematic approach adopted from Trafford and Leshem (2008) via four stages, namely: summary of sources, synthesis of sources, analysis stage and authorization text phase. The paper identified 18 main aspects through analysing the main issues surrounding the oil refining industry, in order to find the main characteristics of the oil refining SC. These key aspects are (transportation, procurement, technology, risk, forecasting, inventory management, contracting, capacity, green aspects, environmental issues, pricing, health and personal safety, quality, uncertainty, zero discharge, operational excellence, social impacts and logistics activities). Secondly, the paper excluded 12 sectors due to limited number of publications. Hence, the paper considers 6 main aspects to be analyzed (i.e. technology, environment, security, transportation, health and personal safety and social). Thus, the paper will analyze in the coming section the previous studies concerning these 6 aspects to identify the relevant KPIs under each aspect. Accordingly, the paper will attempts to allocate each KPI under one of the three pillars of sustainability (Economic – Environment – Social) in the following figures 1,2,3,4,5 and 6.

I. Technology Aspect

According to Moro (2003), IBM (2009), Emerson Process Management, (2010), ABB (2011) and IBM (2013) have presented some technical technological solutions, innovations, methods and tools like process automation, data coordination, data visibility, monitoring control technology, wireless communication solution and remote operator's technology. These technologies will transform the oil refining companies to be smart oil refining company. Besides, Borgne and Quintero (2003) and Diya'udden, David and Abdul (2011) that orient their studies to the technological environmental perspective. Hence, Borgne and Quintero (2003) was concerned by bio-refinery technology, which is a techniques used as an alternative development for some of the oil refining process, requires less temperature, pressure and cost as less energy used when compared with the common oil refining process and still environmentally friendly. In addition, Diya'uddeen et al. (2011) attempts to treat petroleum refinery effluents (waste water contaminant) in a way that protects the environment to be reused again. Thus to say, technologyenables the oil refining companies to have more efficient operations and still maintain less cost, more profit and environmentally friendly techniques.

Technological Aspect	• Smart Refinery **(Economic)** • Bio- refinery **(Economic & Enviroment)** • Refining Effluents **(Economic & Enviroment**)

Figure 1: Technological Aspect's KPIs and their Sustainability Allocation

II. Environment Aspect

Sánchez et.al (2011) and Szklo and Schaeffer (2007) reveals that the quality of crude oil is currently declining, as average reservoirs with higher sulfur and metal contents which considered undesirable characteristics. Consequently the previous studies mentioned, there will be a tradeoff between providing crude oil with low sulfur contents (quality specifications) and the increase in energy usage and higher carbon dioxide emissions released to the atmosphere, which will leads to higher greenhouse gases emission and negative impact on the environment. In addition, Emam (2015), Rajović, Kiss, Maravić and Bera (2016) and Tahouni, Gholami and Panjeshahi (2016) are concerned to assess the gas flaring system, greenhouse gases and other emission in refineries and their relevant environmental impacts. Moreover, Hu, Li and Zeng (2013), Yu, Han and He (2013) Hasani and Nabhani (2016) clarify that aside from air pollution, there are also water and land pollution. These studies point out that water and land pollution constitute environmental problems, so it is expected to treat the company's residual in environmentally friendly manner before discharge. Furthermore, IPIECA (2015) focus on the total quantity of energy consumed and the total amount of water consumed in oil refining operations. Finally, Panwar, Kaushik and Kothari (2011), Hoggett, Bolton, Candelise, Kern, Mitchell and Yan (2014) and Guivarch and Monjon (2017) was interested to review the use of alternativeenergy sources. These renewable energy sources is a great opportunity for energy saving, reduction in greenhouse gas emission and less pollution.

Environmental Aspect	• Crude Oil Feedstock's Quality **(Economic & Environment)** • Flared Gas, Greenhouse Gas Emission & Other Gas Emission **(Enviroment)** • Discharge to water, Wastes & oil Spills **(Enviroment)** • Fresh Water **(Enviroment)** • Energy Use **(Environment & Econmic)** • Alternative Energy Sources **(Enviroment)**

Figure 2: Environmental Aspect's KPIs and their Sustainability Allocation

III. Security Aspect

Winzer (2012) and Azzumi and Breyer (2018) reviewed a great number of papers to extract the energy security definition. These papers observed common concepts behind all energy security definitions, which is the ability of energy system to react properly to sudden changes or uncertainty risks (politically, environmentally, economically, advances in technology). In addition, Hoggett et.al (2014) and Guivarch and Monjon (2017) pointed out the relation between the energy security and low carbon transition through using renewable energy resources. Thus, these papers investigate that there is a positive relation between using renewable energy resources and energy security. Accordingly, using renewable energy resources will maintain energy security, consequence to energy saving, greenhouse gas emission reduction and economic benefits.

Security Aspect	• Energy Security Against Uncertainty Risks **(Economic)** • Renewable Energy Sources **(Enviroment)**

Figure 3: Security Aspect's KPIs and their Sustainability Allocation

IV. Transportation Aspect

Hasan, Ghannam and Esmail (2010), Martinez-Palou, Mosqueira, Zapata- Rendom, Aburto, Mar- Juarez, Bernal- Huicochea and de (2011) and Santos, Loh, Bannwart and Trevisan (2014) pointed out that the significant share of the total oil world reserves are with higher sulfur and metal contents (heavy crude oil), which represents crude oil viscosity. That is, heavy crude oil are characterized by high viscosity that render difficulty in oil flow through pipeline (not pumped easily through pipelines). Subsequently, the preceding papers highlighted that oil transportation has become a complex and highly technical operation, which require efficient and economical way to transfer heavy crude oil from head well to the refineries.

Transportaion Aspect	• Crude Oil Feedstock's Quality **(Economic & Environment)**

Figure 4: Transportation Aspect's KPIs and their Sustainability Allocation

V. Health and Personnel Aspect

Eyayo (2014), International Finance Corporation (IFC) (2016), American Petroleum Institute (2017) and Kumar, Karthick, Bhuvaneswari and Nandhini (2017) highlighted that the oil refining industry undertakes intrinsically hazardous activities, so it is essential to provide adequate protection to all members in workplace and prevent people being harmed or ill through work. These studies were concerned with occupational health and safety risk management, which considered one of the critical factors to protect workers from occupational risks (hazard) they could be exposed to. Further-more, the previous studies discussed the product stewardship subject. The preceding papers mentioned that oil refining companies are responsible to aware and inform everyone involved in the product cycle (using, storing, handling, transporting and disposing) to know product's health, safety environmental risks. This means of communication can be established on safety data sheet which provide general health, safety and environmental information about the products. These aspects will assist the oil refining companies to create healthier environment and to be more competitive and effective.

Health and Personel Aspect	• Occupational Health and Safety **(Social)** • Product StewerdShip **(Social)**

Figure 5: Health and Safety Aspect's KPIs and their Sustainability Allocation

VI. Social Aspect

Tordo, Warner, Manzano and Anouti (2013), RTENN (2016) and Olawuyi and The Oxford Institute for Energy Studies (2017) pointed out that several national governments have passed local content rules and legislations requiring foreign companies to give priority to employ local workers. In-addition, give preferences to national companies and locally produced materials in the procurement of goods and services used in petroleum operation. In other words, the aim of local content is the employment of national workforce (local hiring practices) and the procurement of goods and services from companies residing in the host country (local procurement). Therefore, local content is significant for host country's economic development. In addition, Anderson and Bieniaszewska (2005) and IPIECA (2008) explains the company's social responsibility to implement social investment activities to provide bigger and stronger society, similarly, these activities will provide social wellbeing. In addition, Asad, El-Emadi and Marquardt (2007) and Bozick, Gonzalez, Ogletree and Carew (2017) discuss the guidelines for developing the workforce skills. The aforesaid papers pointed out, that implementing powerful training and developments programs will increase the worker skills, productivity and employee loyalty. Respectively, all the precedent aspects will allow the company to accomplish organization objective and goals efficiently and effectively.

Social Aspect	• Local Content **(Economic and Social)** • Social Invetment and Workforce Development **(Social)**

Figure 6: Social Aspect's KPIs and their Sustainability Allocation

According to previous discussions, the paper will attempt to illustrate the oil refining SCPM framework in figure 7. This figure will represent the allocation of each KPI under one of the three pillars of sustainability and the measurement for each KPI.

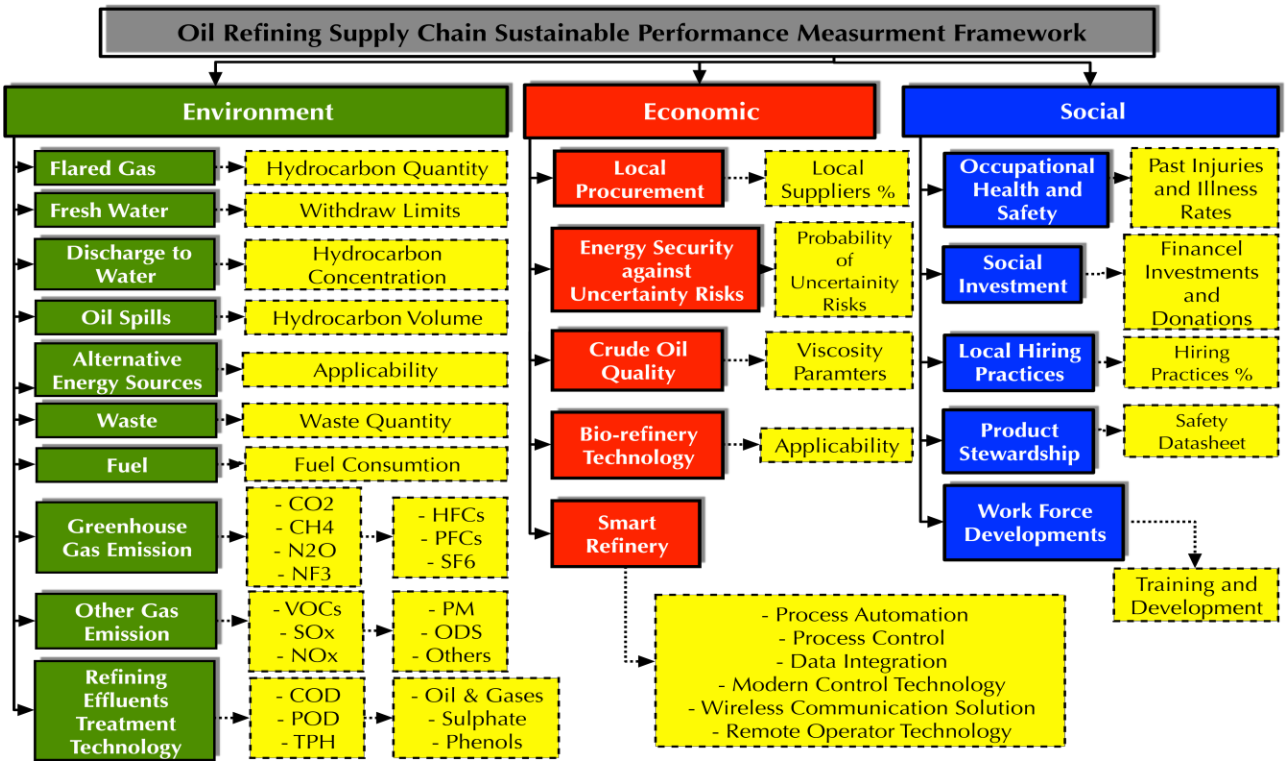


Figure 7: Oil Refining Sustainable Supply Chain Performance Measurement Mode

3. Conclusion

This paper has attempted to review previous studies focusing on identifying SCPM models applied in the oil refining sector. Accordingly, previous studies revealed that there is a limited number of papers that consider the oil refining SCPMs models. Similarly, it has been realized that most of the previous studies assign the well-known models such as the BSC model. That is, the application of the BSC model involves identifying the oil refining criteria under the assigned model perspectives to evaluate the performance of the oil refining company's SC on these criteria. However, this paper realized that there was some desirable characteristics for the oil refining theme (such as the environmental aspect), where not presented in the BSC model and (security aspect) where not presented in the BSC and the SCOR modes. Hence, this paper observed that there are restrained attempts to integrate the various oil refining criteria under the BSC and the SCOR perspectives especially that oil refining industry has specific characteristics which distinguish it among other kinds of process industries. On the other hand, previous studies stated there is growing awareness in the oil refining companies heading towards sustainability. Although, the importance of integration of sustainability theme in the oil refining SCPM system, previous studies indicated that still literature reviews are limited in this area where more efforts are needed to identify performance measurement indicators that can be used to measure the SC performance and are able to integrate the sustainability perspective. Thus, oil refining industry still has inconsistent guidance on performance measurement systems which are able to comprise the main characteristics of the oil refining industry and capable to incorporates the sustainability aspects. Thus, this paper's contribution was to develop a framework for the oil refining SCPM model that integrates the sustainability theme to assist the oil refining companies in measuring and evaluating their performance from the sustainability aspect to realize operation excellence.

References

- ABB. (2011). Enhancing productivity and energy efficiency of oil refineries, terminals and downstream complexes. PP. 1-16. Retrieved from https://library.e.abb.com/public/5db14a2de51a36efc1257a7000336958/Refining%20and%20PetroChem_lo.pdf.
- American Petroleum Institute (API). (2017). *Workplace Injuries and Illnesses Safety (WIIS) Report*. Washington D.C.
- Anderson, C. L., & Bieniaszewska, R. L. (2005). The role of corporate social responsibility in an oil company's expansion into new territories. *Corporate Social Responsibility and Environmental Management, 12,* 1, 1-9.
- APICS. (2017). *SCOR® supply chain operations reference model*: APICS, Inc.
- Asad, M., El-Emadi, S. & Marquardt, M. J. (2007). Relationship between employees' beliefs regarding training benefits and employees' organizational commitment in a petroleum company in The State of Qatar*. International Journal of Training and Development, 11,* 1, 49-70.
- Azzuni, A., & Breyer, C. (2018). Definitions and dimensions of energy security: a literature review. *Wiley Interdisciplinary Reviews: Energy and Environment, 7,* 1-34.
- Borgne, S. L., & Quintero, R. (2003). Biotechnological processes for the refining of petroleum. *Fuel Processing Technology, 81(*2), 155-169.
- Bozick, R., Gonzalez, G. C., Ogletree, C. & Carew, D. G. (2017). *Developing a skilled workforce for the oil and natural gas industry: An analysis of employers and colleges in Ohio, Pennsylvania, and West Virginia*. Santa Monica, Calif.: RAND Cooperation.
- British Petroleum. (2015). *BP sustainability report 2015*. London: British Petroleum.

- Diya'uddeen, B. H., Daud, W. M. A. W., & Abdul, A. A. R. (2011). Treatment technologies for petroleum refinery effluents: A review. *Process Safety and Environmental Protection, 89(*2), 95-105.
- Emam, E. A. (2015). GAS flaring in industry: An overview. *Petroleum and Coal, 57,* 5, 532-555. Global Reporting Initiative (GPI). (2012). *Sustainability Reporting Guidelines & Oil and Gas Sector Supplement.*
- Emerson Process Management, Ward, T., Poirier, L., Nieto, F., Haas, G., Peckham, J., Hitchings, M. A., & Gilleland, K. (Eds.). (2010). Smart Refinery Supplement. PP.1-24. Retrieved from http://www 2.emersonprocess.com/siteadmincenter/PM%20Articles/SmartRefinerySupplement_Sept2010_Fina l.pdf.
- Ente Nazionale Idrocarburi (Eni). (2016). *Integrated Annual Report 2016*. Rome: Eni SPA.
- Eyayo, F. (2014). Evaluation of Occupational Health Hazards among Oil Industry Workers: A Case Study of Refinery Workers. *IOSR Journal of Environmental Science, Toxicology and Food Technology, 8,12,* 22-53.
- George, R. A., Siti-Nabiha, A. K., Jalaludin, D., & Abdalla, Y. A. (November 10, 2016). Barriers to and enablers of sustainability integration in the performance management systems of an oil and gas company. *Journal of Cleaner Production: Part A, 136,* 197-212.
- Guivarch, C., & Monjon, S. (2017). Identifying the main uncertainty drivers of energy security in a low-carbon world: The case of Europe. *Energy Economics, 64,* 530-541.
- Gunasekaran, A., & Kobu, B. (2007). Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995-2004) for research and applications. *International Journal of Production Research, 45,* 12, 2819-2840.
- Hasani, F. & Nabhani, N. (2016). Waste Management System in Petroleum Refinery. *International Journal of Advanced Biotechnology and Research (IJBR) 7*, 3, 1446-1452.
- Hasan, S. W., Ghannam, M. T., & Esmail, N. (2010). Heavy crude oil viscosity reduction and rheology for pipeline transportation. *Fuel, 89(5),* 1095-1100.
- Hoggett, R., Bolton, R., Candelise, C., Kern, F., Mitchell, C., & Yan, J. (2014). Supply chains and energy security in a low carbon transition. *Applied Energy, 123,* 292-295.
- Hu, G., Li, J., & Zeng, G. (2013). Recent development in the treatment of oily sludge from petroleum industry: A review. *Journal of Hazardous Materials, 261,* 470-490.
- International Business Machines (IBM). (2009). Orchestrating the chain Supply chain performance management for chemicals and petroleum companies. PP. 1-18. Retrieved from ftp://129.35.224.1 12/software/data/sw- library/cognos/pdfs/whitepapers/wp_supply_chain_pm_for_chemicals_and _petroleum.pdf.
- International Business Machines (IBM). (2013). Energy excellence: Maximizing returns in the oil and gas industry. PP. 1-4. Retrieved from http://cdn.iotwf.com/resources/4/IBM_Point_of_View_on_En ergy.pdf.
- International Finance Corporation (IFC). (2016). *Environmental, Health, and Safety Guidelines for Petroleum Refining.*
- International Petroleum Industry Environmental Conservation Association (IPIECA). (2008). *Creating Successful, Sustainable Social Investment: Guidance document for the oil and gas industry.* London: UK.
- Julka, N., Karimi, I., & Srinivasan, R. (2002). Agent-based Refinery Supply Chain Management. *Computer Aided Chemical Engineering, 10,* 895-900.
- Kojima, M., Matthews, W., & Sexsmith, F. (2010). *Petroleum Markets in Sub-Saharan Africa: Analysis and Assessment of 12 Countries*. Extractive Industries for Development Series #15.
- Kumar, R.M. M., Karthick, R.B., Bhuvaneswari, V. & Nandhini, N. (2017). Study on Occupational Health and Diseases in Oil Industry. *International Research Journal of Engineering and Technology (IRJET).*
- Lin, L.-C., & Li, T.-S. (2010). An integrated framework for supply chain performance measurement using

six-sigma metrics. *Software Quality Journal, 18,* 3, 387-406.
- Martinez-Palou, R., Mosqueira, M. D. L., Zapata-Rendon, B., Aburto, J., Mar-Juarez, E., Bernal-Huicochea, C., & de, . C. C.-L. J. (2011). Transportation of heavy and extra-heavy crude oil by pipeline: A review. *Journal of Petroleum Science and Engineering, 75,* 274-282.
- Martins, R. A., Scavarda, L. F., Maximo, M. L., & Hellingrath, B. (2014). Designing a performance measurement system: A case study at the Oil and Gas Sector. *IIE Annual Conference and Expo 2014*, 2573–2583.
- Moro, L. F. (2003). Process technology in the petroleum refining industry-current situation and future trends. *Computers & Chemical Engineering, 27,* 1303-1305.
- Norouzi, S. & The School of Industrial Engineering and Management of KTH Royal Institute of Technology. (2013). Measuring Iranian Petroleum Downstream Supply Chain Management Performance: A Combination of Analytical Hierarchy Process and Balance Score Card. Stockholm.
- Olawuyi, D. S., & The Oxford Institute for Energy Studies. (2017). *Local content and procurement requirements in oil and gas contracts: Regional trends in the Middle East and North Africa.*
- Panwar, N. L., Kaushik, S. C., & Kothari, S. (2011). Role of renewable energy sources in environmental protection: A review. *Renewable and Sustainable Energy Reviews, 15(3),* 1513-1524.
- Pati, N., Wan, A. W. N. K., de, B. M. P., & Tavasszy, L. A. (August 01, 2016). Sustainable supply chain management in the oil and gas industry. *Benchmarking: an International Journal, 23,* 6, 1423-1444
- PETRONAS. (2014). *Sustainability Report 2014: reimagining energy*. Malaysia: PETRONAS.
- Rajović, V., Kiss, F., Maravić, N., & Bera, O. (2016). Environmental flows and life cycle assessment of associated petroleum gas utilization via combined heat and power plants and heat boilers at oil fields. *Energy Conversion and Management, 118,* 96-104.
- Raut, R. D., Narkhede, B., & Gardas, B. B. (February 01, 2017). To identify the critical success factors of sustainable supply chain management practices in the context of oil and gas industries: ISM approach. *Renewable and Sustainable Energy Reviews, 68,* 33-47.
- RTENN Petroleum. (2016). *Informing Local Communities, Civil Society and Local Government About Oil & Gas: A Practical Guide on Technical Aspects.*
- Sahebishahemabadi, H., & Nickel, S. (2013). *Strategic and Tactical Crude Oil Supply Chain: Mathematical Programming Models*. Karlsruhe: KIT-Bibliothek.
- Sánchez-Reyna, G., & Ancheyta, J. (2011). Preface to the special issue "Environmental modeling of catalytic reactions in the oil refining industry". *Fuel, 90(12),* 3489-3491.
- Santos, R. G., Loh, W., Bannwart, A. C. & Trevisan, O. V. (2014). An overview of heavy oil properties and its recovery and transportation methods. *Brazilian Journal of Chemical Engineering,* 571-590.
- Stevens, P. (2008). A methodology for assessing the performance of national oil companies. *The World Bank*, 1–48.
- Szklo, A., & Schaeffer, R. (2007). Fuel specification, energy consumption and CO2 emission in oil refineries. *Energy, 32(7),* 1075-1092.
- Tahouni, N., Gholami, M., & Panjeshahi, M. H. (2016). Integration of flare gas with fuel gas network in refineries. *Energy, 111,* 82-91.
- Tordo, S., Warner, M., Manzano, O.E. & Anouti, Y. (2013). *Local content policies in the oil and gas sector: A World Bank study*. Washington, D.C: World Bank Publications.
- Trafford, V.N. & Leshem, S. (2008), Stepping stones to achieving your doctorate: by focusing on your viva from the start. *Open University Press, Maidenhead.*
- Varma, S., Wadhwa, S., & Deshmukh, S. G. (2008). Evaluating petroleum supply chain performance. *Asia Pacific Journal of Marketing and Logistics, 20(3), 343–356.*
- Winzer, C. (2012). Conceptualizing energy security. *Energy Policy, 46,* 36-48.
- Yu, L., Han, M., & He, F. (2013). A review of treating oily wastewater. *Arabian Journal of Chemistry, 10.*

FINANCIAL VALUE-ADDED SERVICES BY LOGISTICS SERVICE PROVIDERS – TOWARDS A GUIDANCE OF EXTERNAL GOVERNANCE

Philipp Wetzel and Erik Hofmann
ISCM-HSG, Switzerland

1. Introduction

Today's world is highly integrated and connected, despite the current trade tensions between single countries. Trade occurs oftentimes cross-border, with goods being transferred from one country to another. With the physical flow of goods, also informational and financial flows are finding their way from sender to receiver and vice versa. However, often the physical, informational, and financial flows in the supply chain are not managed holistically. Therefore, solutions such as the concept of supply chain finance (SCF) and financial value-added services (FVAS) are becoming more significant.

Logistics service providers (LSPs) have included FVAS into their offering portfolio in order to become a single point of contact solution for their clients, be able to exhaust possible profits, and draw on their inherent process knowledge. Despite the wide application in practice, little research has been conducted with regard to the governance of LSPs offering FVAS. Against this background the aim of this paper is to explore the external governance with regard to FVAS from a LSP's perspective.

2. Research approach and methodology

The paper applies an explanatory research methodology, including a thorough explanation of theoretical concepts with regard to the supply chain, its actors and logistics services in order to explore the prevalent concepts of SCF and FVAS. It addresses the following overall research questions (RQs):

RQ 1: How do LSPs offer FVAS in terms of external governance?
RQ 2: What is the rationale behind offering FVAS with a certain governance structure?

To address these research questions, five interview-based case studies with LSPs are conducted and analysed. As LSPs need to be aware of the requirements along the supply chain when starting to offer FVAS, an overview of the supply chain, its actors and logistics services will be given in Section 3.1. In Section 3.2. the FVAS offered by LSPs are analysed and the benefits for single companies, LSPs, and the supply chain as a whole is highlighted. In Section 4, the external governance of LSPs offering FVAS is examined, with a focus on customs clearance services, freight payment services, and inventory financing. The selection of these services grounds on the different levels of expertise required to provide them. Additionally, a matrix is derived regarding FVAS and the external governance structure. Section 5 summarizes and indicates areas for future research.

3. Theoretical background and framework evaluation

3.1. The Supply Chain, its Actors and Logistics Services

When analysing the supply chain, its actors and logistics services, it is possible to consider different cases where logistic processes occur.

First, there is an inbound process, where the manufacturer (in this case the focal company) experiences an inflow of raw materials from the supplier into its production system (Takita & Leite, 2016). To order these raw materials, a purchase order is sent to the supplier. Within the ordering process, the parties involved have to agree on time and specifications of the delivery as well as on payment terms. This includes the definition of the freight cost payment responsibility and other terms of payment. The LSP connects the buyer and supplier and in most cases is selected by the supplier but in some cases could also be organized by the manufacturer. Overall, the inbound process includes a procurement company buying from one or more suppliers.

Second, an outbound process can be differentiated, where the manufacturer sells goods to a buyer such as a retailer (Takita & Leite, 2016). The perspective is opposite from the first example, particularly focusing on outbound logistics with finished goods going to the buyer. This can also include a delivery

service to the buyer's door or from a warehouse to a retailer's store. In this case, the manufacturer usually selects the LSP.

Third, there is intra-multinational logistics as studied by Wütz (2016), which is similar to the last example with goods hauled from a warehouse to a store. However, this is more about transportation of goods or spare parts between different sites of a multinational company. In contrast to the second example, this does not include an external buyer but rather one or two affiliated subsidiaries or a parent company of the manufacturer.

As highlighted by these examples and illustrated by Figure 1, there is an inbound process for the manufacturer when buying raw material from the supplier and feeding it into its production system. Once the goods are finished, there is an outbound process going from the manufacturer to the buyer. Meanwhile, the manufacturer could have one or more subsidiaries in need of spare parts that are delivered in an intra-multinational enterprise process.

In order to analyse the supply chain in more detail, we will further elaborate on the setting introduced in Figure 1, which includes a supplier, a manufacturer with its subsidiaries, and a buyer. All these supply chain actors are connected by a LSP and its services (similar to Hofmann and Belin, 2011). Primarily, the LSP is known for its traditional services such as transportation, handling, and storage of goods. There are also third party platform and technology providers as well as financial service providers (FSPs), all of which connect the actors as intermediators and offer various services to them.

The supply chain can be divided into three flows: a physical flow of goods and services, a flow of information, and a financial flow. The physical flow includes the products and services that move between the supplier, the manufacturer and its subsidiary, and the buyer along the supply chain.

The parallel informational flow, on the other hand, contains information associated with the physical movement of goods through the supply chain. Particularly, details regarding payments, purchase orders, inventory documents, and invoices are exchanged among the actors in both directions. Without the necessary information, the movement of goods and the financial transaction behind it would be disturbed or even interrupted. Typically, physical and financial flows happen at different points in time but are linked to the same order or transaction (Hofmann & Westerfeld, 2010).

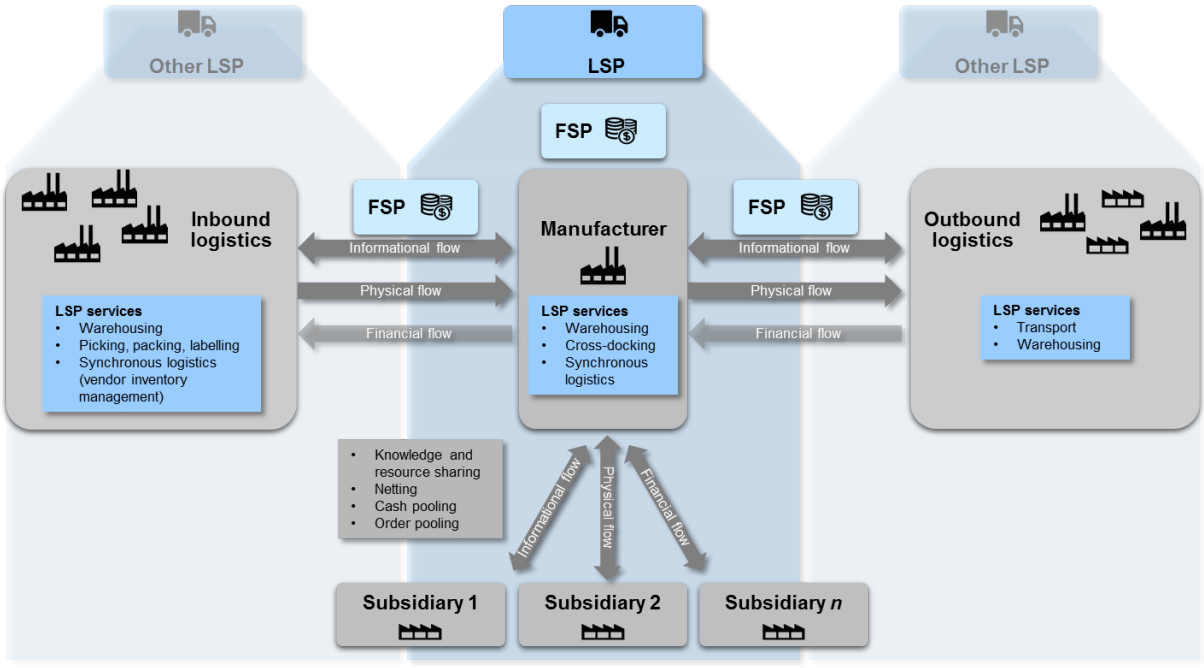


Figure 1: Classical supply chain, its actors and associated logistical services of an LSP

Regarding financial flows, the major movements between the companies involved are payments, invoices, and credit notes. According to Hofmann and Belin (2011), this is the reversed flow of the physical counterpart and the direction of this stream is going from the buyer towards the manufacturer and then to the supplier. The financial and the physical flow between the manufacturer and its subsidiaries are different, as they can move both directions. This occurrence is because the business transactions between these two actors can involve payments or transfers of goods flowing both ways.

By synchronizing the three flows among the actors, an enhancement of efficiency is reachable. Problems that have to be solved within these supply chain processes according to Hofmann and Belin (2011) include the manual collection of payments, a lack of timely information, delays in invoice reconciliation, and poor credit line management. When solving these issues, optimizing only one flow (e.g. the physical flow) without recognizing the potential in the other two streams would lead to a suboptimal solution. Fairchild (2005) argues that disregarding financial flows will lead to only partially successful supply chains.

This was mostly the case until now, seeing that information and financial flows have not been managed as thoroughly as the physical supply chain (Selviaridis & Spring, 2007; Hofmann & Belin, 2011). The latest IT technology, however, allows new solutions such as FVAS to include valuable data on transactions, receipt of payment, and quantities delivered (Hofmann & Belin, 2011). Electronic availability of such information can improve the processes along the supply chain and further integrate the different flows in one system. What is more, Robinson (2007) emphasizes the importance of not redistributing risk to weaker supply chain members when optimizing financial supply chain related cost through FVAS. The establishment of fully integrated LSPs could address the issues arising in this context. A framework for such an integrated supply chain is presented in Section 3.3.

3.2. Benefits of Financial Value-Added Services for Single Companies, Logistics Service Providers, and the Supply Chain as a Whole

LSPs offer a variety of integrated logistical services, both on a national and international scale, thereby often outsourcing tasks to subcontractors in order to reduce costs (Hoffman, 2001). Primarily, LSPs manage the physical flow of goods along the supply chain for various customers (Selviaridis & Spring, 2007). Besides the physical flow of goods, there is a reversed financial flow along with a flow of information between the actors of a supply chain (Lambert & Pohlen, 2001). While many companies have been optimizing the flow of goods along the supply chain according to the principles of supply chain management, the potential for efficiency enhancements regarding financial and informational aspects often has been neglected. Hofmann and Belin (2011) find that even companies with rather efficient physical supply chains rarely have visibility into financial receivables or payables, which leads to delayed payments and unnecessary high working capital. Moreover, the authors state that issues of this nature – regardless of industry or size – affect nowadays almost every global corporation. The companies react with expensive hedging strategies in order to balance the uncertainties of financial flows. Robinson (2007) also recognizes that physical supply chains are highly sophisticated but opportunities for further improvements can be found in the financial supply chain. Croft (2007) concludes that new solutions will lead to significant improvements, particularly in financial flows, making them not only more reliable but also more efficient. During the last decade, this topic has become more relevant in the academic literature under the term of supply chain finance (SCF). Lugli (2006) defined SCF as “a combination of technology solutions and services that link buyers, their suppliers and financing providers to optimize the visibility, financing cost and the delivery of cash on the occurrence of one or several supply chain events.” For Hofmann and Belin (2011) the “inter-organizational management of working capital, the financial flows and the respective information exchanged across the supply chain” are key for SCF.

In order to gain additional earnings, LSPs look for potential differentiation strategies as revenues in the traditional logistics market are declining. Switzerland’s total market value for logistics services in 2015, for example, experienced a decrease of 0.3 % to a total value of 38.9 bn Swiss Franc (CHF) after low growth rates in the previous years (Stölzle et al., 2016). As growing interest in the financial flows along the supply chain is visible, services regarding SCF can be worthwhile for LSPs to offer. Selviaridis and Spring (2007), for example, suggest that LSPs can use SCF related financial value-added services for differentiation purposes in an increasingly competitive market. Hofmann (2009) confirms this

recommendation and views FVAS as a possibility to increase revenues and efficiency in the supply chain, next to the traditionally offered solutions in transport, handling, and storage. This is not a recent development, as already Hoffman (2001) identified a growing number of value-added services (VAS) offered by LSPs for differentiation purposes. The graph within Figure 2 identifies several FVAS a LSP might offer. Although this encompasses a rather broad understanding of FVAS, the graph gives an idea of the wide spectrum of solutions in this field. It needs to be noted that three FVAS are selected due to most prevalent presence and the different level of required expertise, leading to a cross-section of the services.

Companies using such services offered by LSPs can realize various advantages, while the whole supply chain benefits from the measures taken. This is becoming more important, as nowadays it is rather supply chains than companies that compete (De Boer et al., 2015). Hofmann and Belin (2011) divide the advantages of FVAS into two categories: quantitative and qualitative benefits. The former includes funding, improved liquidity, working capital savings, risk cost savings, and administrative cost savings, whereas the latter encompasses benefits such as increased transparency, improved relationship management, and enhanced compliance. Fairchild (2005) confirms quantitative and qualitative benefits of applying SCF, namely lower costs, financial stability, transparency, and a strategic advantage. Overall, the relevance of financial services offered by LSPs is increasing due to the observation of growing competition, advancing digitization, and rising volumes in cross-border trading.

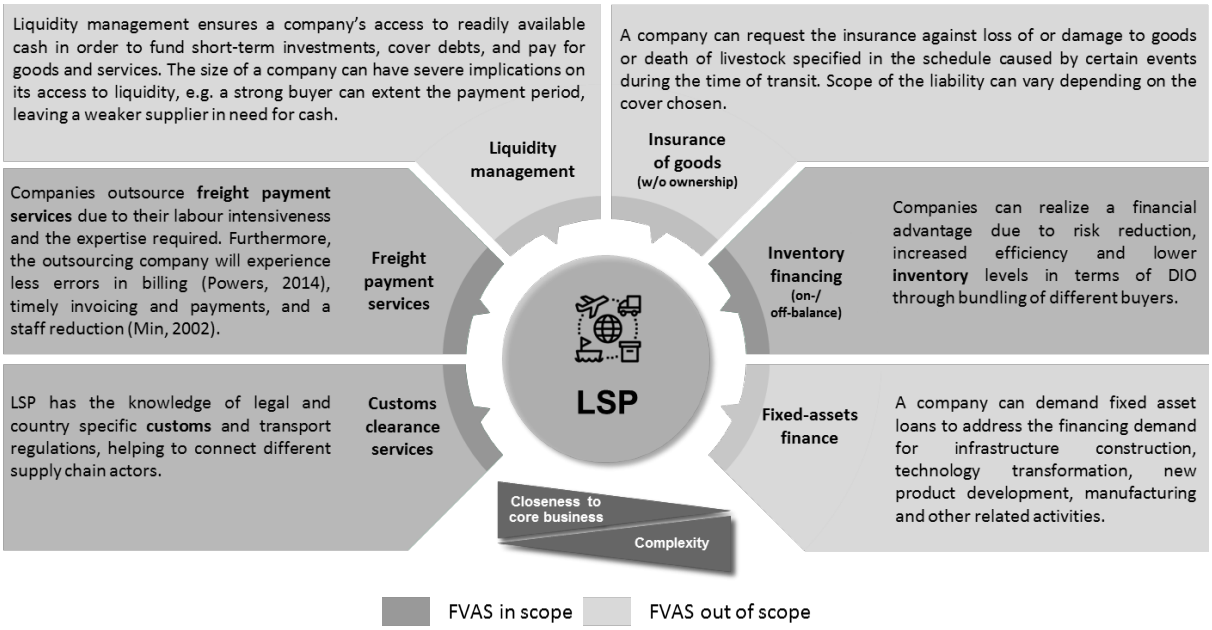


Figure 2: Overview of selected financial value added services (FVAS) by LSP

Consequently, the opportunities for LSPs launching state-of-the-art FVAS seem promising. However, different actors within the supply chain process have different interests and this can arise in possible conflicts of interest and imperfections resulting from short-term or partial optimization strategies.

An LSP's goal, regardless of its classification, is to increase revenues through additional FVAS offered, while at the same time becoming more efficient and reducing costs. The supplier aims for more transparency, higher visibility regarding the electronic processing and corresponding higher cash flow certainty due to more stable processes. Furthermore, the supplier wants to improve its relationship with the buyer from a strategic point of view, lower its costs, and achieve improved financing terms. The buyer, on the other hand, wishes to reduce unit costs, increase delivery certainty, and lower the total cost of its supply chain through more efficient processes. At the same time, the buyer does not want a financially unsound supplier base. Moreover, the buyer prefers an open, bank-independent platform for managing the supply chain flows.

An imperfection can result if a company tries to optimize working capital exclusively from its own perspective, as it is often done in practice (Hofmann, 2010). De Boer et al. (2015) confirm this view, as they state that suboptimal results are achieved when each company tries to optimize its own outcome

rather than coordinating the activities with the other actors of the supply chain. Therefore, a single company approach will not be appropriate to integrate the financial, informational, and physical flows of the end-to-end supply chain in order to overcome the manifold conflicts of interested. The aim of a SCF initiative and FVAS in particular should be to create value in terms of lower cost, higher transparency and less risk for all supply chain constituents without increasing the risk or working capital of a weaker actor. Consequently, the whole supply chain will benefit in terms of a strategic advantage, improved competitiveness, greater profitability, and lower risk (Randall & Farris, 2009).

3.3. External Governance Framework for Logistics Service Providers with Financial Value-Added Services, and Actors

As introduced in Section 3.2., several imperfections arise if companies try to optimize working capital exclusively from their perspective, as it is often done in practice (Hofmann, 2010). Figure 3 illustrates how an LSP could integrate FVAS into his portfolio to enable a holistic management of physical, informational and financial flows along the supply chain:

1) A fully integrated LSP is not merely focussing on transporting goods from sender to receiver, but also providing a wide-range of value-added services such as information management and financing solutions, thus establishing himself as a single point of contact for his clients. He works closely together with sub-contractors, financial service providers (FSPs) and platform and technology providers to ensure support for his clients along all three flows in a supply chain, namely the physical, financial and informational flow.
2) To minimize risk, innovative contract systems such as performance-based contracts (PBC) are in place between the LSP and his co-creators.
3) Where applicable, the LSP bundles his clients' need for financial services to ensure feasibility for each principal (in this case the manufacturer) and economic viability for the bank.
4) The need for several forms of financial services is highlighted in Figure 3. Externally, the LSP supports his clients in invoicing and payments transactions, such as payment transactions processing.
5) For the internal operations of the manufacturer, liability and receivables financing is offered, oftentimes in cooperation with a FSP.

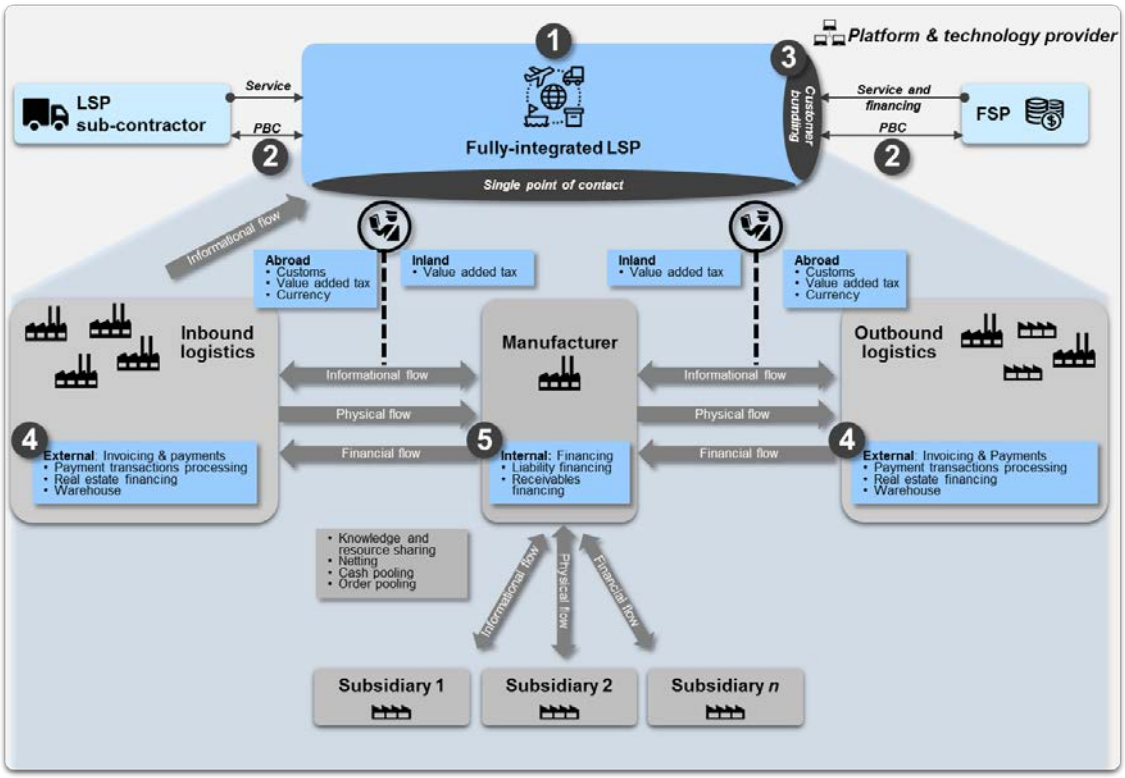


Figure 3: Fully integrated LSP and its services along the supply chain

Several high-level issues arising for the LSP through an integrated offering should not be neglected. As inferred from Figure 3, offering FVAS increases the complexity through enhanced coordination efforts due to more actors involved. Furthermore, a LSP has to be capable of taking on an interorganizational view. However, benefits overweigh, as processes along the supply chain are streamlined and thus value for the clients of the LSP is generated. What is more, the LSP results as a suitable partner for offering FVAS, as he has an overview over the flow of goods and can adequately assess the risk associated. Due to his superior information and industry insight, he excels traditional banks as a SCF-partner, especially concerning complex products.

4. Core results of the case studies and cross-case analysis

Five European LSPs were interviewed through a questionnaire sent by email to the respective managers or C-level executives. Companies had prior been selected according to their internationalization of activities and service range and customization. The five case studies selected cover all four generic business models identified by Hofmann and Osterwalder (2017), allowing one to derive differences and similarities across those business models.

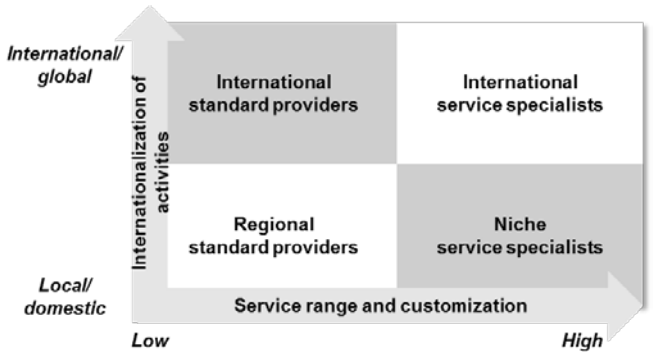


Figure 4: Classification of LSPs according to internationalization of activities and service range. Adapted from: Hofmann & Osterwalder, 2017

The goal of the applied case-study-approach is to understand which of the selected FVAS are offered by LSPs, how LSPs offer those FVAS in terms of external governance (RQ 1) and why LSPs provide the FVAS in that specific manner (RQ 2).

Table 1 highlights which of the selected FVAS are most commonly applied by LSPs. The first column identifies the company, while the second defines the type of LSP interviewed. The next three columns point out whether or not the service in question is provided by the respective LSP. Regarding the FVAS analysed we can summarize that four out of five companies provide customs clearance, only one out of five provides freight payment services, and three out of five offer inventory financing. Inferring from the interviews, freight payment services are less common than inventory financing. This slightly contradicts the assumption that the typical LSP would be most familiar with customs clearance and freight payment services, while inventory financing is a more recent offering which requires additional financial expertise. An explanation for this might be the perception of freight payment services at the LSPs. Case Partner 4's representative, for instance, does not consider freight payments as a distinct service category. Therefore, it might be the case that the interviewees responded "no freight payment services" but actually had some similar service in place.

Company	Type	Customs clearance	Freight payment services	Inventory financing
Case Partner 1 ***International standard provider***	2PL/3PL	×	×	✓
Case Partner 2 ***Regional standard provider***	2PL	✓	×	×
Case Partner 3 ***International service specialist***	2PL,3PL, 4PL, 5PL, LLP	✓	✓	✓
Case Partner 4 ***Niche service specialist A***	2PL /3PL	✓	×	✓
Case Partner 5 ***Niche service specialist B***	3PL	✓	×	×
Total		**4**	**1**	**3**

Table 1: Cross-case overview of the five case studies

The corss-case matrix in figure 5 illustrates how the LSPs are providing their FVAS with regard to the external governance structure. The matrix highlights the make-or-buy decision for each of the three FVAS customs clearance, freight payment services and inventory financing.

The analysis is starting on the bottom left corner, where customs clearance is offered autonomously. The two companies in this field are Case Partner 4 and Case Partner 5. Case Partner 4 does not use collaboration in customs clearance, as it is a profitable business for him. Moreover, Case Partner 4 has better control over the overall execution and can apply its industry-specific knowledge. At the same time, the company serves as a single point of contact for its clients. Additionally, the employees benefit from a much more varied work content.

We now move up the next field in the matrix, which is at the intersection of customs clearance and collaboration. The companies located in this field are Case Partner 3 and Case Partner 2, where the former offers a full customs clearance service. The service is provided mainly by a subsidiary. Therefore, the customs clearance service is not outsourced but rather done in partnership with this subsidiary of Case Partner 3. Although the interviewee of Case Partner 3 did not list the main reasons for collaboration, the general purpose of collaboration with an external partner at Case Partner 3 is the required expertise. Consequently, when selecting a potential collaboration partner, expertise is the most important factor. For their customers the logistics company identified several positive effects of collaboration, such as achieving the desired economic results for all involved partners. Case Partner 2 also has a collaboration in place with external partners in customs clearance. Through this partnership, own staff requirements in the specific region or country are lowered and costs are saved. Moreover, the collaboration increases the availability of profound experts and the employees can concentrate on the regulatory conditions they know, which leads to reduced risk. The rationales for the partnership are therefore cost savings, acquisition of expertise, and risk reduction.

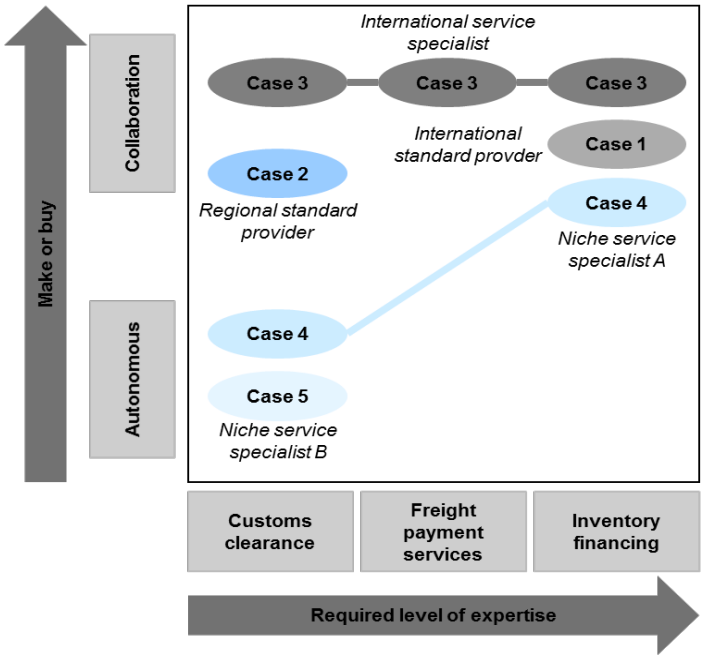


Figure 5: Cross-case matrix of the five case studies

The most overlapping motive here with Case Partner 3 is clearly the required expertise. Compared to the previously highlighted field in the matrix with the autonomously provided customs clearance, several interesting points can be addressed. For instance, as a disadvantage of providing the service autonomously the Case Partner 4 representative named the fact that the company does have all the staff on its own payroll. This was exactly the reason for Case Partner 2 to collaborate with external partners. Nevertheless, Case Partner 4 decided to provide the service autonomously as it is a profitable business for them. A reason for this external governance decision could be the different business models in place. While Case Partner 4 operates mainly in the port of Rotterdam, Case Partner 2 has operations widely spread in Central Europe and needs expertise at different places. In addition, Case Partner 4 has specific industry expertise. Thus, the company wants to offer and sell this knowledge directly to its customer, which is why the LSP prefers an in-house solution.

As we have analyzed the first service in the matrix, we will now study freight payment services. There is only one field in the matrix filled in, which is freight payment services as collaboration and it is done by Case Partner 3. As predicted by Powers (2014), LSPs operating on a global scale benefit from the consolidation in freight payment services solutions, as more and more customers are demanding a global application. Therefore, it is not surprising that the only global LSP of our sample is offering this service.

Case Partner 3 offers a limited service in freight payments with the help of external partners. How this collaboration is designed was not further specified in the questionnaire filled in; however, the company's representative stated that Case Partner 3 collaborates with various fintech partners in the payment services field. Overall, the main reasons for collaboration with an external partner can be derived from the previous Case Partner 3 example, where expertise was essential.

Finally, we will analyze the inventory financing in the last column. As it is visible in Figure 5, this service is only provided in collaboration with an external party. The LSPs in this field include Case Partner 3, Case Partner 4, and Case Partner 1. Case Partner 3 collaborates with banks as funding partners and with structured finance boutiques in order to offer their clients off-balance sheet structures. The main reasons for the partnership are the required expertise and the avoidance of unfavorable effects on the group's balance sheet. For their customers, the logistics company identified several positive effects of collaboration, such as achieving the desired economic results for all involved partners. In addition, the employees benefit in terms of improved future stability and profitability due to the ameliorated balance sheet situation. Case Partner 4 has external collaboration partners involved in inventory financing as well. The external collaborators, in this case the banks, are selected according to their ability and willingness to finance certain specialty goods. Finally, Case Partner 1 collaborates with the logistics division in inventory financing, which is not an external company but rather an affiliate from the same group. Therefore, the collaboration is considered as a relatively low-risk partnership, where Case Partner 1 is responsible for the financial aspects. Additionally, the credit risk in inventory financing is outsourced to a credit insurer, which is in line with a general policy in place, stating that there is no bearing of risk at the company. The credit insurer is selected based on its ability to finance the entire risk. Although this means some part of the inventory financing business is not done internally, it is only a marginal hedging of risk compared to the large scale collaboration with the logistics division and therefore the service is still located at the intersection of inventory financing and collaboration. Overall, the collaboration between Case Partner 1 and the logistics division can be considered as complementary, combining the required expertise within the same group. Compared to Case Partner 4 and Case Partner 3, the requirements for combining financial and logistical expertise are similar, which is the main reason for collaborating with FSPs in inventory financing.

To conclude, the LSPs use some form of collaboration in three out of five cases (RQ 1). The reasons (RQ 2) for providing services autonomously include financial, risk, quality, and business model considerations. On the other hand, motives for collaboration (RQ 2) include expertise and staff requirements, cost considerations and the impact on the balance sheet, complementary capabilities, risk management, and strategic rationale.

5. Conclusion and Outlook

This paper points to the problem, that the physical, informational, and financial flows in a supply chain are in many cases not treated equally. Especially the potential for efficiency enhancements regarding financial and informational flows are often neglected. Therefore, solutions such as the concept of SCF and FVAS are taking on greater significance. While LSPs struggle with a market decline in traditional logistics markets, differentiating their business models through FVAS can be a worthwhile option and this offering has started growing in the recent years. This paper explains how and why LSPs offer FVAS in terms of the external governance structure.

The most prevalent FVAS offered among the LSPs analysed are customs clearance, followed by inventory financing and freight payment services. The LSPs include external partners in three out of five cases. The reasons for providing FVAS autonomously include financial, risk, quality, and business model considerations. On the other hand, motives for collaboration include expertise and staff requirements, cost considerations and the impact on the balance sheet, complementary capabilities, risk management, and strategic rationales. LSPs developing into the field of FVAS can use these insights to design a (niche) strategy and to reflect on potential collaboration partners.

The exploratory and qualitative character of the paper leads to certain limitations. For example, the small sample size and geographical focus on LSPs operating mainly in Europe may limit the generalizability of the findings. Moreover, as the paper lacks a quantitative research approach, the findings and cannot be

extrapolated from a statistical point of view. Future studies might take on a more quantitative approach in terms of the LSPs analysed and extend the geographical scope. Finally, it would be valuable to get insights regarding the external governance structure of the remaining FVAS, which were not part of this paper.

Acknowledgement: This research was supported by the Nederlandse Organisatie voor Wetenschappelijk Onderzoek. We thank our colleagues Michael Henke, Axel Schulte, Philipp Sprenger, Tanja Brink and Yaghoob Mohammad Ali Nia Omran from Fraunhofer (Germany), Federico Caniato, Antonella Moretto and Agostino Bonzani from Politecnico di Milano (Italy), Janet Godsell, Donato Masi and Sumeer Chakuu from Warwick (UK) and Michiel Steeman, Ronald de Boer and Luca Gelsomino from Windesheim University of Applied Sciences (the Netherlands), who provided insight and expertise that greatly assisted the research, although they may not agree with interpretations and/or conclusions of this paper.

- **References**

- Croft, J. (2007). Supply chain finance utilised to save money. *Financial Times*. Available at: http://www.ft.com/cms/s/0/43c72082-b006-11db-94ab-0000779e2340.html [Accessed 08 May 2017].
- De Boer, R., Van Bergen, M., & Steeman, M. (2015). *Supply chain finance, its practical relevance and strategic value*. Zwolle: Supply Chain Finance Community.
- Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532–550. doi:10.5465/AMR.1989.4308385
- Fairchild, A. (2005). Intelligent matching: Integrating efficiencies in the financial supply chain. *Supply Chain Management*, 10(4), 244–248.doi:10.1108/13598540510612703
- Hofmann, E. (2010). Zum Wandel des Working Capital Managements in Supply Chains: ein Blick zurück und zukünftige Handlungsoptionen. In: *Strukturwandel in der Logistik. Wissenschaft und Praxis im Dialog. 5. Wissenschaftssymposium Logistik*. (2010). Hamburg: Deutscher Verkehrs-Verlag - DVV Media Group.
- Hofmann, E., & Belin, O. (2011). *Supply chain finance solutions. Relevance - propositions - market value*. Heidelberg: Springer.
- Hofmann, E. & Osterwalder, F. (2017). Third-party Logistics Providers in the Digital Age: Towards a New Competitive Arena? *Logistics*, 1(2), 1-28.
- Lambert, D. M., & Pohlen, T. L. (2001). Supply Chain Metrics. *The International Journal of Logistics Management*, 12 (1), 1-19. doi:10.1108/09574090110806190
- Lugli, P. (2006). Spotlight shifts to money in the supply chain. *Financial Executive*, 22(9), 54–55.
- Randall, W. S., & Farris, M. T. (2009). Supply chain financing: using cash-to-cash variables to strengthen the supply chain. *International Journal of Physical Distribution & Logistics Management*, 39(8), 669–689. doi:10.1108/0960030910996314
- Robinson, P. (2007). *The 2007 Guide to Financial Supply-Chain Management*. Available at: http://www.euromoney.com/images/502/51463/financial_supply_chain_management.pdf [Accessed 04 May 2017].
- Selviaridis, K., & Spring, M. (2007). Third party logistics: a literature review and research agenda. *International Journal of Logistics Management*, 18(1), 125–150. doi:10.1108/09574090710748207
- Silvestro, R., & Lustrato, P. (2014). Integrating financial and physical supply chains: the role of banks in enabling supply chain integration. *International Journal of Operations & Production Management*, 34(3), 298–324. doi:10.1108/IJOPM-04-2012-0131
- Stölzle, W., Hofmann, E., & Oettmeier, K. (2016). Einblick in den Schweizer Logistikmarkt 2017 – Zusammenfassung wichtiger Fakten aus der Logistikmarktstudie. Bern: GS1 Switzerland.
- Takita, A. M., & Leite, J. C. (2016). Inbound Logistics: A Case Study. *Business Management Dynamics*, 5(12), 14–21.
- Wütz, S. M. (2016). *Global integration of cross-functional business processes within multinational companies. A governance approach for intra-firm supply chain management*. Dissertation; Universität St Gallen. Nürnberg: KDD Digital-Druck.

INCENTIVIZING SALES TEAMS TO SUPPORT CATEGORICALLY DIFFERENT SERVICE PORTFOLIO EXTENSIONS: A QUALITATIVE STUDY OF FNINACIAL VALUE-ADDED SERVICES AT LOGISTICS SERVICE ROVIDERS

Philipp Wetzel and Erik Hofmann
ISCM-HSG, Switzerland

1. Introduction

In recent years, overall industry growth for logistics service providers (LSPs) has been modest. At the same time, the trend for profit margins has stagnated at low rates or even decreased in the course of the last ten years (BCG, 2017). In order to stabilize or increase profitability, LSPs therefore need to lower costs or alter their revenue streams. To increase revenues beyond just delivering more of the same services at a lower price, LSPs can develop new or enhance existing business models for value-adding service offerings in their portfolio (Baron et al., 2014). For example, they can provide value-added services in the areas of information- and communication systems, manufacturing, and facility or financial services.

With respect to financial value-added services (FVAS) there are many ways how LSPs can add value to their clients through externally completing business processes. However, LSPs that are mainly familiar with selling logistics services might encounter challenges – in particular its sales team – when offering such new financial services. From the perspective of a LSP, financial services require a fundamentally different set of competencies, which effects the required qualification and motivation of sales teams in the first place. For example, sales people will now have to talk to the financial department (and not to the logistics or purchasing department) of their clients and thus have to be profoundly knowledgeable about the financial products they offer and inherent financial risks. Therefore, in order to be able to create additional value with FVAS, LSPs needs to adapt new knowledge and skills (Prockl et al., 2012). In particular, it is highly critical that the existing sales team gets equipped with expert support, trainings, and tools to compensate the missing expertise. Likewise, the sales force has to be motivated to adapt the new knowledge and sell FVAS to new contact persons (now the financial department) of its customers.

A number of studies has focused on how to incentivise sales teams, among others at financial institutions, in general (see for example Ahearne et al., 2010, and Fu et al., 2010). However, these studies have not focused on the topic of how sales teams at LSPs can be qualified and motivated to offer FVAS. Against this background and in accordance with the identified research gap, this paper tackles the following overall research question (RQ):

RQ: How can sales teams of LSPs be incentivized to support categorically different service portfolio extensions in form of value-adding financial services?

The paper aims to derive impulses for incentivizing sales teams to promote services that are categorically different to the ones prior offered. In particular, it tries to give impulses on how diverse issues regarding qualification and motivation can be addressed to foster the development of a relevant and promising service offering. It is important to note, that the paper focuses on a specific part of the front-office. It assumes that the respective back-office and hence the organization in question is actually able to provide FVAS. Though this condition is not naturally pre-existing, such an assumption enables a clear focus on the main topic this paper examines.

In order to answer the research question, a qualitative approach is chosen (Silverman et al., 2016). The applied research methodology encompasses 34 expert interviews that have been conducted throughout 2017 by academic researchers in Germany, Italy, the Netherlands, Switzerland, and the UK. To provide the reader with comprehensive insights, companies of different sizes, origins and types have been selected. From those 34 semi-structured interviews, 26 are held with representatives of LSPs. The remaining eight interviews are conducted with customers of such LSPs to complement the

picture of the industry landscape. 16 of the 26 interviewed LSPs actually offer FVAS and are examined closer in this paper.

The paper is structured as follows: First, the two important dimensions qualification and motivation of sales teams are elaborated from an academic perspective, drawing back on the *modern expectancy-value theory* by Eccles and Wigfield (2000). Second, different FVAS offered by LSPs are categorized. Following this, the impacts of different service portfolio extensions on required qualification and motivation of LSPs are elaborated and incentive systems to adjust qualification and stimulate motivation of sales teams are introduced. Third, incentive systems used in practice to adjust qualification and stimulate motivation of sales teams of LSPs are presented. Fourth, the findings from the interviews are discussed and a table is derived, which indicates both qualitative and motivational incentive measures to overcome the gaps identified. Fifth, a conclusion and outlook is given.

2. Theoretical background

Motivation and incentivization of employees have for several decades been subject to behavioural research. There exist different avenues to approach this topic. One prominent approach is the ability-opportunity-motivation model by Ölander and Thøgersen (1995). Following this model, one needs the opportunity, the ability, and the motivation to exhibit a certain behaviour (see Figure 1). The paper at hand examines how extending the product portfolio affects both the required ability (hereinafter equated with the term qualification) and motivation, while the opportunity is regarded as given as we focus on a specific part of the front office.

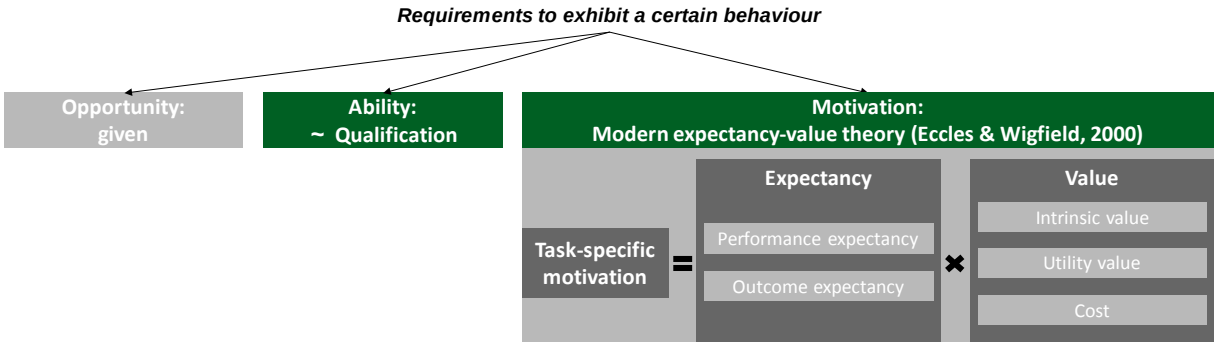


Figure 1: Theoretical framework for the paper at hand following Ölander and Thøgersen (1995)

With regard to the dimension of motivation, this paper relies on the *modern expectancy-value theory* established by Eccles and Wigfield (2000), which defines task-specific motivation as the product of an individual's expectancy about his performance and result and the value he perceives from fulfilling the task.

2.1. Impact of categorically different service portfolio extensions on required qualification and motivation of sales teams at LSPs

Financial services are naturally different to transportation and logistics services as the former processes the flow of intangibles, such as money, and the latter the one of tangibles, such as goods. To enable a differentiation among relevant FVAS, this paper splits financial services into categories according to their distance to the core service offering of LSPs. *Table 1* shows the definition of each category, ranging from Category *Basis* (closest to LSP core business) to *Category C* (furthest to LSP core business).

Category	Definition	Example
FVAS Basis	Services that are technically financial services but are closely and commonly tied to the core service offering of transportation.	Customs clearing

FVAS A	Financial services that are closely related to the core service offering of LSPs but not necessarily logically tied to it. Services in this category do not require specific financial expertise. They are merely the external offering of basic competencies that LSPs holds internally. This category can be seen as outsourcing financial parts of administrative work.	Invoice management; Exchange of information with bank
FVAS B	Financial services that typically surround the core service offering of LSPs. These services are in some distance related to the core services but rather loosely. Offering them requires dedicated capacity and basic financial expertise. They are not logically tied to conventional transportation and logistics services and are traditionally performed by financial service providers.	Collection of accounts receivable without ownership of goods; Insurance of goods without ownership
FVAS C	Financial services that are only loosely related to the core service offering. Such services require high financial expertise and noticeable capacity at LSPs. Partly, being able to perform these services uses up liquidity or even necessitates a partner from the financial industry.	Ownership of goods; Dynamic discounting; Reverse factoring; Financing of fixed assets

Table 1: Categories of financial services from a LSP-perspective

This paper makes use of the above defined categorization. It is to note that due to their conventionality, FVAS belonging to *Category Basis* will not be considered further. In the following, the impacts of a service portfolio extension through value-adding financial services at LSPs are analysed and clustered along the remaining three categories.

Impact on qualification: Specifically looking at sales employees of LSPs, it is common that they went through a hauler or forwarding agent apprenticeship before switching into a sales-oriented role. Even for the instances in which this does not hold true, most sales team members at least worked several years in the industry. It is therefore reasonable to assume that members of sales teams of LSPs exhibit the necessary product or service knowledge of their industry to sell logistics services and financial services that are closely related to their traditional portfolio (Kaschek, 2002). However, the impact of a service portfolio extension at LSPs on the required qualification of the sales teams substantially increases, the "further away" a service is to the core logistics services.

As illustrated in *Table 1*, the financial services in *Category A* are administrative services such as invoice management for which LSPs generally possess competencies internally. Offering and promoting such value-adding services is not too distant for sales teams of LSPs. Deriving from this example, it can therefore be assumed that the knowledge that underlies financial services from *Category A* is within a fair range of expectations of logistics sales teams. The impact of service portfolio extensions from *Category A* on the required qualification of sales teams is rather low.

However, services from *Category B* or *C* require greater financial expertise. According to standard literature, such expertise is not necessarily present in logistics sales teams. Following the argumentation of Dench (1997), this knowledge gap impacts the ability of the sales teams to fulfil the need to know about products or services their organization offers. Not being able to provide sufficient and hence credible information about respective services in a portfolio extension affect the customer purchasing decision. In the end, sales teams need to receive education and gather knowledge about value-adding services as products are increasingly sold with complementary services (Gieseler, 2009). In sum, the expertise necessary to promote financial services is commonly not adequately present in sales teams of LSPs. Services from *Category A* are a stated exception and might partially be able to be promoted due to their short distance to core logistics services. For the remaining services, literature suggests that additional expertise is necessary. Missing qualification in the form of missing expertise to adequately present FVAS therefore greatly affect the motivation of sales teams.

Impact on motivation: With regard to the dimension of motivation, this paper relies on the *modern expectancy-value theory* established by Eccles and Wigfield (2000). Eccles and Wigfield (2000) define task-specific motivation as the product of expectancy and value. Expectancy is driven by the two addends performance expectancy and outcome expectancy.

Performance expectancy nearly fully relates back to the concept of qualification. In an ideal state, an increase in qualification influences the performance expectancy to the same extent. Considering the assessment of the impact of categorically different service portfolio extensions on the qualification of sales teams, this construct can be represented as a given in the current assessment of impact of said extensions on the motivation. The overall effects are covered in this paper but – due to the categorization – the necessary incentive systems will be addressed with regards to qualification.

Outcome expectancy is a construct that generally adds little to the motivation in this equation when used for sales processes. Ultimately, the purchasing decision resides at the customer. In the business environment of sales, this construct is therefore a constant low and does hardly affect the motivation sales teams experience for a specific task (Brösamle, 2015).

The paper therefore focuses on the impacts and incentive possibilities for the value factor. Eccles and Wigfield (2000) identify three addends of value, which can be denoted as incentive and attainment value (hereinafter referred to as intrinsic value), utility value, and cost (Brösamle, 2015).

Intrinsic value describes the joy and value the performance of the task brings to the individual. The "joy" of selling a FVAS can derive from the joy of selling in general and from the joy of working in this specific topic. It can be assumed that with a given base interest in the topic the joy of working on it proportionally relates to how comfortable a salesperson can deal with it. Thus, the building blocks of the intrinsic value construct can either be assumed to be constant or directly related to qualification –similar to performance expectancy.

Utility value depends on the goals of an individual. If one considers professional development as a key goal at work, the utility of the challenge of selling services form a categorically different portfolio extension might be rewarding in itself. For individuals that are rather setting their goals in terms of short-term performance and monetization, a challenging new task may need to be implemented in an institutionalized framework that comprises such goals. The utility value construct is therefore highly relevant for this paper. In the case of LSPs offering FVAS, sales people might experience the need for being knowledgeable about FVAS when clients actively ask for those services (market pull) and otherwise would consult a competing LSP.

Costs also need to be carefully addressed. The opportunity cost of putting effort into the sales of categorically different, new services is that the sales team of an LSP could use that effort to sell more of the traditional logistics services. Especially for individuals with utility values that are not long-term and development-oriented, this can lead to putting more effort into promoting services they are comfortable with and that will thus earn them more. It is critical, that FVAS are reasonably priced in into the overall rewards and compensation system.

In summary, an adaption of the *modern expectancy-value theory* indicates a strong link of motivation to qualification. The expectancy dimension seems to be greatly driven by the ability of an individual to perform the task. The value dimension consists of three constructs: intrinsic value, utility value, and cost. The analysis shows that also intrinsic value is directly related to the qualification. The utility value and the cost construct of motivation, however, indicate a strong dependency on short- and long-term motivational aspects. The value dimension needs to be targeted by specific incentives measures to have sales teams foster the promotion of FVAS. The resulting focus on qualification and the value factor of motivation applied in this paper make it possible to identify changing requirements and incentive alignment instruments in areas that can directly be measured and influenced by companies. The overall impact of introducing FVAS are presented in *Table 2*, which represents the financial service categories introduced in this chapter and the two main aspects of changing requirements: qualification and motivation.

Category	*Qualification*	*Motivation*
FVAS A	No considerable issues	Costs
FVAS B	Missing product knowledge	Utility value, costs
FVAS C	Missing product knowledge	Intrinsic value, utility value, costs

Table 2: Impact of introducing FVAS on required qualification and motivation of sales teams at LSPs

Regarding qualification, *Table 2* shows that this dimension basically boils down to making sure the sales team achieves a certain degree of product knowledge. The analysis reveals that though expert status is not universally required within the personnel in the sales team, expert knowledge needs to play into the sales process. It is highlighted that for FVAS belonging to *Category A* the knowledge is partly already in place in existing sales teams of LSPs.

The implications for motivation refer back to the value dimension of the *modern expectancy-value theory* and its three constructs: intrinsic value, utility value, and cost. Intrinsic value must be tackled by making dealing with financial topics a comfort zone. This relates back to establishing expertise through qualification and is targeted by means addressing the qualification column. It is also suggested that costs and the utility value are sufficient motivation to promote services from *Categories A* and *B*. Intrinsic value in form of enjoying the sales of financial services due to a certain level of understanding of the products only becomes a necessity for services that are very distant to the core logistics service.

Utility value becomes important for FVAS from *Categories B* and *C*. Selling those services requires more effort than the ones from *Category A*. Therefore, costs are not a sufficient motivator. However, they are a key motivator throughout the categories. Decreasing costs by giving monetary incentives is a common incentive system in sales and an important transactional method. (Ferreira, 2017)

2.2. Incentive systems to adjust qualification and stimulate motivation of sales teams

Qualification: General literature identifies three categories of systems that can incentivize sales teams in terms of lacking product or service expertise: expert support, training, and tools (Nieveen & Gustafson, 1999, Erffmeyer et al., 1992, Cron et al., 2005).

Expert support is the one quick fix method that could eradicate the lack of knowledge and hence incentivize the sales team to promote value-adding financial services amid missing expertise. Every sales team member of an LSP needs to have a clear and well defined big picture of the complete product and service portfolio. If this is not the case, it can be sufficiently helpful to be able to know where to find the expertise, i.e. to know the expert contact person (Kaschek, 2002).

Training is an intuitive idea when it comes to a lack of qualification – especially concerning product or service specific knowledge. In fact, most of the ongoing training provided in sales is for updating the knowledge about the offering (Dench, 1997). Concerning the affected services of LSPs from *Categories B* and *C*, trainings will inevitably vary with regards to intensity and volume (Duncan, 2018).

Tools represent the third set of incentive systems. They are a set of guides that help the sales team members to perform well with a specific client. In the context of LSPs, tools for FVAS illustrate best practices on how a salesman best explains a service, finds the right person to talk to at the client, or simply how to ideally initiate and process the expert support (Kaschek, 2002, Dench, 1997). A playbook or reference guide can for example give guidance on how to best structure an argumentation once the discussion exceeds a trainable depth.

Motivation: It is empirically shown that the motivation to conduct a task and the effort that is put into it have a strong positive effect on the performance of sales team members (Brown & Peterson, 1994). Ferreira's (2017) study on motivational factors in sales team management indicates that – apart from qualification – motivation is mainly dependent on the personal educational (*utility value*) and

monetary goals (*cost construct*) of the individual. These two goals can be addressed with different sets of incentive systems.

Utility value needs to be targeted by awareness creation measures. Focusing on the company dimension, management can either hint at opportunities and emphasize client demand, or create a sense of urgency by addressing internal or industry pressure to change. Both directions can be powerful measures to mobilize the workforce and set free energy that incentivizes people to push forward (Bruch & Vogel, 2011). For example, a LSP could elaborate on the concept of rather positioning itself as a service provider for tangible and intangible asset flows (including LSPs) than as a service provider for pure logistics. If framed adequately, such a vision impacts the utility value construct and fosters long-term motivation.

Perceived costs of selling FVAS by an LSP can be diminished by setting monetary incentives. Setting such incentives allow to target sales goals directly and generally influence the motivation and self-organization of sales teams (Kaschek, 2002). Monetary incentives can be split into base payments and additional performance-based payments. Though an increase in base payment does have a positive effect on autonomous motivation, feasibility suggests to rather adjust the performance-based payment when supporting a service portfolio extension. This variable performance-based part of the compensation is commonly available in two forms: provision and bonus (Kuvaas et al., 2016) (Kaschek, 2002).

3. Empirical results

The interviews of 26 LSPs serve as a base for the research into practical experiences with offering FVAS. 16 of the 26 interviewed LSP representatives reported that their organizations actively offer FVAS. *Table 3* below gives an overview of how often a specific FVAS is mentioned and part of the service portfolio of the respective LSP.

It becomes obvious that no specific service category is offered significantly more often relative to others. The distance of a financial service to the core logistics service offering does not seem to affect the probability of a LSP to include the financial service in its portfolio in general. However, it has to be noted that reverse factoring – the service that arguably requires the deepest financial knowledge – is offered only three times.

Category	*Service*	*# of LSPs offering*	*% of LSPs offering*
FVAS A	Invoice management	8	50%
	Exchange of information with bank	6	38%
	Other: Factoring*	4	25%
	Average	**6**	**38%**
FVAS B	Collection of accounts receivable without ownership of goods	4	25%
	Insurance of goods without ownership of goods	6	38%
	Average	**5**	**31%**
FVAS C	Ownership of goods	8	50%
	Dynamic discounting	6	38%
	Reverse factoring	3	19%
	Financing of fixed assets	6	38%
	Average	**5.8**	**36%**

Table 3: Count and share of LSPs offering example FVAS

In the following, we take a closer look at how the interviewed LSPs tackled or plan to tackle the issue by installing incentive systems or procedures to adjust qualification and stimulate motivation of their sales teams.

Qualification: The interviews indicate that the majority of LSPs offering FVAS installed specific structures that ensure an adequate supply of expertise to their sales teams. In particular, nine LSP representatives reported that their company installed structures that equips the sales teams with additional expertise. Three of these nine LSPs installed specific structures to provide expertise to the sales team right from setting up the business. They stated that such knowledge provision is rooted in their business model and that sales teams are built accordingly. Those companies therefore surely represent special cases but nevertheless support the conclusion that qualification would have otherwise been an issue.

One German LSP reports that its sales team works together in a cross-functional team with finance and R&D. The collaboration is enabled via a software that indicates which solutions can be offered for the specific client in general. R&D then customizes the base solutions further. The sales team serves as a mediator that receives the client request and enables R&D and finance to deliver on the request. Concerning success, the interview partner reports that especially ownership of goods and dynamic discounting are worthwhile as they equip their clients with freedom and flexibility.

Three other LSPs report they not only established a collaboration between the sales team and the finance department but a large-scale collaboration with a bank. One LSP actually has a bank in its corporate group that is providing guidance in deals that include financial services. Both constructs ensure a guaranteed influx of expertise as well as a common goal due to ownership. This service offering is considered as a valuable source of competitive advantage although the three LSPs only sell it to a small group of clients.

Moreover, one LSP set up a cross-divisional supply chain finance-team. The members of this team stem from the sales division and the financial department or in-house bank. On top of that, the company cooperates with five banks globally to make sure to incorporate local product knowledge. They claim this setup is a competitive advantage and servicing a client end-to-end is their business model.

In sum, the interviews suggest that the setting up of a formal structure to connect the sales team with financial experts – may it be to the finance department, to R&D, in a cross-functional team, or in collaboration with a bank – yields success. The interview partners that reported to have set up the structure initially in a way that ensures flow of financial information to the sales team add to the theme. Henceforth, qualification seems key and the provision via connections to experts preferred.

Motivation: The *modern expectancy-value theory* indicates strong links of motivation to qualification. The utility value and the cost construct of motivation, indicate a strong dependency on short- and long-term motivational aspects. The drawn interviews support the view, that there are effects on the motivation of sales teams. However, fewer mentions have been made compared to the impact on employee qualification. It can therefore be argued that qualification seems to be the most powerful driver of motivation from the perspective of a practitioner.

In general, the interviewees report a positive impact on motivation when sales employees see the services as a valuable support to their logistics services. Therefore, the mind-set within the LSP allegedly considers anything that helps the core service not only useful but as a source for competitive advantage. Employees are incentivized and motivated by the overall success of the company and therefore care about any service that drives overall success.

Concerning incentives for the *utility value*, the interviewed LSPs also hand insights. By offering and delivering financial services to clients that demand it, retention and loyalty increases which in turn has a reported positive impact on the motivation of sales teams. The whole purpose of the offering is to gain a competitive advantage and improve customer loyalty. As this seems to be communicated well to the sales teams, motivation increases. Only few LSP representatives mention the existence of

measures targeting motivation via the *cost construct* of the value dimension.

Concluding, the interviews do not hold as rich information on incentive systems to stimulate motivation as they do for the adjustment of qualification. Then again, the latter stimulates the former, hinting at it being a huge lever. While only little data is provided on monetary incentives, two examples suggest that addressing the utility value of motivation is an important part of incentivizing.

4. Discussion

Table 4 summarizes and combines the findings from literature and the expert interviews on the topics of qualification and motivation as they are elaborated in the previous sections.

Category	***Qualification***	***Motivation***
FVAS A	Supplementary training	Monetary incentive
FVAS B	Expert support, auxiliary tools, supplementary training	Awareness building (driven by data), monetary incentive
FVAS C	Expert support, auxiliary tools, profound training	Awareness building (driven by personal engagement and data), monetary incentive

Table 4: Incentive measures to adjust qualification and stimulate motivation of sales teams at LSPs to sell FVAS

In general, literature identifies three categories of systems that can incentivize sales teams regarding a lack in *product or service expertise*: expert support, training, and tools. Whereas expert support is a solution external to the sales team, training and tools aim to convey the knowledge into the sales team itself. Adding the perspective of practitioners, expert support seems to be best practice. While for FVAS relatively close to core business (*Category* A) supplementary training seems sufficient to overcome knowledge gaps, auxiliary tools and expert support are necessary to be competent for FVAS of *Category B* and *C*.

Concerning incentive systems to stimulate *motivation*, literature identifies two types based on the utility value and cost constructs of the *modern expectancy-value theory*. The first type regards awareness creation by data or personal engagement. The second type circles around monetary incentives in form of provisions and bonuses. The expert interviews confirm that awareness creation and monetary incentives are relevant topics. While sufficient for *Category A* FVAS, it is not feasible to motivate sale teams only monetarily for FVAS in *Category B*. If sales employees do not understand the urgency of promoting rather sophisticated FVAS, the monetary incentives come costly and deals are less likely to be finalized. However, data-driven means might be enough to convey the message on this level. For FVAS far from the LSPs core business (*Category C*), those data-driven means alone are not sufficient, as they cannot create enough relevance to overcome significant knowledge gaps. Instead, personal engagement has to be fostered – sales people have to experience the need to acquire the financial product knowledge, for example by realizing that customers will otherwise switch to a competitor.

5. Conclusion

This paper studies how sales teams of LSPs can be incentivized to support categorically different service portfolio extensions in form of value-adding financial services. Overall, literature identifies three categories of systems that can incentivize sales teams regarding a lack in product or service expertise: expert support, training, and tools. Adding the perspective of practitioners, expert support seems to be the preferred solution for FVAS that are only loosely related to the core offering of LSPs. A major learning from the interviews is that most LSPs address incentive problems with qualification. Concerning incentive systems to stimulate motivation, awareness creation through data or personal engagement and monetary incentives in form of provisions and bonuses are most relevant.

Considering *limitations*, the two sources of data need to be separated. For the literature review, source texts are not always exclusive to the industry of LSPs. General observations about sales teams in comparable scenarios are taken and adapted where needed. Concerning the expert opinion and experience that is drafted from the interviews, the interview sample and setup limit the findings of this paper. For the sample, only 26 of the 34 interviews are with actual LSPs. Of those 26 only 16 offer FVAS.

This paper provokes the need for *further research* for different fields within business studies. For example concerning the concept of motivation, it would be interesting to examine how the components of expectancy that are not directly linked to qualification are affected by offering FVAS at a LSP. Further, it should be investigated to which extent LSPs differ from other service providers and where eventual commonalities exist. Other studies might investigate how FVAS could best be implemented on an operational level at LSPs and which spill-over effects FVAS have on other services provided.

Acknowledgement: This research was supported by the Nederlandse Organisatie voor Wetenschappelijk Onderzoek. We thank our colleagues Michael Henke, Axel Schulte, Philipp Sprenger, Tanja Brink and Yaghoob Mohammad Ali Nia Omran from Fraunhofer (Germany), Federico Caniato, Antonella Moretto and Agostino Bonzani from Politecnico di Milano (Italy), Janet Godsell, Donato Masi and Sumeer Chakuu from Warwick (UK) and Michiel Steeman, Ronald de Boer and Luca Gelsomino from Windesheim University of Applied Sciences (the Netherlands), who provided insight and expertise that greatly assisted the research, although they may not agree with interpretations and/or conclusions of this paper.

References

- Ahearne, M., Rapp, A., Hughes, D. E., Jindal, R. (2010) Managing Sales Force Product Perceptions and Control Systems in the Success of New Product Introductions. *Journal of Marketing Research*. 47(4), 764-776.
- Baron, R., Lerner, W., Zieris, M., & Zintel, M. (2014). *Integrierte Logistikdienstleister unte Druck*. Düsseldorf: Arthur D. Little.
- BCG. (2017). *Transportation, Travel & Tourism*. Retrieved Jan 8, 2018, from BCG: https://www.bcg.com/expertise/industries/transportation-travel-tourism/logistics.aspx
- Brösamle, S. (2015). Motivation of Customer-Facing Staff to Sell Highly Innovative Products - Theoretical Framework and Empirical Tests. Schesslitz: Rosch-Buch.
- Brown, S. P., & Peterson, R. A. (1994). The effect of effort on sales performance and job satisfaction. *The Journal of Marketing*, 70-80.
- Bruch, H. & Vogel, B. (2011). Fully Charged: how great leaders boost their organization's energy and ignite high performance. Boston, Massachusetts: Harvard Business Review Press, ISBN 978-1-4221-2903-6.
- Cron, W. L., Marshall, G. W., Singh, J., Spiro, R. L., & Sujan, H. (2005). Salesperson selection, training, and development: Trends, implications, and research opportunities. *Journal of Personal Selling & Sales Management*, 25(2), 123-136.
- Dench, S. (1997). Trading Skills for Sales Assistants. Brighton: Sussex University.
- Duncan, J. (2018, Feb 19). Phone interview.
- Eccles, J., & Wigfield, A. (2000). Expectancy–Value Theory of Achievement Motivation. *Contemporary Educational Psychology*, 25, 68-81.
- Erffmeyer, R. C., Russ, K. R., & Hair Jr, J. F. (1992). Traditional and high-tech sales training methods. *Industrial Marketing Management*, 21(2), 125-131.
- Ferreira, T. S. (2017). Motivational factors in sales team management and their influence on individual performance. Tourism & Management Studies, 13(1), 60-65.
- Fu, F. Q., Richards, K. A., Hughes, D. E., Jones, E. (2010). Motivating Salespeople to Sell New Products: The Relative Influence of Attitudes, Subjective Norms, and Self-Efficacy. *Journal of Marketing*. 74(6), 61-76.

- Gieseler, J. (2009). Qualifikation: Technisches Verständnis ist im Verkauf gefragt - Technik-Know how im Vertrieb gefragt. Industrieanzeiger, 2, 16.
- Kaschek, B. (2002). Vertrieb für Logistikdienstleister - Aufgaben, Organisation und Instrumente. Wiesbaden: Betriebswirtschaftlicher Verlag Dr. Th. Gabler GmbH.
- Kuvaas, B., Buch, R., Gagné, M., Dysik, A., & Forest, J. (2016). Do you get what you pay for? Sales incentives and implications for motivation and changes in turnover intention and work effort. Motiv Emot, 40, 667-680.
- Nieveen, N., Gustafson, K. (1999) Characteristics of Computer-based Tools for Education and Training Development: An Introduction. In: van den Akker J., Branch R.M., Gustafson K., Nieveen N., Plomp T. (eds) Design Approaches and Tools in Education and Training. Springer, Dordrecht.
- Ölander, F. & Thøgersen, J. (1995). Understanding of consumer behaviour as a prerequisite for environmental protection. *Journal of Consumer Policy*. 18(4), 345-385. https://doi.org/10.1007/BF01024160
- Prockl, G., Pflaum, A., & Kotzab, H. (2012). 3PL factories or lernstatts? Value-creation models for 3PL service providers. *International Journal of Physical Distribution & Logistics Management*, 42(6), 544-561.
- Silverman, D., Eberle, T. S., & Maeder, C. (2016). *Qualitative research. Edited by David Silverman*. London Sage, [2016].
- Stölzle, W., Hofmann, E., & Oettmeier, K. (2016*). Einblick in den Schweizer Logistikmarkt 2017*. Bern: GS1 Schweiz.

POWER ASYMMETRY AND CO-OPETITION IN THE IRISH AGRI FOOD SUPPLY CHAIN

Declan Allen[1] and Marty Reilly[2]
[1]School of Management, College of Business, Dublin Institute of Technology, Ireland
[2]Business School, Dublin City University, Ireland

Introduction

The Agri-food sector is Ireland's largest indigenous industry, employing 8.4% of the working population. These jobs are dispersed throughout the country, especially rural areas. The sector achieved revenues of €26 Billion in 2015, contributing enormously to the viability of Ireland's rural and coastal communities. As an export-orientated sector, Agri food businesses account for 10.7% of total product exports (DAFM, 2018). As key actors, it is a widely held belief among farmers that they are not getting their fair share in the food supply chain and the scope to maintain their very viability is now being seriously threatened. It is both timely and imperative that research examines how these actors can secure a sustainable future and how both competition and collaboration can be pursued to overcome current issues around power asymmetry within the Agri food supply chain.

The Agri-food supply chain has been in existence for centuries and many would argue that the Agri-food industry is one of the oldest industries worldwide. It is also evident that there is a rich history of cooperation within the Agri-food supply chains (Parnell, 1995) where actors realised that there were many benefits to be gained by both cooperating and competing. This was particularly true in Ireland where local co-operatives play a significant economic and social role in the Irish Agri-food industry.

This paper examines power asymmetry and co-opetition between food producers, food processors and retailers in today's Irish Agri-food Supply Chain. As an industry, the Irish Agri business sector comprises of multiple stakeholders of varying size and power. Collectively the Agri business is characterised by a large number of small actors, yet power tends to be consolidated; with the concentration of buying power in the hands of a small number of retail groups with significant market share. For local actors, including farmers with little bargaining power, competition at the local level must also be balanced with collaboration to ensure fairer pricing and sustainability. While the simultaneous pursuit of competition and collaboration is captured in the literature around co-opetition, such frameworks have yet to be applied to Agri supply chains. This study seeks to explore how power asymmetry impacts upon co-opetition within the setting.

Review of relevant literature

Power Asymmetry

Nyaga et al.(2013) carried out a study to see how power structures and the quality of supplier relationships influenced adaptive behaviour to suit their partner's needs and collaborative activities. They found that the quality of the relationship can offset the negative effects of power asymmetry as it lowers the risk of opportunism by the stronger party (Nyaga, et al. 2013). Managing supply chain relationships continues to be a challenge for firms due to cultural, product and service range differences. Changes can be required to processes to accommodate the needs of business partners. Collaborative activities and adaptive processes require information sharing between firms, which can bring about transactional efficiencies and enable greater collective returns. Power asymmetry is generally inevitable in supply chain relationships and so needs to be understood in order to achieve a win-win situation for all partners (Cox, 2004). The stronger partner may assume greater influence in the Supply Chain network and thereby provide some stability, or on the other hand, they may seek to gain an advantage at the weaker partner's expense (Nyaga et al. 2013). This creates greater risks for the weaker party as it may not have the mechanisms to monitor or influence the stronger partner's

performance. The weaker party is also more likely to comply with the stronger partner's requests for fear of losing business. Such adaptations may amplify the risk for potential conflict and relationship termination. A number of studies have also looked at the use of power and influence in supply chain relationships and have focused on its effects on relationship commitment (Zhao, Huo, Flynn, & Yeung, 2008), relationship strength (Benton& Maloni, 2005; Maloni & Benton, 2000), opportun-ism (Brown, Grzeskowiak, & Dev, 2009), value creation (Terpend, Tyler, Krause, & Handfield, 2008) and performance (Crook & Combs, 2007).

Supply Chain Collaboration

Collaboration with suppliers is an opportunity for organisations to align and reengineer existing processes and can be an enabler of two-way expertise sharing (Christopher, 2011). Collaboration can also reduce overall supply chain costs, and it facilitates communication that generates long lasting improvements. (Van, Hoof and Thiell 2014). The previous authors identify three collaboration routines that enable sustainable supply chain management; Operational, Coordinative and Communicative.

Collaboration can also have a positive impact on sustainability performance and collaboration, and should be integrated into sustainability initiatives, and needs to be considered at all levels of the supply chain (Chen et al, 2017). Deviation from supply chain collaboration practices will have a negative effect on sustainability performance (Blome, Paulraj and Schuetz 2014). Like Chen et al (2017,) Blome et al (2014) state that sustainability initiatives require joint thinking. They also note that sustainability collaboration requires the setting of long-term goals, and designing environmentally friendly products and processes, and that performance can improve if supply chain actors have access to relevant sustainability information.

Collaboration within a supply chain allows visibility throughout the supply chain by linking production, processing and consumption (Dani, 2015). He developed further by stating that co-ordination should be effective and efficient in order to meet the key performance indicators within the chain. These key indicators include quality, quantity and on-time delivery performance; which when combined, can result in gaining competitive advantage (Dani, 2015). Collaborative relationships requires high interaction between parties involved and consists of activities such as information sharing, collaborative communication, mutually created knowledge and joint relationship efforts which resulting in stronger resilience by increasing both visibility and flexibility (Scholten & Schilder, 2015).

Previous studies show that it is somewhat still unclear on how to collaborate, and what collaborative activities are vital across various industries and supply chains (Scholten & Schilder, 2015).

Numerous researchers however, have found that a collaborative culture needs to be set up (Rodrigues et al, 2015; Lindgreen, Balazs, & Glynn, 2009; Barrat, 2004). This can be achieved by focusing on enhancing several important factors that act as enablers to both horizontal and vertical collaboration in environmental uncertainties. Ultimately this can makes a huge difference to the effectiveness of the planning in response to a disruption and the number one worry of risk sources: suppliers which in the case of agriculture supply chain are the producers (Dani, 2015). These factors evolve around information sharing and collaborative communication (Scholten and Schilder, 2015; Lindgreen et al., 2009). Both factors have been found to be useful in making decisions on what is the best response for specific situations, as it increases visibility and velocity and improves resilience (Scholten & Schilder, 2009). The table below describes the factors and enablers of collaboration in building resilience in supply chains.

Factors and enablers	Description
Trust	Trust is a major factor of effectiveness in horizontal collaboration and should be enhanced to avoid conflicts between partners who may have different backgrounds (Jepsen, 2014). Dani (2015) mentioned that low trust leads to competitive behavior, which is unfavorable. Dani (2015) explained that long-term collaborative relationship and trust in food supply chains encourages co-ordination between partners and requires mutual agreements to meet specific targets.
Joint-relationship efforts	This involves joint problem solving and sharing of information as well as access to resources from both ends in order to respond in a speedy manner as well as remaining flexible during a disruptive event (Schilton & Schilder, 2015; Lindtgreen et al., 2009).
Mutual dependency	This is essential in order to meet the satisfaction levels by working collectively and willingly to achieve good performance and deliver on time and in the right quality (Madu & Kuei, 2014; Schilton & Schilder, 2015).

Table 1: Factors and enablers of collaboration in building supply chain

Coopetition

Traditionally relationships between organisations had normally been seen as either competitive or cooperative. In recent years however this is no longer the case as many organisations are now actively involved in both competing and cooperating simultaneously between two or more actors in the supply chain. This form of organisational relationship has come to be known as 'coopetition' (Bengtsson and Kock, 2003,Hong & Snell, 2015; Luo, Slotegraaf, & Pan, 2006; Strese, Meuer, Flatten, & Brettel, 2016).

Research on cooperative relationships, although a relatively new concept of relations between firms, shows they are of huge significance for firms' development (Chin, Chan, Lam, 2008; Hoover, 2004; Kitchen, Snow, Mariani, 2007).

For example, in their study, Walley and Custance (2010) found numerous instances of coopetition in the Agri-food supply chain, yet also highlighted that many people were unaware of their own involvement in cooperation. Such findings appear to provide further evidence to support Soubeyran and Weber (2002) concept of 'tacit coopetition' and present an avenue for further research.

<u>Research Approach</u>

This research project adopts a qualitative approach, using individual actors within the Agri supply chain as the primary source of empirical data. As the research is largely explorative in nature, discussions with respondents were left relatively open, using a semi-structured discussion guide informed by the relevant literature around power asymmetry and co-opetition.

The semi- structured interviews were conducted as follows;

1. Informal Interviews: Informal interviews conducted with a group of 19 farmers in Carnaross Mart Co. Meath.
2. Formal Interviews: Formal interviews conducted with four beef farmers in Devlin Mart Co. Westmeath

This approach allowed for emergent themes and topics to inform subsequent interviews in an iterative manner. Interviews conducted were recorded and transcribed verbatim. Since this research is of

explorative nature and takes an inductive approach to reasoning, we have chosen a data-driven approach to interpret meaning from findings on power asymmetry and co-opetition. The figure below shows the different themes and codes retrieved from interview answers and analysis.

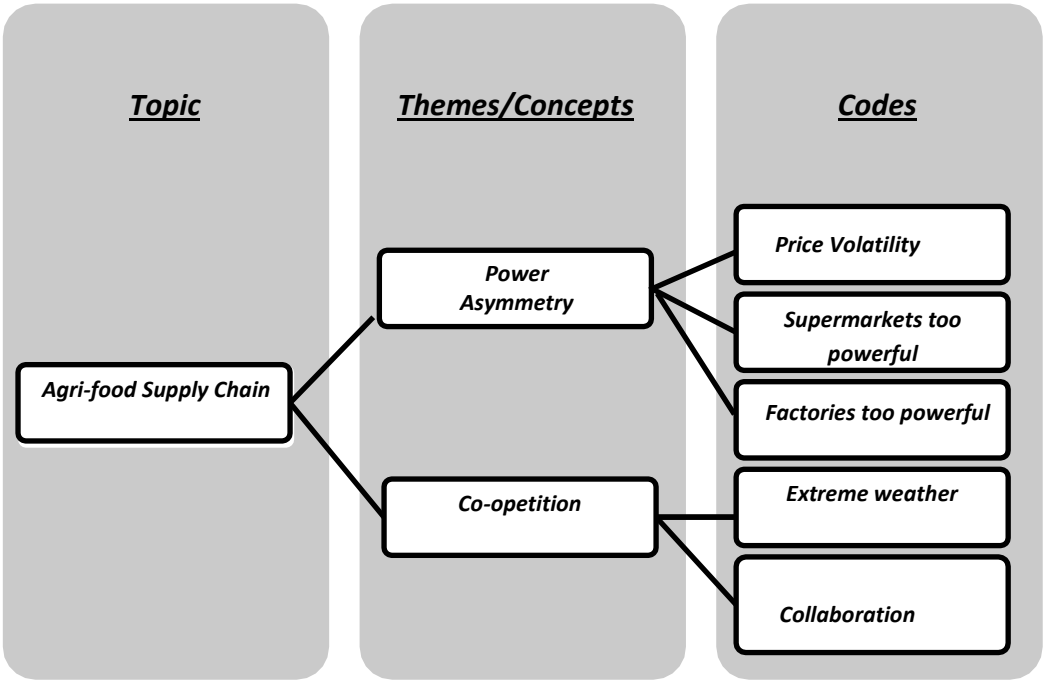


Fig 1: Streamline of codes- to-theory model of this research Results/Analysis

Findings & Discussion

Initial interviews had been conducted with 19 farmers. These interviews have assisted in refining the discussion guide whilst also revealing some interesting insights. Additionally, more formal in-depth interview were conducted with four beef farmers.

Price volatility

One of the major worries of farmers is price volatility in the market as it directly affects their income with many farmers extremely dependent on farming as a main if not the only source of income. Farmers buy the calf, outlay it and feed it, which is costly, while not knowing how much the returns will be at the end of it. The world commodity prices is an uncontrollable example, farmers buy wheat and barley for calves as their mainstay diet out of grass, and if wheat and barley goes up in value, it imposes a threat to the business as it increases expenses while having uncertainties on how much they will sell for. One Participant explained that since commodity prices are uncertain and out of their control, farmers try to make sure to produce the best quality of animal they can and hope to be able to sell it at the best prices. We have good traceability now; High regulations are not translating into higher prices.

Many believe that farming may become part time due to the low returns, and an off-farm job will be required to supplement income.

Extreme weather challenges

Having just come out of one of the worst winters in over 36 years farmers are now facing one of the driest summers in over 42 years. They explained multiple common challenges faced during extreme weather conditions that impact their performance, when the cattle are kept in the sheds during disruption rather than out in the field of grazed grass, these challenges can be explained under three categories: challenge of keeping cost low and limited and lack of resources, and timely delivery of the

end product. Collaborative practices are assisting many farmers in their ability to respond to extreme weather challenges. This is achieved by coordinating with some neighbours specifically when in need of help and involves sharing of storage capacity and resources. This is an example of 'tacit coopetition' as mentioned in the literature. Soubeyran and Weber (2002).

Supermarkets and Processors are too powerful

There is a strong belief among the farmers interviewed that both the supermarkets and processors have too much power. One participant stated Supermarkets have all the power, pushing down on factories and they in turn are pushing down of farmers. While another believed that the supermarkets are worse than the Department of Agriculture, Food and the Marine (DAFM) when it comes to regulations and red-tape. He also held a firm belief that *"It was only a matter of time before Tesco starts buying farms".* (Farmer 21)Concerns were also expressed with regard to the closure of the local slaughter houses and the reduction number of cattle agents as a contributing factor to the rise in power of the supermarkets. Others were concerned that their representative bodies were no match for the likes of the supermarkets and processors. There is a strong sense among the smaller farmers that they were powerless and had no control while they believed that the bigger farmers were in a better position to deal with the supermarkets and processors. Many farmers believe beef production factories do not take into consideration the cost of rearing stock and as a result, the price of the animal at finishing weight is not substantial enough.

Collaboration

In the literature, trust is mentioned as one of the enablers to collaborative relationships and that when it is enhanced, conflict is most likely to be avoided between partners (Scholten & Schilder, 2015; Jepsen, 2014; Dani, 2015). Some participants confirmed that lack of trust might arise as an issue in relationships between farmers, which reveal its importance in collaborative relationships. There is evidence of a collaborative culture in place now between many farmers; including informal collaboration between farmers which is purely based on trust that has been built in the community over years. There were strong opinions from some farmers that getting into formal and legal agreements could cause a hassle which is best avoided, giving the reason that "no one wants to fall out with anybody". Other farmers foresees a possibility of long-term collaboration between farmers down the line, but explains that it is highly unlikely to happen now as some farmers dislike working together and prefer to do their own thing - one of the reasons being that they disagree about many things. A number of farmers were in or had been involved in a formal Purchasing Group, those still involved in this type formal co-opetition believe that these arrangement will become commonplace in the future.

Scholten et al. (2014) & Sheffi (2005) explained that collaboration should be thought of as long term in order to be able to deal with future uncertainties the supply chain is exposed to. Most farmers responded with a preference of only working together when in need, as short-term collaboration rather than long-term, although they do see a positivity to working collaboratively in terms of ability to perform well in good quality delivery and meet requirements in timely manner. The main concerns from farmers to unfavourable long-term relationships were for reasons related to the following;

- Getting into formal and legal agreements could cause a hassle as many farmers generally disagree on many issues

- With climate change trending towards longer winters and drier summers every farmer would rather ensure to have enough feed for themselves rather than put themselves at risk by sharing with others.

Conclusion

In terms of contribution, while there is an emerging stream of literature and research around co-opetition, such frameworks have yet to be applied to Agri-food supply chains. The focus up until this point has been more on collaborative aspects rather than on both the simultaneous pursuit of both competition and collaboration.

Whilst also highlighting new avenues for further research on the role of co-opetition in supply chain optimization

It is envisaged that this research project when concluded will make a significant contribution to academic understanding of Power Asymmetry and Co-opetition between food producers, food processors and retailers, including significant advances in our understanding of how various actors navigate, leverage and augment power in the pursuit of securing greater sustainability.

References

- Barratt, M. (2004). Understanding the meaning of collaboration in the supply chain. *Supply Chain Management: An International Journal*, 9(1), 30-42.
- Benton, W C and Maloni, M (2005) The Influence of Power Driven Buyer/Seller Relationships on Supply Chain Satisfaction, Journal of Business Logistics, 21, 1.
- Bengtsson, Maria and Kock, Sören (2003): Tension in Co-opetition. Paper presented at the 2003 Academy of Marketing Science Annual Conference, May 28-31. Washington D.C.
- Bell, M, J. (2014). Supply Chain Risk: Understanding Emerging Threats to Global Supply Chains. Great Britain and United States: KoganPage.
- Blome, C. Paulraj, A. Schuetz, K. (2014) "Supply chain collaboration and sustainability: a profile deviation analysis", International Journal of Operations & Production Management, Vol. 34 Issue: 5, pp.639-663
- Blumberg, F, B., Cooper, R, D., & Schindler, S, P. (2014). Business Research Methods (4th ed.). Berkshire: McGraw-Hill Education.
- Brown, J. R., Grzeskowiak, S., & Dev, C. S. (2009).Using influence strategies to reduce marketing channel opportunism: The moderating effect of relational norms. Marketing Letters, 20 (2), 139–154.
- Bryman, A., & Bell, E. (2015). Business Research Methods (4th ed.). United Kingdom: Oxford University Press
- Chin, K.S., Chan, B.L., Lam, P.K. 2008. Identifying and prioritizing critical success factors for coopetition strategy, Industrial Management & Data System, 108 (4), 437-454.
- Chen, Lujie & Zhao, Xiande & Tang, Ou & Price, Lydia & Zhang, Shanshan & Zhu, Wenwen, (2017). Supply chain collaboration for sustainability: A literature review and future research agenda. International Journal of Production Economics, 194(1), 73-87.
- Christopher, M. (2011). Logistics & Supply Chain Management (4th ed.). London: Pearson.
- Department of Agriculture Food and the Marine, www.agriculture.gov.ie/ [May 15th ,2017]
- Cox, A (2004) Win-Win? The Paradox of Value and Interests in business relationships,
- Stratford-upon-Avon, UK: Earlsgate Press.
- Crook, T. R., & Combs, J. G. (2007). Sources and consequences of bargaining power in supply chains. Journal of Operations Management, 25 (2), 546–555.
- Dani, S. (2015), Food Supply Chain Management and Logistics: From Farm to Fork (1st ed.) Kogan Page.
- Denzin, N.k. Lincoln, Y.S. (2011) The SAGE Handbook of Qualitative Research (4th ed.) SAGE Publications
- EQUITY FOR FARMERS IN THE FOOD SUPPLY CHAIN (2010), The Irish Farmers Association.
- Fiksel, J. Ensuring Supply Chain Resilience: Development and Implementation of an Assessment Tool

- French Jr., John R. P.; Raven, Bertram. Cartwright, Dorwin (Ed). (1959). Studies in social power (pp. 150-167). Oxford, England: Univer. Michigan, ix, 225 pp.
- Gulati, R and Sytch, M (2007), Dependence Asymmetry and Joint Dependence in inter-organizational Relationships: Effects of Embeddedness on a manufacturer's performance in Procurement Relationships. Administrative Science Quarterly, 52 (3), 32-69.
- Hong, J.F.L., & Snell, R.S. (2015). Knowledge development through co-opetition: A case study of a Japanese foreign subsidiary and its local suppliers. Journal of World Business, 50(4): 769-780.
- Jepsen, B, L. (2014). Critical success factors for horizontal logistics collaboration. Paper presented from Innovative Methods in Logistics and Supply Chain Management, Hamburg.
- Kitchen, D. Jr, Snow, Ch. C., Hoover, V.L. 2006. Research on competitive dynamics:
- recent accomplishments and future challenges, Journal of Management, 30 (6)
- 2004, 779-804.
- Luo, X., Slotegraaf, R.J., & Pan, X. (2006). Cross-functional "coopetition": The simultaneous role of cooperation and competition within firms. Journal of Marketing, 70(2): 67-80.
- Maloni, M and Benton, W C (2000) Power Influences in the Supply Chain, Journal of Business Logistics, 21 (1).
- Matopoulos, M. Vlachopoulou, V. Manthou, B. Manos, (2007) "A conceptual framework for supply chain collaboration: empirical evidence from the agri-food industry", Supply Chain Management: An International Journal, Vol. 12 Iss: 3, pp.177 – 186
- Nyaga, G N, Lynch, D, Marshall, D and Ambrose, E (2013) Power Asymmetry, Adaptation and Collaboration in Dyadic Relationships involving a Powerful Partner, Journal of Supply Chain Management, 49(3), 42.
- Parnell, E. 1995. Reinventing the cooperative – enterprises for the 21st century. Plunkett Foundation: Oxford.
- Rodrigues, S, V., Harris, I., & Mason, R. (2015). Horizontal logistics collaboration for enhanced supply chain performance: an international retail perspective. Supply Chain Management: An International Journal, 20(6), 631-647.
- Saunders M., Lewis P. and Tornhill A. (2009), Research Methods for Business Students, 5th edition, Pearson Education Limited, Upper Saddle River
- Republic of Ireland. Department of Agriculture, Food and the Marine. (2018).
- https://www.agriculture.gov.ie/agri-foodindustry/[assessed [24th January 2018]
- Saldana, J. (2009). The Qualitative Manual for Qualitative Researchers. London: Sage Publications.
- Saldana, J. (2011). Fundamentals of Qualitative Research: Understanding Qualitative Research. New York: Oxford University Press.
- Saunders, M., Lewis, P and Thornhill, A,. (2016). Research Methods for Business Students (7th ed). England: Pearson Education Limited.
- Scholten, K., & Schilder, S. (2015). The role of collaboration in supply chain resilience,
- Supply Chain Management: An International Journal, 20(4), 471-484.
- Strese, S., Meuer, M.W., Flatten, T.C., & Brettel, M. (2016). Organizational antecedents of cross-functional coopetition: The impact of leadership and organizational structure on cross-functional coopetition. Industrial Marketing Management, 53(2): 42-55.
- Terpend, R., Tyler, B. B., Krause, D. R., & Handfield, R. B. (2008). Buyer–supplier relationships:
- Derived value over two decades. Journal of Supply Chain Management, 44 (2), 28–55.
- Van Hoof, B. Thiell, M., (2014) Collaboration capacity for sustainable supply chain management: Small and medium-sized enterprises in Mexico Journal of Cleaner Production 67:239–248 March 2014
- Walley, K., Paul Custance, P. (2010) Coopetition: insights from the agri-food supply chain, Journal on Chain and Network Science 10(3): 185-192
- Yin. R. (2014) Case Study Research Design and Methods (5th ed.) Thousand Oaks, CA: Sage

- Zikmund, G, W., Babin, J, B., Carr, C, J. (2013). Business Research Methods (9th ed.). Canada: SOUTH-WESTERN CENGAGE Learning.
- Zikmund, G, W., Babin, J, B., Carr, C, J., & Griffin, M. (2010). Business Research Methods (8th ed.). Canada :SOUTH-WESTERN CENGAGE Learning.
- Zhao, X., Huo, B., Flynn, B. B., & Yeung, J. H. Y. (2008). The impact of power and relationship
- commitment on the integration between manufacturers and customers in a supply chain. Journal of Operations Management, 26 (3), 368–388.

INVESTIGATING THE INFLUENCE OF COMMODITISATION WITHIN LOGISTICS OUTSOURCING

Samir Dani[1], Ayanda Mpofu[1], Rob Krikhaar[2] and Jo Godsmark[3]
[1]Huddersfield Business School, University of Huddersfield, Huddersfield, UK
[2]Fortna, UK
[3]Labyrinth Logistics Consulting Ltd, UK

Introduction

In recent years, there has been an increase in competition and sector growth in the area of LSP freight transportation outsourcing. One of the reasons is the increase in companies outsourcing their transportation activities to external transportation vendors as a way of reducing transportation costs (Selviaridis & Spring, 2007). Whilst the logistics outsourcing sector is booming and the global economy and emerging markets are growing and maturing, retailers and manufactures at a local and global scale are still shopping around for lower transportation prices (Burnson, 2014). This has led to a view on commoditised logistics outsourcing. Commoditisation in its entirety refers to "the process in which non-commodity products or services are transformed into a commodity" (Wever et al, 2008, p. 2). Commoditised products are products that customers and suppliers perceive to be homogenous in which the only distinguishing feature is the price. However, in commoditised outsourcing, profit margins are generally low and any innovation effort "will be typically directed at cost reduction" (Burnson, 2014). This paper will try to ascertain whether there is commoditisation of logistics versus its opposite, differentiation. This purpose of this paper is to analyse perceptions of logistics outsourcing professionals of the trends towards commoditisation of logistics outsourcing

Logistics outsourcing

Logistics outsourcing or third party logistics is when a firm uses outside vendors to perform some of its functions and activities like transportation, distribution, warehousing and other activities that could have been performed internally (Ho et al, 2012). These functions can be distinguished as being transportation based (associated with the movement of the products) or warehousing based (warehousing, managing inventory, etc.). According to the resource-based view, companies must identify their core competences to specialise in and outsource non- core activities (Prahalad & Hamel, 1990). Most companies that outsource their transport or logistics function to LSP's do not possess the core-competence in transportation, hence they decide to outsource these functions to dedicated LSP's who have the expertise (Prahalad & Hamel, 1990; Yeung et al, 2012). Despite a plethora of academic literature on outsourcing, managing outsourcing relationships is one of the key areas in need of further research. Outsourcing relationships that are inadequately managed could lead to financial loss to a company and could also cause brand damage. Logistics outsourcing has increased in recent decades because the supply chain is becoming more complex and costly to manage (König & Spinler, 2016). Although there are benefits associated with logistics outsourcing (such as reduced costs, reduced resource requirement, focus on core competencies, improved coordination, etc.), there are risk associated with logistics outsourcing too (such as loss of control, loss of cargo, Supply chain security risks, IT and cyber security, etc.) (König & Spinler, 2016).

Commoditisation

Commoditisation according to Wever et al (2008, p. 2) "is the transformation of a non-commodity product into a commodity". The other definition of commoditisation according to Burnson (2014) "commoditization is defined as the process by which goods that have economic value and are distinguishable in terms of attributes (uniqueness or brand) end up becoming simple commodities in the eyes of the market or consumers". In business, commodities are traded products that customers perceive to be homogenous amongst traders and suppliers, other than the price (Wever et al, 2008). The term commodity in academic literature refers to soft and hard commodities like rice, cotton and

industrial metals (lead, copper) and oil. In road parcel and freight transport, commoditisation is still evolving and characterised with little research in commoditised outsourcing. However, a few studies have attempted to stress the importance of commoditisation as a concept within the fields of marketing (Reimann et al, 2010; Olson & Sharma, 2008; Sharma & Sheth, 2004). According to Reimann et al (2010), commoditisation is a multi-dimensional construct that consist of product homogeneity, price sensitivity; switching costs and industry stability.

Effects of commoditisation of buyer-supplier relationships

Fulconis et al, (2016) have suggested that the relationship between shipper and logistics service provider (LSP) in the past has been marred with tension and conflicts. In recent decades, logistics outsourcing using third party logistics companies has seen an enormous rise thereby putting competitive price pressures on logistics service providers. The move by shippers to negotiate for lower prices has an adverse impact on the LSP's profit margins. Considering the definition of commoditisation and the drive for reduced prices, it is suggested that the trend in logistics outsourcing is a commoditisation trend. Fulconis et al, (2016) have considered the Kraljic matrix in the context of transport procurement and have suggested that "the shipper will always want to position logistics purchases as non-critical". Hence there is a tussle between the buying and provision of logistics services and LSPs will project their service as a value added service to move it out of the 'non-critical' quadrant. For example, there is a distinction between transport services and warehousing.

Commoditisation processes

The normal process for commoditisation will be through the purchasing process through negotiation and contracting. Purchasing negotiations will strive to drive down costs. However, from a commoditisation perspective there are other processes too for procuring commoditised products.

Auctions

The rise in internet commerce have increased online auctions that have changed the way logistics transport services are procured (Xu & Huang, 2017). The logistics auctions are commoditised, price only auctions (Huang and Xu, 2013; Xu and Huang, 2015; Xu & Huang, 2017). However, Gupta et al (2012), argues that price only auctions are no longer practically applicable, especially when you are dealing with complex logistics purchases where price is not the only determining factor to consider. In logistics purchasing literature, price only auctions have been identified as one of the main causes of conflict between LSP's and sellers. In recent times, another type of logistics transport auction has emerged called multi-attribute auctions.

Futures market

Futures markets are markets where buyers and sellers interact so as to auction future standardised contracts for goods and services. According to Tibben-Lembke & Rogers (2006, p. 253) "futures are an agreement between parties to buy or sell a specific amount of a commodity or financial instrument at a particular price on a stipulated future date". Within the road transport or logistics futures contracts are in its infancy however, in maritime freight transport, futures trading of future contracts and derivatives is evident (Tsai et al, 2009). Examples of current futures exchange markets for maritime according to Tsai et al (2009) include the Baltic futures exchange, New York Mercantile Exchange (NYMEX) and the International Maritime Exchange (IMAREX).

Hedging

According to Korkeamäki et al (2016, p. 492), freight logistics providers "can use derivatives either for hedging or to seek additional returns". However, Brunzell et al (2011) also argues that speculative motives may also be a catalyst for freight logistics companies to use hedging of freight transport contracts. Empirical research in road freight transport hedging of transportation prices and contracts is non-existent, however some theoretical future models have been developed by a small number of

academic researchers on how hedging of contract prices could benefit both the logistics transport provider (LTP) and the shipper (Tibben-Lembke & Rogers, 2006; Tsai et al, 2009).

Methodology

The main aims of this research project is to investigate the perceptions of this phenomenon of commoditisation within the freight transport sector from a supply side perspective (consultants, academics & logistic service providers) and demand side or buyer/shipper perspective (manufactures, retailers, public sector and charity). Moreover, what are the expected effects of innovation, ethical procurement and the environment on this trend?

To achieve these aims, the following research questions were set:

1. Is there a trend toward commoditisation, or the opposite, differentiation?
2. What are the causes and effects of commoditisation of transport outsourcing?
3. How does innovation impact the commoditisation trend?

Exploratory research is conducted when the information about the topic or research area is not known (Saunders et al, 2012). There are many ways that exploratory studies can be undertaken. These may include, "reviewing literature that is available on the phenomenon under-study or interviewing industry experts in the field" (Saunders et al, 2012, p. 171). One main advantage of undertaking exploratory studies is that they provide an element of flexibility for the researcher to understand the subject of inquiry and they are adaptable to change (Saunders et al, 2016). The reason for choosing exploratory design in this paper is to explore the aspect of commoditisation in logistics procurement and outsourcing. In this research project, an online questionnaire survey was used to collect primary data and interviews were conducted with logistics professional to explore their perceptions of commoditisation. The primary data for this analysis was from the survey questionnaire for the CILT Outsourcing and Procurement Forum's 8th Annual Outsourcing Attitudes survey. The survey yielded a total number of 250 responses from a suppliers and buyer perspective. The questionnaires consisted of both closed and open-ended questions. The data analysis in this paper used only those questions that focused on 'commoditisation'. To explore the topic of commoditisation further, Interviews were conducted with nine respondents from the logistics industry. The respondents represented both buyers and LSP providers. The interview data was recorded in the form of notes and analysed using the thematic analysis technique (Miles and Huberman, 1994).

Key findings of the survey data

This section briefly discusses the analysis of the questions from the CILT's Annual Outsourcing survey. The analysis in this paper only pertains to those questions that directly relate to commoditisation. The respondents were divided into two groups: buyers/users of logistics services and logistics service providers. The descriptive statistics of the survey return provides the following themes and insights.

Commoditisation Trend

Commoditisation trend was categorised into five levels: strong differentiation, some differentiation, neutral, some commoditisation and strong trend towards commoditisation.

Buyer representatives reported a 22.2% strong trend towards commoditisation, 38.9% perceived some trend towards, 23.6% were neutral, and 15.3% reported some differentiation.

Logistics service providers reported: 24.5% reported a strong perception towards the trend of commoditisation, 34% some perception towards commoditisation, 28.3% of population were neutral, and 13.2% reported some differentiation.

Percentage of Transport and Distribution Outsourced

56.3% of logistics service buyers reported that they outsourced (81 – 100%) of their transportation and distribution to logistics service providers, 10% reported (61-80%), 3.8% of buyers reported outsourcing (41-60%), 11.3% outsourced between (21 and 40%), 8.8% reported (1-20%) and 9.8% none.

Logistics services providers reported: 40.4% outsourced (81-100%) of their transport and distribution services to LSP's, 15.6% reported 61-80%, 11% of the respondents reported (41-60%), 12.8% reported 21-40%, and 12.8% reported (1-20%).

These results show that both logistics service providers and buyers reported a high percentage of logistics transport outsourcing. This result also presents a mismatch between high market demand and commoditisation due to 'pricing'.

Involvement of Procurement Department

The question related to involvement of the procurement department in purchasing logistics services was categorised into four distinct groups: never, rarely, sometimes and always.

For logistics services providers, 46.67% of respondents reported that the procurement was always involved in the procurement of logistics and distribution services. 32.38% sometimes, 12.36% rarely and 8.57% reported never. The buyer's representatives reported a high percentage of the procurement department involvement in logistics services procurement- 50.70% almost always, 26.76% sometimes, 11.27%rarely, and 11.27% never. From both types of respondents, the key finding is that the procurement department is very much involved in the procurement of logistics and distribution services. The survey showed that the focus is greater on the aspect of purchasing transportation services and lesser on warehousing.

The survey also considered the effect of 'contract length'. The analysis showed that LSPs preferred a contract length of 3-4 years whereas buyers preferred 1-2 years. The preference of a short length of contract by the buyer suggests the 'commoditisation' of transport services.

Importance of Innovation

Buyers of logistics services, were asked about the importance of innovation in outsourcing relationships and what support they expected from their logistics service providers? 35.5% reported that innovation was very important, 48.7% reported that innovation was important, and 15.8% reported that it was not important. 46.5% of logistics service providers reported that innovation was very important. 36.4% important and 13.9% reported that it was not important. It is important to query how the high perception of innovation match with the high perception of commoditisation. The question focused more on general logistics services and not specifically on transport services.

Environmental sustainability

Environmental sustainability featured as a major factor within contract negotiations. It is important to note that although the respondents provided a perspective of increased commoditisation they also provided a positive increase in terms of environmental factors being considered strongly within the purchasing decisions. 35% of the buyers reported that environmental issues were part of the outsourcing contract, 32.5% sometimes, 18.8% rarely and 13.8% reported never. Logistics service providers had somewhat similar figures, 23.6% reported that environmental issues were considered in the contract, 39.1% of respondents reported sometimes, 28. 2% rarely, and 9.1% reported never.

<u>Key findings of the interview analysis</u>

The interview notes were analysed to create themes. These themes were supported by comments and perceptions from individual respondents. The focus of the analysis is to understand the perception of commoditisation in Logistics along with the causes and impacts.

Theme 1: Perception of commoditisation is high in the transport and logistics sector
From the CILT survey results, it is evident that there is high perception towards the trend of commoditisation. Outsourcing intensity is on the rise as the LSP sector is booming however, the competition is fierce.

"*Yes is see a trend towards commoditisation, unless the LSP can offer value add, its very price driven unlike DPD who have added value with a track and communication system that alerts the customer the time their parcel is goings to be delivered*". (Respondent C)

"*Yes, I see a trend towards commoditisation, especially in parcel delivery and palletised networks and fully vehicle truckloads where there are many price pressures. One of the main reasons why I am saying transport outsourcing is in my opinion already commoditised is due to the lack of innovation of transport companies, without innovation they will remain commoditised*" (Respondent B)

The respondents agreed that commoditisation is on the increase due to the following points:

- Price driven
- Maximisation of Vehicle cost (full truck load/palletised networks/parcels)
- Specialist procurement involvement- transactional process
- Cost savings
- Lack of innovation
- Buyer choice (specifically within Transport)

Although price was the biggest determinant when choosing to contract with a LSP, respondent G who is a chemical manufacturer did not perceive any trend towards commoditisation:

"*No I don't see a trend to commoditisation, we are a chemical manufacturer and when we contract with companies that do chemical transportation, they first have to have a licence to carry chemicals*" (Respondent G).

Theme 2: Perception of importance of innovation is high in relation to reducing commoditisation.
Theme 2a. Differentiation is important to reduce the effects of commoditisation
Based on the results of the CILT survey, interviews and the literature review, it is evident that innovation is the biggest factor that LSP's must initiate in order to gain a competitive advantage against the competition. Technology is reported as the highest differentiator. Transport and LSP's are working towards adopting new technology as a competitive advantage.

As seen in the previous theme, innovation featured strongly in the perceptions of the respondents in regards to commoditisation.

"*Transport as a cost is getting more and more attention due to price pressures. One of the causes of commoditisation is that LSP companies do not innovate. They tend to opt for dedicated contracts in transport, warehousing and logistics in general"* (Respondent C).

"*Innovation is a way of combating price pressures, be it scheduling, utilisation, productivity, reliability and efficiency*". (Respondent B).

Most of the logistics service providers agreed that innovation would have a negative impact to the trend of commoditisation. Their argument was, once logistics providers innovate, then it's no longer commoditisation but the opposite, differentiation. It is important to note that a differentiated product will work only if the market demands it.

Theme 3: The increased perceived involvement of procurement departments in logistics outsourcing is a cause of commoditisation

Based on the results from the CILT and the interviews, it is evident that the involvement of the procurement department in logistics purchasing is on the rise. Procurement specialists provide specialist procurement strategies that in turn reduce the cost of logistics and transportation purchases.

"*Most companies nowadays including ours, have people that are specialised in procurement who deal with logistics outsourcing contracts and they know how to get the best deal*". (Respondent H)

"*Most companies nowadays see logistics in the supply chain as a cost therefore they will try and get the cheapest costs as possible*". (Respondent J)

"*The procurement specialists are increasingly involved in the outsourcing process, used to be the logistics and distribution teams who were involved in the outsourcing process within organisation*". (Respondent A)

"*Probably if the logistic outsourcing spend of the company is big, then they would involve procurement professionals along the warehouse and the logistics teams*". (Respondent C)

"*Yes the procurement teams that have specialist knowledge are now actively involved in the outsourcing process because they would know how negotiate outsourcing contracts, and they tend to prefer shorter time commitments and price guarantees*". (Respondent D)

The majority of the respondents agreed that the purchasing function is playing an ever increasing role on procuring and contracting logistics services. The perception is that this has led to the focus on price rather than value addition done through differentiated or focused services. Although some of respondents have reported that their organisations or the users' may involve procurement specialists who will have a knowledge about the logistics sector.

Discussion

RQ1. Is there a trend toward commoditisation, or the opposite, differentiation?

Commoditisation as a phenomenon within logistics outsourcing is a relatively new subject. Research by Burnson (2014) and the Eye-for-transport (2015), are the few sources which define Logistics commoditisation as a construct. The survey showed that there is a strong perception of a trend towards commoditisation. Results from the interviews also confirmed that the industry perceives an increase in commoditisation of transport and distribution services. However, in some instances as portrayed within the interview, transporting or managing high value goods or hazardous chemicals, commoditisation may not be possible. With price pressure and low margins LSP's, must innovate so as to differentiate and provide value added services. One example of a transport company that has embraced innovation as identified by the interview respondents is DPD, which provided real time track and trace information to their customer about their deliveries as a differentiating service.

RQ2. What are the causes and effects of commoditisation of transport outsourcing?

One of the causes of commoditisation as suggested by the interview analysis was the lack of an innovation led environment within LSP companies. According to Burnson (2014) shippers lack the ability to innovate which in turn leads to commoditisation of LSP outsourcing. Pricing plays a very important factor in the outsourcing process and transportation or logistics services as considered only from a cost perspective. Technology can act as a cause of logistics commoditisation due to the provision on online auction platforms and trading exchanges. The users use LSP provision as a 'commodity' and the LSP provider uses 'transportation 'as a commodity. The purchasing of these services flows upstream through the 'logistics services supply chain' as a commodity purchasing

process which is supported by technology. Online auctions run by third part auctioneers are commoditised in a sense that they are transactional and are price driven. The other cause for commoditisation is market demand for logistics and transport services especially in online home delivery. The servicing of home delivery is a price sensitive business model and is prone to follow the 'commoditisation' process.

RQ3: How does innovation impact the commoditisation trend?

According to a report by Eye for transport (2015), the data from the CILT survey and the interview analysis, it is evident that innovation plays a very important role in fulfilling customer demands and creating value-added services. Most of the logistics service providers agreed that innovation has the potential to reduce the trend of commoditisation. Logistics providers through innovation can create value added services, thus reducing the characteristics of a commodity product and increase differentiation. The other aspect of innovation that was brought up was speed. Respondents agreed that speed was one of the differentiators of innovation, especially in the online home delivery sector where speed and order accuracy was of great importance (Burnson, 2014).

Conclusion

The paper has provided an insight into the topic of commoditisation within Transport and logistics services. The paper presented a brief analysis of the results from the CILT Outsourcing and Procurement Forum's 8th Annual Outsourcing Attitudes survey and semi structured interviews conducted with practitioners. The paper has introduced the concept of commoditisation within the area and inquired whether innovation can lead to differentiation and a competitive advantage thus limiting 'commoditisation'. However, it is also important to note that some companies may be very efficient in their chosen marketplace and are happy to compete on price and attract high volumes. The research project needs further work to explore the topic of commoditised services with practitioners and study the correlation within various factors affecting this trend. Until then, the research will help academicians and practitioners to gain insights into understanding the topic of commoditisation within Transportation and Logistics service sector which is still in its infancy within the literature. The academic work on this is limited however there is discussion regarding these areas within practitioner articles. Hence, this research will provide academics and researchers a new direction for further work.

References

- Brunzell, T., Hansson, M., & Liljeblom, E. (2011). The use of derivatives in Nordic firms. *The European Journal of Finance*, *17*(5-6), 355-376.
- Burnson, P. (2014). *Optimizing Third-Party Logistics Relationships and how to Avoid Commoditisation*. Retrieved from: http://www.scmr.com/article/optimizing_3pl_relationships_how_to_avoid_commoditization.
- Eye for Transport (2015) 3PL contracting report, https://www.eft.com/technology/3pl-contracting-report-2015
- Fulconis, F., Fulconis, F., Nollet, J., Nollet, J., Paché, G., & Paché, G. (2016). Purchasing of logistical services: a new view of LSPs' proactive strategies. *European Business Review*, *28*(4), 449-466.
- Gupta, A., Parente, S. T., & Sanyal, P. (2012). Competitive bidding for health insurance contracts: lessons from the online HMO auctions. *International journal of health care finance and economics*, *12*(4), 303-322.
- Ho, W., He, T., Lee, C. K. M., & Emrouznejad, A. (2012). Strategic logistics outsourcing: An integrated QFD and fuzzy AHP approach. *Expert Systems with Applications*, *39*(12), 10841-10850.
- Huang, G. Q., & Xu, S. X. (2013). Truthful multi-unit transportation procurement auctions for logistics e-marketplaces. *Transportation Research Part B: Methodological*, *47*, 127-148.

- König, A., & Spinler, S. (2016). The effect of logistics outsourcing on the supply chain vulnerability of shippers: Development of a conceptual risk management framework. *The International Journal of Logistics Management*, *27*(1), 122-141.
- Korkeamäki, T., Liljeblom, E., & Pfister, M. (2016). Airline fuel hedging and management ownership. *The Journal of Risk Finance*, *17*(5).
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.
- Olson, E. G., & Sharma, D. (2008). Beating the commoditization trend: a framework from the electronics industry. *Journal of Business Strategy*, *29*(4), 22-28.
- Prahalad, C. K., & Hamel, G. (1990). "The core competence of the corporation". *Harvard Business Review,* Vol. 68 No. 3, pp. 79-91.
- Reimann, M., Schilke, O., & Thomas, J. S. (2010). Toward an understanding of industry commoditization: Its nature and role in evolving marketing competition. *International Journal of Research in Marketing*, *27*(2), 188-197.
- Saunders, M., Lewis, P., & Thornhill, A. (2012). *Research methods for business students* (6th Ed.). Harlow: Pearson.
- Selviaridis, K., & Spring, M. (2007). Third party logistics: a literature review and research agenda. *The International Journal of Logistics Management*, *18*(1), 125-150
- Sharma, A., & Sheth, J. N. (2004). Web-based marketing: The coming revolution in marketing thought and strategy. *Journal of Business Research*, *57*(7), 696-702
- Tibben-Lembke, R. S., & Rogers, D. S. (2006). Real options: applications to logistics and transportation. *International Journal of Physical Distribution & Logistics Management*, *36*(4), 252-270.
- Tsai, M. T., Regan, A., & Saphores, J. D. (2009). Freight transportation derivatives contracts: state of the art and future developments. *Transportation Journal*, 7-19.
- Wever, R., Boks, C., & Stevels, A. (2008). *The commoditization of consumer electronics products and its influence on packaging design*. International Association of Packaging Research Institutes. Retrieved from: file:///C:/Users/u1166524/Downloads/Wever_P1-28_IAPRI2008.pdf
- Yeung, K., Zhou, H., Yeung, A. C., & Cheng, T. C. E. (2012). The impact of third-party logistics providers' capabilities on exporters' performance. *International journal of production economics*, *135*(2), 741-753.

RURAL SUPPLY CHAIN MANAGEMENT: A LITERATURE REVIEW AND RESEARCH AGENDA

Pietro Evangelista[1], Bettina Williger[2], Girma Gebresenbet[3] and Ulrich Müller-Steinfahrt[4]
[1] Institute for Research on Innovation and Services for Development (IRISS), National Research Council (CNR), Naples, Italy
[2] Fraunhofer Center for Supply Chain Services, Nuernberg, Germany
[3]Swedish University of Agricultural Sciences, Uppsala, Sweden
[4]University of Applied Science Wuerzburg-Schweinfurt, Wuerzburg, Germany

Introduction

With the ongoing trend of people moving to cities and residential areas close to the city, there is a growing need to supply urban areas with limited infrastructure and restricted space. Many studies on the supply chain of cities or megacities have been done in recent years, while rural areas, which are changing as a result of the urbanisation, have so far been little researched. However, changes in rural areas require lessons to be learned. A lack of infrastructural offer, limited job opportunities and declining supply offers reduce the attractiveness as a place of residence and work and foster depopulation of rural areas (Eurostat, 2017). For example, the goods for daily needs cannot be readily obtained by many citizens in rural areas, public transport is often sparse and not easy to use, and local food retailers lose their appeal or are not often economically sustainable (i.e., Williger & Wojtech, 2018). The supply chain in rural areas is often fragmented due to scattered settlement and production and it leads to high logistics cost, particularly transport cost, and significant environmental impact. This is particularly true in the context of rural agriculture production were the delivery of means of production (such as fertilizer and machinery and collection of produce) are not coordinated, the load capacity utilization level of vehicles is low and varies between 10% and 95% (Gebresenbet and Ljungberg, 2001).

So far, the current challenges of a robust, economical and efficient supply have been largely related to the supply of manufacturing production facilities, retail or end customers without a differentiation according to region-specific conditions. Research activities were more related to cities from a spatial perspective (Lagorio et al., 2016). With the topic of smart urban logistics, insights were collected in relation with urban areas. There has been hardly any focus on rural areas, regions and countries having a distinct rural settlement structure. One of the main reasons for the poor focus on rural logistics and supply chain management is the low attractiveness and challenges to design efficient value-added chains to the end customer. An interesting example is the case of some postal and parcel service providers in Germany, Austria, Denmark and UK, which deliver letters and parcels in rural areas only once or twice a week (see https://wearecitizensadvice.org.uk/are-rural-consumers-getting- a-bad-deal-with-parcel-delivery-e8b6a70dd874). Many universities and research institutions that deal with logistics or supply chain management have focused their research efforts predominantly on the industrial supply, retail supply and strategies on the e-commerce initiated supply of the end customer without any spatial reference. In addition, although the subject areas of geography, settlement structure and agricultural sciences are related to rural areas, they often lack to focus on the logistics problems in these areas.

For these reasons, research is needed on how rural areas can be supplied with sustainable and economically viable solutions in the future. In order to understand the state of knowledge in the context of RSCM, a systematic literature review has been conducted. In this way, it is possible to identify existing studies and related findings as a starting point for developing further research. The idea behind this paper was generated during a comprehensive two-day workshop held at the Fraunhofer Centre for SCS in Waischenfeld (Germany) on December 2017. The workshop aimed at identifying relevant topics and potential research avenues for RSCM (for more information: Prockl et al., 2018). Nine international experts (including the authors of this paper) with knowledge on rural issues and supply chain management research participated in the workshop.

The section following this introduction describes the methodology and the search strategy adopted. The third section provides details about the results of the descriptive analysis, while the fourth section reports the results of the content analysis. The fifth section discusses the results achieved. Some concluding remarks and future research avenues have been outlined in the last section.

The method used to conduct the systematic literature review and results

The methodology approach adopted in this paper has been adapted from the works of Tranfield et al. (2003) and Seuring and Müller (2008), and it comprises the following four steps:

1. Search strategy and materials retrieval. In this step, on the basis of some existing papers and the researchers experience, the following set of relevant keywords have been identified: "Rural", "Rural supply chain management", "Rural distribution", "Rural logistics" and "Rural market". Such keywords have been applied in combination on the Scopus and Web of Science (WoS) databases. 207 documents in total were initially identified using the above keywords in the title, abstract and keywords of documents. The outputs obtained from the two databases were compared and this allowed the elimination of duplicates. In a further step, two inclusion/exclusion criteria were established. The first criterion relates to the inclusion of documents having linkages with logistics and SCM in rural context, while documents with no liaisons with rural logistics and SCM issues were excluded. The second criterion involved the inclusion of papers with a management and economics focus. Papers focusing on technical and political aspects have been considered not directly related with the topic investigated and then excluded. Finally, after the application of the two above criteria, the final sample consisted of 38 documents (see table 1).

	Scopus	**WoS**
Documents retrieved	77	130
Duplications within each database	16	10
Net of duplicates within databases	61	120
Duplicates between the two databases	-	6
Net of duplicates between databases	61	114
Papers out of the scope (first and second criteria)	34	103
Final sample of papers	**27**	**11**

Table 1: Phases and outputs of the search strategy

2. Descriptive analysis. The selected material has been analysed for outlining formal characteristics of the final sample in terms of distribution of papers over time, the methodology adopted, and the countries where empirical studies have been conducted.

3. Identification of relevant topic areas. In this step, three relevant topic areas have been identified and each paper was assigned to one topic area only. To identify the topic areas, it was used a mixed method based on a deductive and inductive approach. Firstly, the potential topic areas have been identified before the documents have been analysed (deductive approach). In a subsequent step, the topic areas identified in the previous phase have been further scrutinised and revised on the basis of the in depth analysis of the prevalent focus of each of the document selected in relation with its main purpose (inductive approach). Moreover, before to assign a document to a specific topic area, it has been compared, contrasted and critically evaluated by the authors. Subsequently, the documents in each topic area have been clustered on the basis of common themes. This allows further classifying the papers in homogeneous sub-topic areas.

4. Content analysis and results. In this final step, the documents included in each topic and sub-topic area have been analysed. The aim was to detect relevant issues and provide the base for interpreting results. The following two sections provide details about both descriptive and content analysis.

Descriptive analysis

In this phase, the formal characteristics of the selected papers included in the final sample have been analysed to identify some key features. In total, the sample contains 23 journal papers, three book chapters, and 12 conference papers. With regard to the distribution of the papers over time (see figure 1), the earliest document was published on 1997.

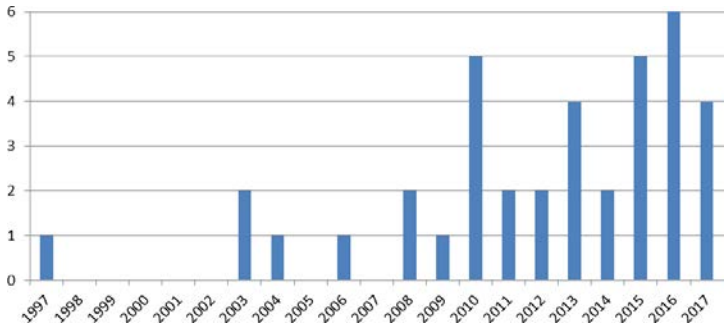


Figure 1: Distribution of papers over time (N=38)

From 1997 until 2008, there has been a relative low interest in this research area with only six publications in this period and with some years with no publication at all (from 1998 until 2002). From 2008 onwards, the number of publications increased significantly with three publications per year on average.

The vast majority of the selected papers applied quantitative (n=14) or qualitative (n=11) methods (see figure 2). Only two papers adopted mixed methods (n=2) and 11 papers were considered to be of a conceptual nature.

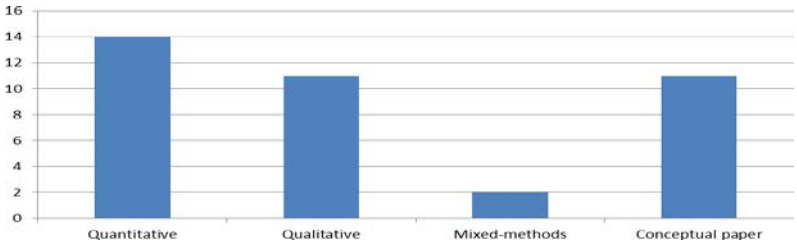


Figure 2: Distribution of papers by research method (N=38)

Figure 3 provides the distribution of selected papers reporting empirical studies (only 25 papers out of 38). Most of such studies relate to China (n=10) and the UK (n=7). Further empirical studies were conducted in India (n=2), U.S. (n=2), and Australia (n=1). Only three studies involved European continental countries.

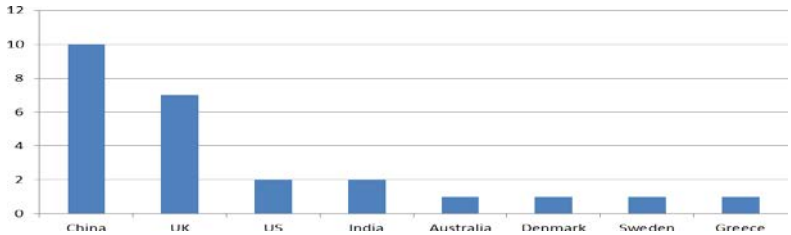


Figure 3: Distribution of papers by country of the empirical study (N=25)

Content analysis

Table 2 provides the distribution of the 38 selected papers by the topic and sub topic areas identified. The following sub-sections provide a summary of the content of the selected papers for each of the four topic and sub topic areas.

Topic areas/Sub-topic areas		# papers
TA.1 - Rural retail and distribution		**13**
Shopping and out-shopping behaviour	2	
Distribution and transport	8	
Retail strategy and channel	3	
TA.2 - Digitalisation and ICT in rural areas		**15**
Implications of online shopping	3	
E-commerce	6	
ICT and platforms	6	
TA.3 - Supply chain models and capabilities in rural areas		**10**
Operational issues in managing rural supply chain	3	
Supply chain capabilities	4	
Supply chain models	3	
Total		**38**

Table 2: Categorisation of papers by topic area and sub-topic area

Topic area 1: Rural retail and distribution

This topic area includes 13 papers analysing retail and distribution issues in rural areas. The first two papers investigated consumer shopping behaviour in rural areas of U.S. and India. The work of Miller and Kean (1997) focused on analysing consumer in-shopping behaviour through a number of factors affecting consumer out-shopping in the Midwest area of US. Among other factors, the authors found that the low importance attributed to customer service in consumer in-shopping behaviour. The paper of Venugopal (2012) investigated the out-shopping behaviour of rural consumers in India and identified that the decision concerning what and where to buy could be influenced by the urban orientation of consumers. The paper provides suggestions to outline a distribution plan for consumer goods companies interested in expanding in the rural markets of India.

The second sub-topic area deals with distribution and transport issues in rural context. A number of papers is focused on China and their common denominator is to address the problem of minimising logistics costs in rural areas through the optimisation of distribution networks. Using a simulation tool, Nie et al. (2010) proposed a two-direction logistics system model focused on agricultural products. The outcome of the simulation indicates a substantial improvement in logistics efficiency. Similarly, Huang (2012a) provides a new model to locate the optimal rural logistics distribution centre. Haoping (2010) discusses several strategies to improve the post logistic network in Henan. The main strategies relate to service innovation and market expansion. Zhang et al. (2015) suggested a planning model of rural distribution network. Considering the diversification of loads, the work identifies a model that is able to provide economic and environmental benefits. Zhuang et al. (2016) proposed a rural forward and reverse logistics network design using the Pinggu district of Beijing as an example. The work of Hageback and Segerstedt (2004) analysed the potential benefits that co-distribution may have in rural areas. Through a number of interviews involving both local companies and companies providing transport services to and from Pajala (Sweden), the authors discovered that companies receive and distribute goods with a low frequency and the loading capacity of vehicles is often less than 50%. This implies that to lower transportation costs and increase delivery services co-distribution is necessary to reinforce the competitive abilities of companies in Pajala. The work of Vachani and Smith (2010) was aimed at understanding how customers get access to products and services in rural areas. Using five case studies in India, the authors pointed out the importance of cross- sector collaboration among multinationals companies, NGOs and governments and identified a number of factors influencing the

development of “socially responsible distribution” such as infrastructure shortcomings, lack of information, knowledge and skills, and low bargaining power.

The papers dealing with retail strategy tried to fill the gap concerning the lack of specific academic studies in rural retailing. The paper of Byrom et al. (2003) developed a typology of strategic alternatives for retailers in rural areas of Scottish islands. Jasim and Vinoth (2017) studied factors affecting retailer preference towards PepsiCo products and problems faced in distribution channel in the rural market of India. Based on interviews with retailers, the authors examined their preference towards PepsiCo products and problems faced in managing distribution channels in rural areas.

Topic area 2: Digitalisation and ICT in rural areas

This topic area has been divided in the following three sub areas: implications of online shopping, e-commerce, and ICT and platforms. Three papers address the sub topic area “Implications of online shopping” with regard to residents and retailers of island communities. An empirical study by Calderwood and Freathy (2014) reveals that online shopping has modest potential to reduce shopping related travel of residents. In a more recent study, Freathy and Calderwood (2016) illustrate that online shopping is a competitive threat to the local retail economy, and that retailers need react to such developments. The threat of online shopping for local retailers is also the subject of the paper by Schiffling et al. (2015). Interviews with local retailers reveal their problems as well as strategies for the economically sustainable operation of local retail shops.

The sub topic “e-commerce” is addressed by six papers that deal with general concepts and solutions for rural e-commerce activities, collaboration of SMEs via internet portals, and the application of e-commerce to the agricultural sector. Leong et al. (2016) present a case study with two e-commerce villages in rural China. The authors identified critical actors in a rural e-commerce ecosystem, the use of ICT, as well as unintended consequences of e- commerce in rural areas. Sun (2017) summarised the research on rural e-commerce in China: rural areas are seen a consumption market for e-commerce and e-commerce has a lot of potentials for the development in rural areas. In one of the earliest studies in this topic area, Sanders et al. (2010) explored the use and the effectiveness of private and public/charity managed internet portals in rural SMEs e-commerce activities. Interviews with 69 SMEs reveal that there were no perceived differences between the types of internet portals. Andreopoulou et al. (2011) discussed the website features to be accounted when designing a collaborative website for e-commerce purposes. Therefore, the authors analysed 44 websites of rural enterprises with regard to predefined quantitative and qualitative criteria. The optimum group can be used as a benchmark for other e-commerce websites. Carr et al. (2013) explored factors influencing the willingness of SMEs to share knowledge online in business networks in rural areas. Interviews with 198 SMEs show that the main factors associated with willingness to share knowledge online were the willingness to share knowledge face-to-face, the intensity of Internet use, and indirectly entrepreneurial factors. Wang et al. (2016) investigated e-commerce with a special focus on the agricultural sector. Although e-commerce has a high economic potential for farmers and agriculture, it has encountered several challenges. The authors performed a game analysis over the cooperation between farmers and other stakeholders, and they conclude that farmers need to dynamically adjust the cooperative relationships with other stakeholders.

The sub topic area “ICT and platforms” includes six papers illustrating how the use of ICT and information platforms can change the rural supply chain. Javid and Paridh (2006) addressed the potential of technology-based solutions to optimize distribution routes and reduce inefficiency of rural supply chains. Using the example of a company in rural India, they discuss possible technologies that can be used to determine a user's location via a mobile device. Sharma et al. (2008) proposed a low-cost security solution that can prevent theft and fraud in rural supply chains in developing countries. Gao (2015) investigated how the Internet of things may improve the quality of the agricultural supply chain on a conceptual level. Deichmann et al. (2016) proposed a framework for the benefits of ICT in the agriculture sector of developing countries and they subsumed that the benefits do not show in

practice to the extent that might be expected so far. The paper by Yiming and Jia (2017) highlights the potentials of information platforms for urban and rural logistics. The paper presents functional requirements as well as implications for the functional overall structure of these platforms.

Topic area 3: Supply chain models and capabilities in rural areas

This topic area includes ten papers concerning operational issues in managing rural supply chain supply chain capabilities and models in rural areas. Three papers relate to operational issues in managing rural supply chain. The paper of Stanton and Burkink (2008) aimed at identifying strategies to facilitate small farmer participation in international supply chains for fresh produce. The authors carried out a questionnaire survey in a sample of U.S. fresh produce importers. The findings indicate that U.S. importers are not uniformly pessimistic about the ability of small farmers to meet their demands. In general, importers are interested in transactions in which the product meets consumer and government expectations and is grown on the buyer's terms, the grower is reliable over time, the transaction is simplified, and the grower handles transportation. The paper of Yun and Lingyun (2011) investigated the logistics demand forecasting problems in rural logistics context. Using the BP neural network method, the authors analysed the logistics demand forecasting in the rural area of Chongqing (China). Xu et al. (2013) applied the Six Sigma method to rural logistics to optimise agricultural processes. The case study of Shouguang in Shandong province (China) was investigated to illustrate how the application of the Six Sigma method allows reducing logistics costs and streamlining vegetable logistics. The work also points out the differences between the Six-Sigma method and the traditional management methods in the area of quality control.

Supply chain capabilities in rural areas are another topic that has been investigated in the extant literature. The work of Liu and Fu (2015) adopted the fuzzy matter-element approach to build an index system including rural economic environment, logistics capability and logistics potential. The authors provided a comprehensive evaluation of logistics capability in Hebei province (China) through a quantitative survey using data from 2006 to 2013. The results show that in rural logistics environment, logistics capability is rising rapidly.

Three papers addressed the sub topic area "Supply chain models" through developing statistical models or algorithms, and building up conceptual frameworks on the rural supply chain. Using the example of China's agriculture, Jiang and Yang (2009) developed a new algorithm for improving rural logistics construction. Kumar and Babu (2013a) identified factors that might influence the rural supply chain in India. In a second step, they modelled and categorised the relationships between these factors in order to derive implications for the management of rural supply chain. The paper of Kumar and Babu (2013b) studied whether marketing and supply chain in rural areas differ from traditional approaches known in the field. The authors built up a conceptual model for a better RSCM.

Discussion of results

This section discusses the results of the literature review from both the descriptive and the content analysis. Interesting elements emerged from the descriptive analysis. With regard to the year of publication, a significant growth of papers in this area from 2008 on indicates a growing interest in the topic even. However, the global number of published papers remains low. About the country of study, the data suggest that an almost equal number of papers based on empirical analysis originated from both developing (12 papers) and developed countries (13 papers). Among the developing countries, the papers refer to China and India. As far as developed countries, ten papers refer to non-EU countries such as UK, U.S., and Australia. Only three papers refer to EU countries (Denmark, Sweden and Greece). In conclusion, there is a scarcity of papers analysing RSCM issues in the EU countries, as well as a lack of studies comparing RSCM in different countries. The distribution of papers by research methods indicates that most of the papers used quantitative or qualitative methods. This trend leads to belief that future studies need to focus on multi-methods approach as RSCM is an emerging topic. The share of conceptual papers (around 30%) indicates that RSCM is a research field in an infancy stage.

From the content analysis point of view, the analysis of the papers included in each of the three topic areas allows to consider different perspectives concerning RSCM research and to identify some relevant research gaps. It is well known that customer service is a fundamental component of logistics and SCM. One of the main characteristics of rural areas is the sparse population in very large (remote) areas. This poses inevitably the problem on how to provide a satisfactory level of customer service in rural areas that is reflected by a number of relevant implications on the management of logistics and the supply chain in those areas. This specific aspect appears under-researched in the extant literature. More specifically, there is the need to investigate more in depth the trade-off between customer service and logistics costs in rural areas. In fact, logistics in rural areas is often more costly due to the small-scale of manufacturers and the scattered settlement and production. The provision of a satisfactory customer service is then a challenge, which leads to higher logistics costs, particularly transport cost. Considering the above issues, the collaboration between logistics service providers in rural areas is necessary for co-distribution aimed at reducing the higher costs of logistics. Co-distribution in rural areas has been another issue that has not received a great attention in the current literature on RSCM. Managing logistics and SC in rural context requires specific knowledge and capability. Very few studies addressed this point. Besides, ICT and digitalization have been found to be an emerging topic in the field of RSCM. This is not surprising, as empirical studies suggest that Internet and ICT availability positively relate to production gains (Tu & Sui, 2011) and economic growth (van Gaasbeck, 2008). Most papers in this topic area have been published later than 2010. In these years, the internet 2.0 made available new forms of cooperation and communication via e-commerce. The relatively high share of papers dealing with e- commerce (15%) shows that e-commerce has high potential for customers as well as retailers in rural areas. E-commerce was related to new consumption patterns, more diversity and availability of products and services, as well as new ecosystems for retailers.

Finally, all papers lack a definition of RSCM. This may be considered as a further signal of the early stage in which the current literature on RSCM is. The lack of a RSCM definition might be the result of the lack of theoretical foundations in this area. From the analysis of the selected papers, it emerges a very limited use of theories and theoretical discussions, while most of the papers are based on empirical analyses.

Some future research avenues in RSCM

This paper provides an overview of research conducted on RSCM over the last 20 years. Three different topic areas have been identified that are all relevant for managing rural logistics and supply chain and that raise open questions for future research avenues.

The first topic area relates to rural retail and distribution. In this topic area, the research works analysed provide a fragmented picture about physical distribution, transport and retail strategies issues in rural areas. For example, it is not clear if the centralised or decentralised approach to physical distribution better fits the characteristics of rural areas. This will have relevant implication for the management of freight transport and retail strategies in those areas. Future research should also focus on the identification of a specific framework for analysing such issues in an integrated way. A further gap in the existing literature consists in the lack of papers dealing with the impact of RSCM on the environment. Logistics and SCM in rural areas have a relevant environmental impact due to the significance of transport in the life cycle of many rural products, including food products. In relation to digitalization and ICT, few technological-based solutions have been considered for managing logistics and supply chains in rural areas. Future research could focus on the design of successfully operating rural ecosystems, and on the adoption of the Internet of Things for managing shipments in rural areas and secure rural supply chains. Another key focus for further research should be the development of innovative business models that can help ensure economic viability in rural areas (i.e., integration of stakeholders through ICT and platforms). The third topic area deals with supply chain models and capabilities in rural areas. The existing papers assess the capability need in a generic way without

identifying the areas in which such capabilities are requested. Further research is needed to investigate more in-depth which kind of specific capabilities are necessary to support the development of an effective RSCM approach.

Finally, relevant dimensions can be identified to propose a definition of RSCM. This literature review identified three relevant topic areas. In fact, the rural retail and distribution area may be considered the physical dimension of RSCM. The digitalisation and ICT area may be considered the technological dimension of RSCM. The supply chain models and capabilities area provides insights into the operational and people dimension of RSCM.

According with the above three dimensions, the main focus of RSCM is on the design of specific supply chain models and management of physical and informational processes leveraging appropriate capabilities in order to secure and efficient and effective supply of rural population. Following this approach, it is essential for RSCM to design supply chain models based on retail and distribution systems and supported by ICT and digital technology and appropriate capabilities. The above three dimensions have some clear overlapping with the framework proposed by Prockl et al. (2018). The authors identified four main layers as foundation elements of a framework to study RSCM. The rural logistics layer involve the flows systems for delivering goods and services. The rural innovation layer consists in the definition of new business models and the selection of appropriate ICT and related technology. The rural policy layer incorporates institutions, regulations, governance and policies, while the rural community layer involves citizenship, consumer behaviour and community life.

On the basis of the above inputs, it is possible to propose the following definition of RSCM: *"Rural supply chain management is based on the design of specific supply chain models and involves the management of physical, information and financial flows between the point of origin and the point of consumptions in rural areas through interacting with the institutional and governance systems to meet the requirements of local communities".*

Beside the three dimensions identified in this paper, further research should investigate the two missing layers identified by Prockl et al. (2018) that are rural governance/policies and rural community.

Acknowledgements
The Bavarian Research Alliance via the BayIntAn Promoting Cooperation Program funded the workshop on RSCM held in Nürnberg (Germany) on December 2017. We highly appreciate this support.

References *(for the full list of references, please contact the authors)*

INCREASING THE USE OF INLAND WATERWAYS – EVALUATING APPROACHES FOR IDENTIFYING GOODS FLOWS FOR MODAL SHIFT

Vendeal Santén[1], Nick Riley[2], Sara Rogerson[1], Martin Svanberg[1] and Mahsa Zolfaghari[2]
[1]SSPA Sweden AB, Göteborg, Sweden
[2]University of Hull, Hull, UK

Introduction

Inland waterway transportation (IWT) is a more climate-friendly and energy efficient transport option compared to road transportation (European Commission, 2018). Politicians on both national and European level have raised the need for utilizing inland waterway transportation to a larger extent, in order to reduce environmental impact and revealing congestion from the roads. Such ambitions are visible in strategic plans, both nationally as well as on European level. Netherlands has the largest share of IWT within EU, where 18% of amount of goods are transported in inland waterways (CBS, 2016). This figure can be compared to only 0,7% in Sweden (Trafikanalys, 2016), and less than 0.1% in UK (Eurostat 2017), despite that there are inland waterways available for transportation, showing the potential for an increased use of IWT in these regions.

The political focus on developing IWT solutions are also evident in several large EU-funded projects within the area; recently finished Prominent-project, ongoing EMMA-project and recently started IWTS (Inland Waterway Transport Solutions) project. Prominent had a focus on innovations with regards to greening the IWT sector, while Emma and IWTS has a focus on increasing the modal shares of IWT within the Baltic and North sea regions respectively. In IWTS, case studies are included in the Swedish and UK geographical areas, which address the challenges of underutilized inland waterways in specific regional areas within Sweden and UK.

Previous studies on modal shift to IWT do point out barriers related to a number of areas, such as **regulatory**, e.g. piloting regulations in the Swedish setting (Garberg, 2016), **financial**, e.g. additional handling costs (Wiegmans and Konings, 2015), **service quality**, e.g. long transport time (Meers et al., 2017), and **market characteristics**, e.g. competitiveness in relation to other transport modes (Vierth et al. 2012). In particular, related to market characteristics, to find the critical volume of goods for modal shift is one key issue for starting up new logistics solutions on the inland waterways (Meers and Macharis, 2015; Garberg, 2016; Andrén and Lexius, 2017).

However, it is not obvious how to identify such critical volumes of goods. Meers and Macharis (2015) use the following parameters to identify the most suitable freight flows (locations or companies) for modal shift to intermodal transport services: container volumes currently transported by road, prices of unimodal road transport and intermodal alternative, time required for post-haul transport and type of goods transported. They also showed that short post haulage distance is important for intermodal transport to be competitive.

Based on that there are a number of aspects that are crucial to assess in order to identify goods for modal shift to IWT, there is no straight forward way to analyse these in one approach, rather a combination of approaches are needed. To map the current goods flow there are different approaches to use. Westin et al. (2016) report on three approaches for mapping goods flows; regional data collection through interviews and surveys, official statistics, and modelling approaches. Previous studies report on challenges in finding detailed goods flow data on regional and local level (Westin et al., 2016; Grönvall and Johnsson, 2017). In particular, Grönvall and Johnsson (2017) reports on lack in knowledge among actors of the goods flows on a regional level. This is also supported in the study by

Vectura (2012) and Andrén and Lexius (2017), stating that one reason is that the logistics set up is steered from a central function in the company and thereby there are difficulties in distinguishing volumes at a regional level.

Since there is a challenge in how to map goods flows, it is of interest to study alternative approaches for such analyses. The purpose of this paper is therefore to describe methodological approaches for identifying goods flows for modal shift and evaluate their application in the two cases of Sweden and UK, as part of the IWTS-project. The approaches are AIS-data analysis and software tools for analysis, visualization and simulation.

The approaches for goods flow analysis are evaluated in two cases. Each case consists of a geographical area where inland waterways are currently underutilized, 1) the Göta Älv river and lake Vänern in the south-western part of Sweden, and 2) the Aire & Calder Canal linking the Humber Estuary to the city of Leeds in the UK. The cases are described in the next session, followed by the approaches used for goods flow mapping in each case, in which results from the mapping exercise are exemplified and the value of such mapping are evaluated against aspects that are crucial to assess in order to identify goods for a modal shift to IWT.

Case descriptions

The Göta Älv river and lake Vänern

Göta Älv river, with a length of 93 km, has its mouth at the city of Gothenburg, located in the middle of the west coast in Sweden. The inlet is in the south of lake Vänern, the largest lake in Sweden, just at the city of Vänersborg. Göta Älv river and lake Vänern is under the Swedish Inland Waterway regulations, and categorized as zone 3 (wave height up to 0,6 m) and zone 1 (wave height up to 2,0 m). This means that it is possible to navigate with inland waterway vessels on both zone 1 and 3, although up to this date, such vessels do not operate in the area, only seagoing ships. No container vessels operate on the inland waterways, which also means container transportation on the river is rare, and previous studies have identified a potential for containerized goods to be transported on the IWW (Andersson et al., 2016). Today, all transshipment of containers in the port of Gothenburg is made between land based modes and ships, not ship to ship.

To sail the river means also passing six locks, setting prerequisites for the sizes of the vessels allowing for a maximum length of 87 m, width of 12,6 m and depth of 4,7 m. The type of goods transported on Göta Älv and Vänern today consist mainly of paper, wood and agricultural products (Andersson et al., 2016). In the area there are several large forest industries, which is the main sector for export goods. Import goods are of varying type.

Two logistics actors have ambitions of starting up container shipping on the inland waterways, 1) barge operations on Göta Älv River, from port of Gothenburg to Vänersborg, and 2) feeder from port of Gothenburg to Karlstad in the north of Vänern. For the logistics actors aiming for starting IWW operations, it is not an obvious task how to overcome challenges identified. Challenges in the Swedish context are reported in Rogerson et al. (2018), such as a high cost of inland waterway shipping, e.g. port charges has the largest share of the operational costs, fairway dues and piloting fees, also making a large contribution to the total cost picture, technical specification of ships, equipment at ports and available quays, e.g. for unloading and loading goods and in particular the volume available and service level (e.g. frequency and lead time) necessary for meeting goods owners requirements. Also, the transport solution for the first and last mile need to be in place. The Swedish case is a hinterland transport chain, meaning that the transport is between a sea port and hinterland and thus only haulage by truck at one end.

The Aire & Calder Canal

The UK Canal & River Trust is responsible for around 3300 km of inland waterways with a diversity of uses from leisure to commercial. Currently around 1 million tonnes of freight per annum are carried although this figure represents a significant decline from around 4.5 million tonnes in the early 1990's. Shifting freight transport from road to inland waterways is generally seen as environmentally desirable with benefits measurable in terms of reductions in CO_2 emissions, noise, traffic, pollution and accidents. However, in the UK significant challenges are presented due to the current state of the inland waterways infrastructure and the established freight routes. These challenges include a variety of canal widths, low bridges, ageing vessels, lack of or inappropriate trans-modal facilities as well as a low level of public perception of waterways potential.

Within the IWTS-project, we have chosen to focus, within the UK, on the Aire & Calder Navigation (shown black in Figure 1 below) as it connects the industrial conurbation of Leeds, Bradford and Wakefield through to the Humber Estuary, via Goole. Hence, the inland waterways in the area has the possibility of short-sea connections with mainland European ports including Rotterdam and Amsterdam.

Historically, the UK canal network developed to carry bulk products including coal, wool, steel and aggregates between specific locations. The residual freight carried today is still very much focused on bulk products although recent innovations have seen diverse goods including rice, steel, oil and fly ash being carried. There is also the possibility in general to carry abnormal loads which would be very challenging to carry by road.

In terms of vessel sizes, the Aire & Calder Navigation can currently accommodate vessels of length 61m with a beam of 6.1m and draught of 2.5m and headroom of 3.6m, carrying typically 600 tonnes. This is typically equivalent to 21 lorry loads. In the future, infrastructure changes could be made to accommodate Euro Class II barges which are slightly shorter but need an extra 0.5m in beam and an extra 0.1 to 1.1m in headroom.

The challenges associated with increasing the use of waterways transport include identification of appropriate goods flows and routes and increasing public understanding of the potential usage. Ideally both the source and destination of goods carried should have direct access to the inland waterway and many waterways were originally established in this way. However the decline in use of the waterways in the UK has seen many wharves and terminals disappear under modern development therefore road or rail segments often need to be included in the route, with consequent costs associated with transshipment.

The area around the Aire & Calder Navigation currently includes a wide diversity of manufacturing much of which could potentially be carried by inland waterways. Examples include building materials (glass, bricks, and roof tiles), steel, oil, chemicals, recycled waste products and biomass. In this project, we are identifying a number of potential demonstrator freight routes, assessing the relative costs and environmental benefits and finding ways to publicize these demonstrators.

Approaches used to identify goods flows for modal shift

In this section, a description as well as an evaluation of the applied approaches is made with regards to aspects that are crucial to assess in order to identify goods for a modal shift to IWT. The approaches are used to map the goods flow (the Swedish case), and the potential capacity for, and benefits of, a modal shift (the UK case). The approaches and learnings are described for each case below.

The Göta Älv river and lake Vänern

One first step to identify goods flows for modal shift is to understand current transportation pattern. In the Swedish case, challenges relate to what volumes exist to be shifted and what service level is required from the operation. Based on current existing shipping operations, lessons can be learnt, for example of: frequency required, which ports to call and vessel capacity available to have a service running in different segments.

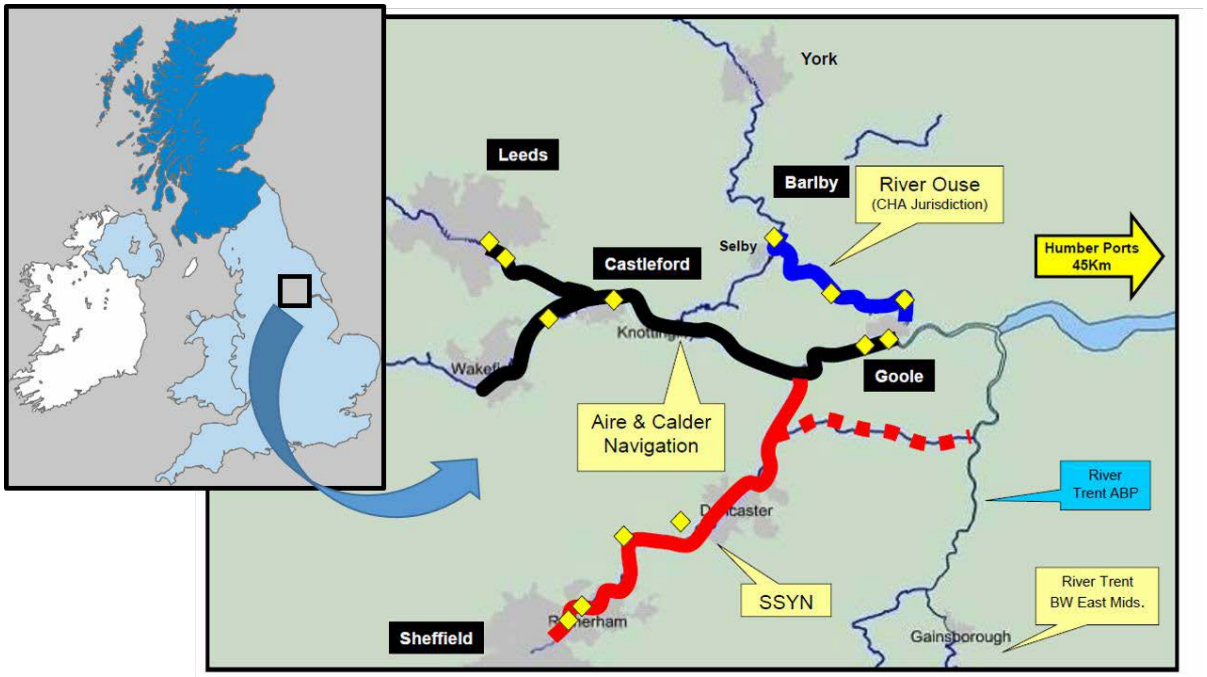


Figure 1: Location of Aire & Calder Canal showing connection with Humber Estuary

In shipping, data from AIS (automatic identification system) offers an interesting possibility to map traffic patterns on the inland waterways today. All ships above 300 GT are obliged to use AIS transponders and transmit messages with short intervals regarding static data (e.g. ship type) and dynamic data (speed, direction etc.). AIS-data has successfully been used by multiple other fields of maritime research, e.g. to measure emissions (Jalkanen et al., 2012), to develop methods to avoid collisions (Qu et al., 2011) or to optimize navigation through ice (Löptien and Axell, 2014). AIS has also been pointed out as a tool for developing traffic statistics (Vierth et al., 2012) and in Santén et al. (2017) Swedish coastal shipping was analysed.

The approach is to use AIS-data to map current traffic on the inland waterways Göta Älv and Vänern and identify traffic pattern in terms of which ports to call, frequency of operations, and types and sizes of vessels operating. This provides a foundation for characterizing traffic patterns and thereby identify how current shipping businesses are set up. AIS-data from the Swedish Maritime Administration 2016, stored at a local database at SSPA, is used in the analysis. For the analysis, software tools are used for the purpose of collecting traffic data for vessel routes operating on the inland waterways, and for visualizing the routes and distribution geographically. Software tools used for these purposes were PgAdmin (PostgreSQL Tool) and QGIS (Open Source Geographic Information system).

AIS-data analysis contributes to understanding current traffic pattern (during 2016) with regards to **port calls, vessel types and their capacity, links between ports and the network in which vessels operates**. The result show, e.g., the number of inland ports used for cargo vessels operating today and the number of port calls in each port, see Table 2, as well as number and type of vessels calling inland ports, see Figure 2. As evident from the figures, there are limited number of port calls in the area within 2016 (849) in which most vessels are general cargo vessels, and no container vesses. Further details about the traffic in terms of **lead time, frequency** and **time at berth** for each port makes it possible to distinguish the service level that are achieved for current goods flows. For a better understanding about the **reliability** of the service, number of disruptions in operation can be studied by analyzing lead time variations for each link. Links to other ports within Sweden, and the share of traffic calling international ports makes an understanding of how current goods flows utilize the IWT today as well as its network of ports. Figure 3, visualizes how the network of inland waterway ports are connected to ports around the Swedish coast.

Port	Number of departures
Lidköping	171
Vänersborg	148
Gruvön	105
Otterbäcken	96
Karlstad	89
Kristinehamn	82
Sture	68
Hönsäter	37
Skattkärr	16
LillaEdet	16
Nol	14
Skoghall	7
Otterbäcken	96
Total	**849**

Table 1: Ports and number of departures in the Swedish case

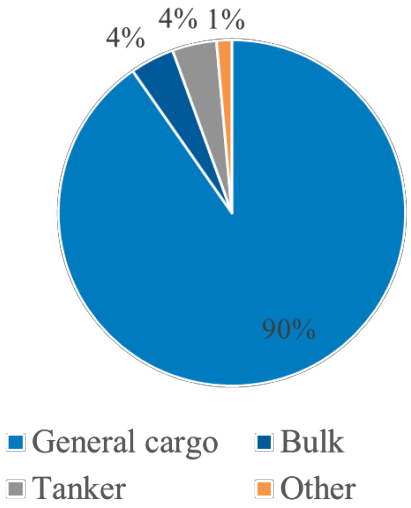


Figure 2: Number of departures per vessel type in Göta Älv river and lake Vänern

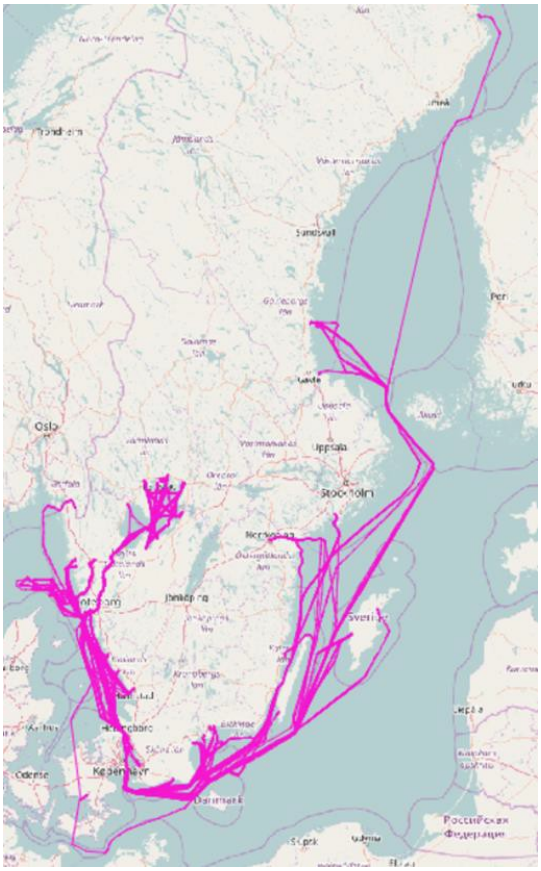


Figure 3: Visualisation of the connection between inland waterway ports and ports around the Swedish coast.

In order to provide a deeper understanding of the goods volumes for the operating conditions of IWW shipping, the AIS data analysis could be complemented with port statistics, and from these statistics volumes of unloaded and loaded goods at each port call could be studied.

The Aire & Calder Canal

In support of attempts to improve utilization of the canal for goods transportation, we have adopted two approaches. Firstly, to implement a number of software tools to allow comparison of available transport modes and routes in terms of appropriate indicators and secondly to adopt a coherent approach to identification of candidate goods flows.

Software Tools for Analysis, Visualization and Simulation

We have compared different software packages for visualization and analysis of the capacity of inland waterways. Suitable packages should be able to produce results including flowcharts and route summaries using high-level user interfaces (including terrain features, transport modes and requirements) whilst avoiding the need for extensive low-level programming code. As a result, two packages were identified: Arena (Simio) and R.3.5 (which is open source) and these used for subsequent analysis. Simio has good simulation capability as well as statistic analytics. We have used Simio to investigate by simulation the capacity of the new barges' including transhipment of goods and vessel traffic control. In the simulation we also include associated freight data flow and have investigated the use of various radio communications technologies (including RFID and LoRaWan to enable internet-based visibility of freight data, via a suitably security-protected Internet-of-Things (IoT) server (The Things Network, TTN).

Geospatial Module for Mapping Route Distance and CO_2 Emission

When attempting to predict the benefits of a potential modal shift from roads to Inland Waterways transport it is necessary to incorporate a geospatial module and database of CO_2 emissions for various engines and fuel types. This functionality is being programmed based on R-Studio software and a Shiny Application is created for easy interface and integration purpose. This geospatial mapping system is a module which can be used in navigation or logistics or similar location-based applications to get real time location, routes and distance and direction data. This data is then plotted onto a map to visualize a route and can be used for real time analytics, statistical analytics or geospatial plotting. The journey time is calculated from real coordinate points along the path. The route is determined by defining the start and destination points, allowing determination of route distance and emission to compare each route. After doing this it is possible to get data just by providing the origin location and destination location. This data is then processed and cleaned to do data analytics and statistical analytics on it. The data point would be plotted according to the route on the map.

A visual animation is provided allowing the user to open a Graphical User Interface (GUI) and specify the starting and end points of the route. When the user hovers their screen pointer over any point plotted along the route, the information including CO_2 emission, distance, speed and time of each journey at that particular point is displayed. There is possibility to add other information, if it is required.

Identification of new freight flows

Three steps to improvement of freight flow on inland waterways may be identified:

- Undertake survey of existing freight flows in the region;
- From above, identify those that have potential for modal shift;
- Identify potential new freight flows into or out of the region.

In support of the third point above we are undertaking an audit of all businesses whose premises are close to the waterways. For each business we identify the volume of goods to be moved, the transhipment potential and the resulting investment that would be needed to implement the modal shift. Figure 4 shows an example of the data extracted, for a short section of the River Hull.

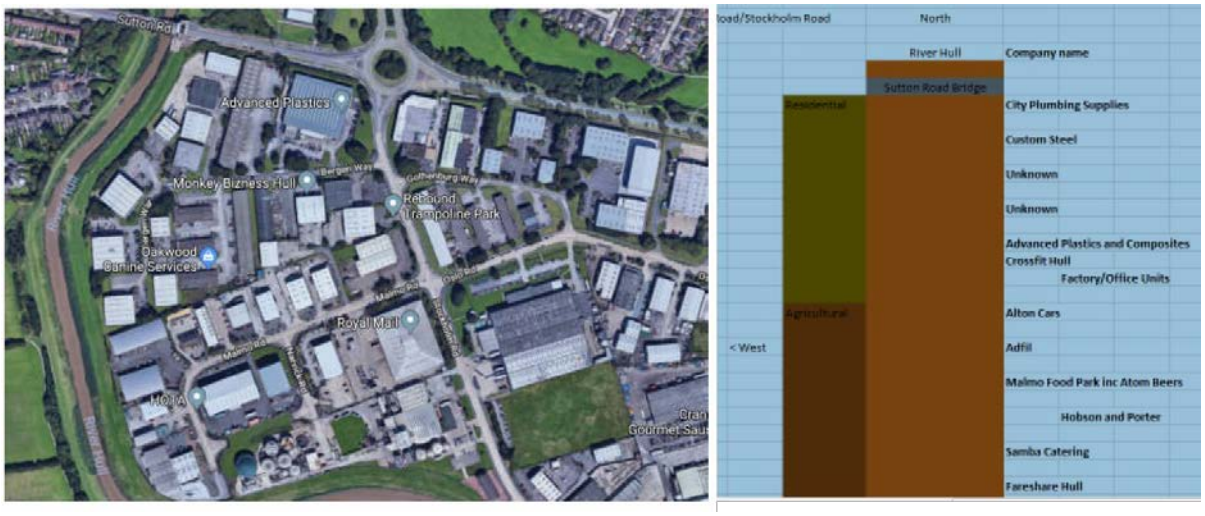


Figure 4: Example of business audit for potential modal shift to waterways

In the Aire & Calder region we have applied the methodology outlined in earlier sections and have identified candidate businesses for modal shift. The next stage is to analyse their transport requirements in further detail and to examine the real-world implications for modal shift. Several lessons have already be learned and many of these arise from detailed practicalities. For example, one company sold land that had access to the canal – this land is now covered in new houses. In another case a short-term successful use of the waterways concluded with scrapping the barges that had been used.

Conclusions

Use of inland waterways for transportation of goods in Sweden and in Great Britain significantly lags behind current best practice in Europe. We have presented experiences from applying approaches for identifying goods flows for modal shifts in two regions (in the UK and in Sweden), in each case providing examples of how the results contribute in the work towards increasing the usage of IWT.

As shown in the Swedish case, analysing AIS-data provides understanding about current traffic situation on the inland waterways related to service level required in today's shipping as well as the capacity available. Possible parameters to analyse are, for example, no. of port calls, vessel types and their capacity, links between ports as well as the network in which vessels operates. Additional analysis based on AIS-data provides information about lead time, frequency, reliability and time at berth for each port.

In the UK case, software tools incorporating a geospatial module and database of CO_2 emissions for various engines and fuel types are used to visualize and simulate potential benefits of using IWT in a plotted map. Mapped information are, for example, routing, distance, emissions, speed and time of each journey.

Alternative approaches include identifying companies with big goods flows and interviewing them about share of their goods flow with potential for shift to IWW transport; sending survey to companies in geographical areas near the IWW asking for their goods volumes; and survey or interview of forwarders. For information regarding price of transport, time of transport and type of goods, other data sources are needed.

Mapping goods flow to identify goods for a potential modal shift is a step in identifying measures which need to be implemented to improve utilisation of the waterways. In both cases significant work has to be undertaken in order to create any significant impact. Our current EU-sponsored (by Interreg North sea) IWTS-project offers the potential to start to effect such changes.

References

- Andersson, T., Malmquist, M., Johansson, J., Kåregård, A. *Ökade godsvolymer på Vänern.*
- Andrén, K. & Rexius, L.. (2017), Pilotprojekt GOTA – Rapport 1 - Genomförbarhetsstudie (Pilot Project GOTA - Report 1 – Feasability study), Seadvise, Göteborg, Sweden.
- CBS (2016), http://statline.cbs.nl/statweb/publication/?dm=slnl&pa=83101ned, Centraal Bureau voor de Statistiek, 2017-03-02
- European Commission (2018), Inland Waterways – What do we want to achieve?, https://ec.europa.eu/transport/modes/inland_en [Accessed 2018-07-01]
- Eurostat (2017), Your key to European Statistics, http://ec.europa.eu/eurostat/web/transport/data/main-tables
- Garberg, B. (2016), *Regeringsuppdrag: Analys av utvecklingspotentialen för inlands- och kustsjöfart i Sverige (Government investigation - Analysis of the potential for inland and coastal shipping in Sweden)*, Swedish Maritime Administration, Norrköping.
- Grönvall, E., Johnsson, P. *En kartläggning av godsflöde aktuellt för förflyttning från väg til sjö mellan Göteborg och Uddevalla.* Bachelor thesis. Chalmers.
- Jalkanen, J. P., Johansson, L., Kukkonen, J., Brink, A., Kalli, J. & Stipa, T. (2012), 'Extension of an assessment model of ship traffic exhaust emissions for particulate matter and carbon monoxide', *Atmospheric Chemistry and Physics*, Vol. 12, No. 5, pp. 2641-2659.
- Löptien, U. & Axell, L. (2014), 'Ice and AIS: ship speed data and sea ice forecasts in the Baltic Sea',
- *The Cryosphere*, Vol. 8, No. 6, pp. 2409-2418.
- Meers, D., & Macharis, C. (2015), 'Prioritization in modal shift: determining a region's most suitable freight flows', *European Transport Research Review*, Vol. 7, No. 3, pp 23.
- Meers, D., Macharis, C., Vermeiren, T. & van Lier, T. (2017), 'Modal choice preferences in shortdistance hinterland container transport', *Research in Transportation Business & Management*, Vol. 23, pp.46-53
- Qu, X., Meng, Q. & Suyi, L. (2011), 'Ship collision risk assessment for the Singapore Strait', *Accident Analysis and Prevention*, Vol. 43, No. 6, pp. 2030-2036
- Rogerson, S., Santén, V., Svanberg, M., Williamsson, J. & Woxenius, J. (2018), 'Modal shift to inland waterways: Dealing with barriers in two Swedish cases', *The Logistics Research Network (LRN) conference*, Plymouth, 5-7 September
- Santén, V., Svanberg, M., Rogerson, S., Andersson, A. *Kartläggning av svensk kustsjöfart genom AIS data.* SSPA. Report no. RR41157556-02-00-A.
- Trafikanalys (2016), Godstransporter i Sverige – en nulägesanalys, Rapport 2016:7
- Vierth, I., Mellin, A., Hylén, B., Karlsson, J., Karlsson, R. & Johansson, M. (2012), *Kartläggning av godstransporterna i Sverige (Survey of freight transport in Sweden),* VTI, Linköping.
- Wiegmans, B., & Konings, R. (2015), 'Intermodal Inland Waterway Transport: Modelling Conditions Influencing Its Cost Competitiveness', *The Asian Journal of Shipping and Logistics*, Vol. 31 No. 2, pp. 273-294.
- Westin, J. (2016), *Fördjupade godsflödesanalyser för Trafikverket region Nord och Mitt (In-depth goods flow analysis for Swedish Transport Administration region North and Middle),* CERUM rapport No. 44/2016, Umeå, Sweden.

DEFINING FREIGHT SHARING IN THE MODERN ECONOMY: PAST, CURRENT AND FUTURE

Robert Mason[1], Irina Harris[1] and Georgina Santos[2]
[1]Logistics and Operations Management, Cardiff Business School, Cardiff University, Cardiff, UK
[2]School of Geography and Planning, Cardiff University, Cardiff, UK

Introduction

Sharing in an economic sense is not new. It has been recognised in business for a long time. Today, the sharing of assets in the conduct of business is normal practice in many industries, such as in the office space, air transport or container liner shipping sectors, where co-working, alliances and consortia in various forms exist. In freight logistics too, the idea of sharing has long been considered part of the basic provision of logistics with the role of logistics providers being, in part, facilitating the 'bringing together' and 'jointly addressing' the logistics requirements of actors across supply chains, feeding in any derived gains to provide extra value for the supply chain actors they serve.

In recent years, the emergence of new digital capabilities and enhanced data access technologies, is leading to a resurgence of interest in the fresh possibilities that sharing can bring about. Usually facilitated by a host, acting as a linking information platform or hub, a new business model phenomenon built around the idea of sharing the use of assets is emerging in many sectors and markets. These peer-to-peer rental marketplaces tap into the potential of extending the use of assets already owned by people, or organisations, through what is known as 'The Sharing Economy'.

The beauty of these businesses is that the facilitator does not have to 'own' assets themselves: they merely provide the link between those seeking use of capacity or of redundant capacity in the assets they own and those that want to use this capacity. Thus, we are witnessing the emergence of an expanding set of "peer economy" (Fraiberger and Sundarajan, 2016) examples in many industries and geographies. However, there are concerns emerging from the freight sharing idea, such as nature of work involved.

Sharing Economy and Emerging Business Models

The concept of having temporary access to goods or services, rather than a permanent one, is becoming more accepted (Matzler et al. 2015), as sharing is seen by many as being:

- More accessible, as the cost of searching and conducting transactions has reduced due to developments in technology;
- More attractive, as it is able to provide efficiencies and deliver the extra convenience customers increasingly demand; and,
- Better for the planet, as assets are utilised more intensively.

It is promoted as a fast-growing area that is leading to companies re-imagining how they operate, especially how they better utilise previously under-utilised assets. Many argue that its emergence represents "a paradigm shift" from the traditional way of conducting commerce (e.g. Gesing, 2017). However, 'The Sharing Economy' is not a new theoretical concept. The core idea of "collaborative consumption" was first proposed by Felson and Spaeth (1978) on the basis of the willingness of people, especially in families or neighbourhoods, to help by sharing items with each other in order to exchange non-material form goods. Today, the 'Sharing Economy' idea goes by many names: as well as Collaborative Consumption it is known as the Peer-Peer Economy, On-Demand, the Gig Economy, Access over Ownership. However, what exactly is "The Sharing Economy"?

Shared mobility can be said to be a loose concept, which includes a number of emerging new business models. The two features common to all of these new services is that there is an element of sharing

an asset (in logistics, a vehicle for instance) instead of owning it and that they rely on technology (apps and the Internet). Santos (2017) in a paper exploring shared mobility, notably in public transport (not freight per se), has identified four main models:

Model 1: This is a peer to peer platform where individuals can rent the assets they own (such as vehicles etc.) when not required by themselves. This allows the customer to temporarily use redundant asset. Santos (2017) envisages the providers are not companies but consumers allowing other people to use their vehicles, but in essence the same principle could apply to companies when freight mobility is concerned. She cites an analogous case of this Model as Airbnb, where people can rent a flat or house or even a room in a town or city for a short period instead of booking themselves in a hotel or B&B. Examples she provides also include Turo (https://turo.com/), easyCar club (https://carclub.easycar.com/), hiyacar (https://www.hiyacar.co.uk/), where peer providers and users can be linked, sometimes through an online platform.

Model 2: This is often a club-based system where short-term rental of vehicles are managed and owned by a provider. This provider owns a number of vehicles, which can be accessed by users from various points in any given area, often urban settings. Once accessed, with a user can drive to another dedicated parking spot close to their destination, leaving the car so that it is available for the next customer and so on. Supported by an app, with unlocking and locking being undertaken via smart-phone or smartcard a membership fee therefore gives club members access to car mobility when and where they need it. Santos (2017) cites examples including Autolib (https://www.autolib.eu/en/), Car2Go (https://www.car2go.com), Zipcar (https://www.zipcar.co.uk/), Getaround (https://www.getaround.com/).

Model 3: This is where peer-to-peer sharing occurs with an extra company linking them together and acting as a broker. These linking companies own no cars themselves, so are not burdened by asset ownership, but sign car owners who act as drivers for the customer. So in effect this Model provides not just an asset for use but also a service as well such as the driver to use the asset to drive the customer to their destination of choice – a taxi service! The service also relies on an app. Examples include Lyft (https://www.lyft.com/), Uber (https://www.uber.com/en-GB/).

Model 4: This is a form of what has become to be known as 'piggy-backing'. In effect it is when 'on demand' transport vehicles make spare space available to other passengers who are going in the same direction to share. It is, in effect, an extension of public transport in a more user-oriented form. Santos (2017) notes, "users can dial-a-ride specifying pick-up and drop-off locations and required departure and/or arrival times", and cites examples which include, Via (https://ridewithvia.com), Chariot (https://www.chariot.com/), UberPool (https://www.uber.com/en-GB/ride/uberpool/), LyftLine (https://www.lyft.com/line).

Later in the paper we will attempt to map the freight sharing examples we have identified in our research to these Models, which in essence can be seen as a spectrum of sharing possibilities. This spectrum ranges from tapping into an asset (Model 4), to club-based access to an asset (Model 2), to temporary access to an asset combined with an associated service (Model 3), to temporary ownership of an asset (Model 1).

Beyond this, the reality is that the landscape of this emerging Sharing Economy concept is complex with a great diversity of exponent players, especially in relation to freight. To unravel some of the complexity Cohen (2016) has drawn up a "Sharing Business Model Compass" which exposes many of the alternative dimensions that are being adopted. Dimensions include whether transactions are free or market based, who is the sharing between, what is the governance model etc.? Examples of peer-to-peer companies can be mapped onto this compass to get a fuller understanding of how different they all are.

Authors take a broad interpretation of what Freight Sharing is, which allows us to include many notable B2B developments in horizontal coordination of logistics that have emerged over the last twenty years or so as well as the newer, much talked about, "Sharing Economy" ideas, which have especially built up around the thinking that the public can become more involved in better utilising idle or redundant assets. Building on this thinking our definition of freight sharing is:

"Freight services provision performed by actors working together at the same level in the supply chain, often facilitated by an intermediary digital platform player that provides added values for all participating entities".

To facilitate many Sharing Economy Business Models, a platform is usually created through which the necessary facilitating connections with the User and Service Provider can be channelled (Figure 1).

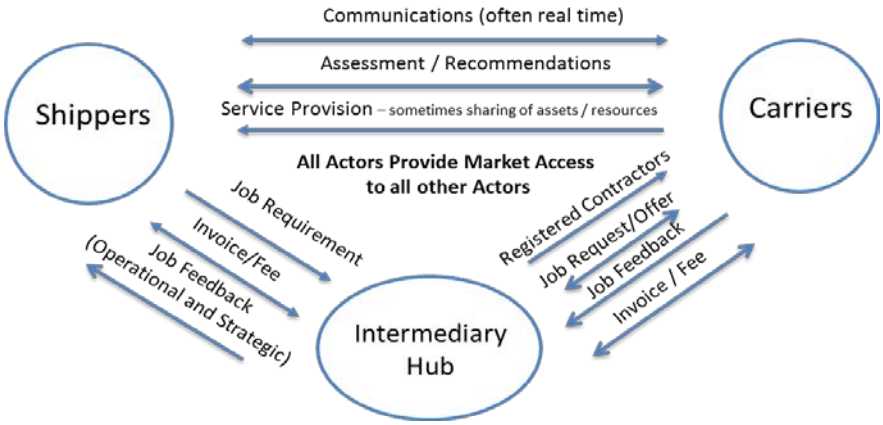


Figure 1: An example of the Sharing Economy Business Model

It should be emphasized that while businesses are increasingly appreciating the benefits from sharing it needs to be carefully handled so that it does not fall foul of competition law. Horizontal cooperation agreements between companies are carefully regulated, as it is viewed that the opposite of cooperation, competition, "encourages companies to offer consumers goods and services at the most favourable terms" (EU 2018). "Competition encourages efficiency and innovation and reduces prices but to be effective, competition requires companies to act independently of each other, but subject to the competitive pressure exerted by the others" (ibid).

Examples of physical logistics freight sharing initiatives in the context of sharing

It would be logical to categorise physical logistics freight sharing initiatives based on the core logistics activities of Freight Transport: 'Last-Mile', Warehousing and Data Sharing (Table 1). The specific area of activity defines most initiatives, although it should be noted that some are applicable to more than one activity area.

	Freight Transport	Last-Mile	Warehouse
Main Challenges Currently Facing Activity Area	***Small, frequent shipments; Delivery reliability; Higher utilisation; Cost control***	***Small, frequent shipments, incl. batch size 1; Higher schedule reliability; Short lead times; Real-time communication; Omni-channel integration;***	***Demand fluctuations Using capacity intensively and consistently; Lower inventory levels; Cost control***
Examples of Sharing	Consolidation Centres	Urban Consolidation centres	1 to 1 sharing
	4PLs / Lead Logistics Providers	CrowdShipping Last Mile Delivery	Multi-user sharing
	Pallet Networks Spare capacity filling	Piggy-backing Shipments	Flex warehouses
	Agricultural Cooperatives	Horizontal Collaboration	On-demand warehouse
	Joint-venture collaboration	Other Innovative Last Mile Freight Sharing Ideas e.g. drop-off lockers	Self-Storage
	Reducing Wasted Miles		
	Spare Truck Capacity Filling		
	Synchromodality		

Table 1: Summary of Physical Logistics Freight Sharing Initiatives

Sharing freight transport initiatives

Consolidation Centres: A challenge logistics providers have had to face up to has been the requirement to move to smaller volume/more frequent orders, as players have 'leaned' up their supply chain operations, reducing inventory levels. With the prospect of running light-loaded vehicles due to these smaller shipment volumes, logistics providers have had to create solutions to meet the service levels required, whilst still ensuring low costs of transport. One answer has been to introduce consolidation centres so that less-than-truck-load supplies can be consolidated early in their journey, allowing for what is termed the 'trunk leg' to be performed as a full vehicle. Sharing allows for these consolidation centres to be mutually owned and operated.

4PL – Lead Logistics Providers – facilitating freight sharing: 4PLs are asset light players who take on the responsibility for logistics whilst not actually carrying out any of the physical logistics duties themselves. In its original form, the concept envisaged that the lead logistics provider would integrate the actors along the vertical supply chain through a Control Tower (not horizontal sharing at all). However, many logistics companies who became involved with this idea restricted it to one activity, such as transport, and looked to optimise activities across parallel supply chains (horizontal optimisation). Advanced information systems meant that this once theoretical idea is now a model of logistics that is quite commonly employed. An example of an industry in the UK where this was introduced over a decade ago and has been sustained since is the steel sector. In 2006 TDG (since been taken over by first Norbert Dentressangle, who in turn were bought up by XPO Logistics) became one of the pioneer 4PLs in making the concept work for Corus (since acquired by Tata Steel). The idea still exists where the 'KeyPL' links many LSPs to move steel (Hobson, 2013 and XPO, 2018).

Pallet Networks: Another successful freight sharing answer to the need to transport frequent, small shipments between businesses, a feature of today's leaner supply chains, has been the Pallet Network. The Pallet Network concept developed in the UK particularly from the mid-1990s onwards, and is still expanding today: in the first 9 months of 2017 full pallets on the Network grew by 6.3% to 19 million and half pallets by 8% to 5.4 million shipped according to the Association of Pallet Networks (Millet, 2017). It comprises of a hub facilitator, who brings together regional haulage partners to be able to offer, often next day, pick-up and delivery of goods by pallet services across the UK. A sophisticated IT

system links up all partners through the hub platform run by the pallet network provider. The Association of Pallet Networks claim that their operations contribute to reducing the number of road vehicles on the road a day by 800, and achieve average vehicle fill rates of 73% (compared to a UK average of 51%), thus substantially reducing congestion, boosting UK productivity and contributing to environmental goals as well (APN, 2018).

Joint-Venture Collaboration: Another form of horizontal partnership in logistics transport is where a joint venture is formed among logistics service providers. A leading example over the last decade or so where medium sized logistics providers in the UK have formed a joint venture to compete with the larger players in terms of bidding for national contracts is Jigsaw, set up in 2002. Jigsaw today has evolved into a 4PL consortium of 11 hauliers and is owned by its largest partner C M Downton. It bids for and wins National contracts, which the regional logistics providers would otherwise be unable to compete for, but by pooling their capabilities they are able to offer a comprehensive yet flexible UK freight transport solution. The shared user traffic efficiencies allow for transport assets to be deployed by regional hauliers on other work when not required for Jigsaw (Hobson, 2017).

Reducing Wasted Miles: Examples of 'one to one' sharing comes from the sharing of trucks and facilities, the sharing of data and systems, and back/front haul sharing that have been used to drive down "wasted miles" in the grocery sector over the last decade or so. Facilitated by the IGD (Institute of Grocery Distribution) on behalf of ECR (Efficient Consumer Response) since 2008, the strategy has resulted in the catalysing of numerous partnerships to share logistics services. This has involved link ups with various retailers, suppliers and logistics service providers, sometimes even between competitors, for example, ASDA, Nestle, Mars, United Biscuits, Tesco, Kimberley Clark and Kellogg's. In 2008 alone they announced this had generated a forecast saving of 900 fewer lorries on the UK Roads, resulting in 53m fewer road miles, 26m less litres fuel used and a £30m cost reduction. One of the key issues was to deal with how improvements were allocated. A gain share mechanism based on the gain from sharing vehicles allocated to partner according to their share of the volume was presented from the experience of Nestle and PepsiCo's shared loads collaboration (ECR UK, 2007). The IGD/ECR's vision in terms of the destination for the grocery sector to evolve from this basis of sharing trucks and facilities, to evolve through shared data and systems ultimately to collaborative network optimisation. To achieve this one of the keys they highlight is compatibility, network management/freight exchanges and smart scheduling based on live updates (Smilie, 2015).

Spare Truck Capacity Filling: The potential to use sharing to reduce partly-filled vehicles and/or to reduce the empty running of trucks is one of the real prizes that many seek. In reality this quest is easier to propose than achieve. A leading technology company supporting the UK road freight sector trialled a marketplace hub for matching requirements for haulage work with spare capacity with the Road Haulage Association for a number of years. They concluded it did not work as what was always left were either jobs that no one wanted or that were priced too low. It was also argued that many activities in logistics actually relied on a relationship of trust between the logistics provider and their customer and often included a certain degree of uniqueness so that a commoditised sharing notion, although on the surface, an attractive option, in reality was difficult to achieve. In the UK a new project backed by Innovate UK, 'FreightShareLab', is aiming to reduce this empty running and improve partly loaded vehicle percentages. They are developing an open data software platform to coordinate the sharing of assets. In a similar way, Clear Chain is looking to use software as a strategic planning tool, integrating job and vehicle data from shippers, fleets and carriers (Cork, 2017).

Sharing last-mile initiatives

Urban Consolidation Centres of deliveries is one strategy that changes the network infrastructure, aims to address last mile logistics challenges and links up traditional with new sharing models. Urban consolidation centres (UCCs), can serve as a decoupling point in the logistics process receiving trunk leg flows and preparing goods for the 'last mile' delivery. Allen et al. (2014) reviewed six UCC schemes and found that UCCs can lead to reduction of environmental impact in relation to deliveries.

Horizontal Collaboration covers the, "voluntarily initiated, long term relationships among autonomous logistics service providers that operate on the same stage of the supply chain as close or distant competitors and that strive for benefits that could not be achieved by individual companies alone" (Schmoltzi and Wallenburg, 2011). It is a well-established working practice in air and sea based logistics, but is not, as yet, common in road freight logistics (Cruijssen et al., 2007). Internal firm barriers such as a concern over sharing data can inhibit collaborative distribution efforts (ECR, 2007 and Hingley et al., 2011). Sanchez-Rodrigues et al. (2015) found that synergies between prospective partners are often vital to make it successful.

CrowdShipping Logistics: It works in the following way– a sender has a package to be delivered which is held at a distribution hub, potentially a UCC. It passes the details of the package to a platform who 'crowdsources' it to a group of approved local distributors (drivers who are not employed by the platform company). One distributor is selected (this may be by price – but can also be influenced by the nature of the package/geography of delivery and/or distributor's service rating). The nature of shippers tends to fall into three categories:

1. "The subcontractors of mainstream brands such as Allied Express, Startruck, DHL (who at best earn 30% of the delivery job costs – but often its far less than that).
2. Professional drivers employed by courier companies who have downtime spare between jobs, empty space in their vans and idle return trips after a drop off.
3. University students, retirees or freelancers" (Botsman, 2014).

Piggy-backing on Journeys: The idea of moving freight via people who are on a journey anyway is an idea that is at the heart of some of these urban last mile delivery solutions, but can also be applied to longer journeys too. An example of this concept is 'Living Packets'. It is another crowdsourcing start up serving customers who require packet delivery between London and Paris. The delivery model operates through travellers – in less than four hours customers can get door to door delivery at a price considerable cheaper than express companies (Livingpackets, 2018). In essence they are turning journeys to work into delivery opportunities.

Drop-Shipping: Drop-shipping is an idea built around conceiving a 'better' way to arrange for fulfilment of customer orders. In this case the 'store' selling the product does not actually keep the products it retails. Instead, the store accesses the ordered product directly from a third party stockist and then arranges for the logistics to deliver the ordered item directly to the consumer (Shopify, 2018). There are many advantages notably around the low capital outlay involved, as no inventory, nor storing capability, is required. There are disadvantages too as obviously margins are low and it is potentially quite a complex operation to handle. It is a form of freight sharing for warehousing inventory in the same way facilitators such as Uber are providing freight sharing for transport.

Sharing warehouse initiatives

The evolution of logistics industry from a centralised to a more decentralised model, means that a potential strategic network of warehouses located closer to the market is available for sharing. There are numerous examples of 1 to 1 and multi-customer space sharing. The traditional multi-customer warehouse is usually managed by 3PLs with the aim of achieving economies of scale. Dedicated operations in one location, can be generally described as inflexible in terms of time and fixed allocation of space (Gesing, 2017). A multi-user facility provides flexibility in space allocation enabling 'truly shared' warehousing (Gesing, 2017). Rental space can be in pallets or other standardised module designs. The digital sharing platform allows utilisation of the vacant warehousing space where mixing diverse sectors with different seasonality peaks supports flexibility (e.g. construction slower in the winter; whereas retail is booming). Flexibility can be achieved by independent logistics companies (e.g. 3PLs) where they can offer bespoke software packages and customised terms to suit client's requirements as illustrated by C.M. Downton Ltd (Downton Deliveries, 2018, Wincanton, 2018). At Downton's the company operates 1.2 million square feet of state-of the-art warehouse facilities strategically located across UK, with majority facilities owned by the company giving them greater

flexibility. At Wincanton, 30 strategically located shared-user warehouses are operated across the UK. Available on a pay-as-you-go basis with a minimum store of 1,500 pallets, all are supported by a warehouse management system that can be tailored to each client. Online warehouse marketplaces (also known as "AirBnB of warehousing", "AirBnB for logistics"', "on-demand warehouse"), such as Flexe can offer sellers next-day delivery options and includes 750 warehouses in over 45 markets across North America (Flexe, 2018). The cloud-based platform connects appropriate warehouse operators with extra space, manages inventory data, and schedules inbound and outbound deliveries with real time alerts and analytics. The implications for participating warehouse operators are to be able to accommodate new customers on short-term arrangements without disrupting their own operations (Bloomberg News, 2017).

Mapping Freight Sharing Examples onto a Sharing Spectrum

Earlier in the paper we set out the Four Models of sharing as envisaged by Santos (2017), in her exploration of sharing in public mobility. We transposed these into a spectrum of four sharing types: tapping into an asset, club-based access to an asset, temporary access to an asset combined with an associated service, and temporary ownership of an asset. In Table 2 we have attributed each of the freight sharing examples above to this spectrum in order to understand a little more theoretically the range of Models that can be envisaged in freight sharing. Interestingly, although some fall neatly into the spectrum categories, others span two or even more of the categories.

Spectrum of Freight Sharing Types			
Tapping into an asset	**Club-based access to an asset**	**Temporary access to an asset combined with an associated service**	**Temporary ownership of an asset**
Piggy-backing	Pallet networks	Inbound Consolidation Centres	
Spare Truck Capacity Fill	Drop-Shipping	Urban Consolidation Centres	
		Crowd Shipping	
		Multi-user warehouses	
Reducing Wasted Miles			Reducing Wasted Miles
		Flexible Warehouses	

Table 2: Spectrum of Freight Sharing Categories with Freight Sharing Examples Mapped on.

Conclusions

There is a view that the logistics industry has been living in the past both technologically and from a mind-set perspective (Winchmann, 2017), but this paper has provided evidence that in the area of Freight Sharing, often driven by technology developments, there is a great deal of innovation (see also IFSTTAR, 2018). We have divided our exploration around three areas of logistics: transport, warehousing and last mile. In the transport and warehousing aspects of logistics, freight sharing practice has been a defining feature of logistics for many years now. In the last mile and data sharing, new forms of sharing are emerging and there are also new forms of sharing in transport and warehousing as well. Combined, this is leading to many possibilities in logistics practice that have implications for the economy, environment and society that needs to be reflected by legislators. By mapping the range of Freight Sharing examples onto a spectrum of Sharing previously drawn from investigations of sharing mobility in the public transport sector fresh insight into how Freight Sharing can be envisaged has been provided which could for the basis of future research in the field.

References

- Allen J., Browne M., Woodburn A., Leonardi J. (2014), 'A review of urban consolidation centres in the supply chain based on a case study approach', *Supply Chain Forum: An International Journal*, Vol. 15 (4): 100-112.
- APN (2018), 'Association of Pallet Networks – Benefits of Using Pallet Network', Available from: https://www.theapn.co.uk/ accessed on 29th January 2018.
- Bloomberg News (2017), 'A warehouse marketplace offers e‑retailers an Amazon alternative', Available from 'Internet Retailer': https://www.digitalcommerce360.com/2017/05/11/a-warehouse-marketplace-offers-e-retailers-an-amazon-alternative accessed on 30th January 2018.
- Botsman, R. (2014), 'Crowdshipping: Using the Crowd to Transform Delivery', Australian Financial Review, 12 Sept 2014. Available at: http://www.afr.com/it-pro/crowdshipping-using-the-crowd-to-transform-delivery-20140911-jyk63 accessed on 12th November 2017.
- Cohen, B. (2016), 'Making Sense of the Many Business Models in the Sharing Economy', Available at: https://www.fastcompany.com/3058203/making-sense-of-the-many-business-models-in-the-sharing-econ omy accessed on 22nd January 2018.
- Cork, L. (2017), 'FreightShareLab Project Aims to Eradicate Empty Runs', Transport Engineer Available at: http://www.transportengineer.org.uk/transport-engineer-news/freightsharelab-project-aims-to-eradicate-empty-runs/166049/ Accessed on 20th January 2018.
- Cruijssen, F., Cools, M. and Dullaert, W. (2007), 'Horizontal Cooperation in Logistics: Opportunities and Impediments', *Transportation Part E,* Vol. 43, pp.129-142.
- DHL My Ways (2018), 'MyWays - deliveries throughout Stockholm by involving the city's residents', Available at: https://www.youtube.com/watch?v=EO7G3ZjTaWM accessed on 18th January 2018.
- Downton Deliveries (2018), 'Service: Warehousing', Available at: http://www.downton.co.uk/services/warehousing accessed on 5th February 2018.
- ECR UK (2007), 'ECR UK Collaborative Green Distribution', IGD: Watford, Herts.
- EU (2018), 'Competition: Anti-Trust Overview', Available at: http://ec.europa.eu/competition/antitrust/ove rview_en.html accessed on 21st January, 2018.
- Felson, M. and Spaeth, J. L. (1978), 'Community Structure and Collaborative Consumption: A Routine Activity Approach', *American Behavioural Scientist*, Vol. 21(4), pp. 614-624.
- Flexe (2018), Homepage. Available at https://www.flexe.com accessed on 18th January 2018.
- Fraiberger, S. P. and Sundararajan, A. (2016). Peer-to-Peer Rental markets in the Sharing Economy. NYU Stern School of Business Research Paper. Available at: http://www.hbs.edu/faculty/conferences/2016-dids/Documents/Fraigerber_Sundararajan_March2016.pdf accessed 15th January, 2018
- Gesing, B. (2017), 'Sharing Economy Logistics: rethinking logistics with access over ownership', *DHL Customer Solutions & Innovation.*
- Hingley, M., Lindgreen, A., Grant, D. and Kane C. (2011), 'Using fourth-party logistics management to improve horizontal collaboration among grocery retailers', *Supply Chain Management: An International Journal*, Vol. 16 (5), pp. 316-327.
- Hobson, S. (2017), 'Interview: Andy Humpherson, MD, Jigsaw - 'Putting the Pieces Together'', Motor Transport, 3rd November 2017. Available at: https://motortransport.co.uk/blog/2017/11/03/putting-pieces-together/ accessed on 3rd May 2018
- IFSTTAR (2018), 'New Trends Impacting Urban Logistics: an Observatory', Available at: http://www.citylab-project.eu/brochure/D2_1_brochure.pdf accessed on 23rd May 2018
- Livingpackets (2018), Available at: Living Packets.com, accessed on 20th March 2018
- Matzler, K. Veider, V. and Kathan, W. (2015), 'Adapting to the Sharing Economy', MIT Sloan Management Review, Vol. 56(2), pp.71-80.
- Millet, C. (2017), 'Pallet Network Volumes Surge as Sector Takes Share of the Parcels Market', *Motor Transport*, 3rd November 2017.
- Sanchez Rodrigues, V., Harris, I. and Mason, R. (2015), 'Horizontal Logistics Collaboration for Enhanced Supply Chain Performance: an International Retail Perspective', *SCM: An International Journal*, Vol. 20 (6), pp. 631-547.

- Santos, G. (2017), 'Incentives to Encourage Shared Mobility', *CERRE Mobility Workshop*, Brussels, 9 November 2017.
- Schmoltzi, C. and Wallenburg, C.M. (2011), 'Horizontal Cooperations between Logistics Service Providers: Motives, Structure, Performance', *International Journal of Physical Distribution & Logistics Management*, Vol. 41 (6), pp.552-575.
- Shopify (2018), 'Understanding Dropshipping', Available at: https://www.shopify.co.uk/guides/dropshipping/understanding-dropshipping?rodeo_token=da57d1f6-13D4-4C8A-DFD3-C6D0DCC1F212 accessed on 5th February 2018.
- Smilie, D. (2015). Reducing Wasted Miles. Your Road map to Success in a New World: Part 1 The Destination. Available at: http://IGD.com/ReducingWastedMiles accessed on 10th January 2016.
- Winchmann, J. (2017), 'The Most Promising Start ups in Logistics', *CultBizzTech*. Available at: http://cultbizztech.com/most-promising-start-ups-in-logistics/ Accessed on 19th January.
- Wincanton (2018), 'Shared User', Available at: https://www.wincanton.co.uk/propositions/warehouse-solutions/shared-user/ accessed on 29th January, 2018.
- XPO (2018), 'A Key PL Solution that Covers the Entire Order-Cash Process, XPO Logistics: A Tata Steel Case Study', Available at: https://uk.xpo.com/en/case_studies/tata-steel-case-study accessed on 29th January 2018.

A COMPARISON OF THE NIGERIAN OIL AND GAS SUPPLY CHAINS WITH THE UK: TAKING A SUSTAINABILITY PERSPECTIVE

Olatunde Olajide, Dong-Wook Kwak and Qile He
Centre for Business in Society, Coventry University, UK

Introduction

For the past three decades, the issue of sustainability has occupied a pivotal role both in the academic and industry. At the corporate level, organizations are moving beyond mere financial performance, to peg their survival on environmental and social performances, which have been conceptualized as the integral part of the triple bottom-line for achieving corporate sustainability (Elkington 1998). Among others, organisations foster sustainability at the supply chain level by infusing sustainability initiatives into their supply chain management (SCM) strategies. This is because SCM has been identified as a critical basis for enhancing organisational competitiveness through effective collaboration with stakeholders to reduce cost and deliver superior customer value. To this end, the infusion of sustainability strategies into SCM has birthed the emergence of the concept of sustainable supply chain management (SSCM) as a way of enhancing organisations' ability to drive their sustainability objectives.

In consideration of the importance and the risk of the Oil and Gas (O&G) industry to human life, the environment and the society, there is no gainsaying that issue of sustainability must not be taken with levity in the industry. Indeed, the negative impacts of accidents and incidents that occurred (and still occurring) in the industry such as Piper Alpha oil spills of 1988 in the North Sea and consistent conflicts between the oil companies and the host communities in the Niger-Delta area of Nigeria, is an attestation to the above. Surprisingly, the extant literature revealed a dearth of research on sustainability issues in the supply chain of the O&G industry, especially in an important O&G producing nation like Nigeria. Although the global O&G industry is generally prone to sustainability risks, studies have suggested that adoption of sustainability measures is popular across the supply chain of the UK O&G industry, with same having a positive linkage with organisational performance (Yusuf et al. 2013).

In view of the postulation that sustainability initiatives can differ across supply chain echelons and geographic locations (Meckenstock et al. 2015; Tate et al. 2010), this study seeks to compare the sustainability initiatives in the supply chain of the UK and Nigerian O&G industry, with a view to making recommendations for the Nigerian O&G industry, based on the working initiatives adopted in the UK O&G industry. Specifically, this paper purports to provide answer to a singular overarching research question which is: 'What are the major differences in the SSCM initiatives adopted in the UK and Nigerian O&G industry?' To put this paper in proper perspective, the remaining parts of this paper is arranged into various sections which are literature review, methodology, SSCM strategies in the UK O&G industry, SSCM strategies in the Nigerian O&G industry, a comparison of SSCM strategies in the UK and Nigerian O&G industry, and conclusion and recommendations.

Literature review

The supply chain of the O&G industry is an integral part of the global supply chain. However, one of its major peculiarities is that most of its activities are highly engineering intensive, carried out in extremely environmental sensitive areas. Logistically, it involves developing and transporting highly inflammable and toxic products across countries, through various modes like barge, ships, rails, pipelines and trucks. The O&G supply chain is inbuilt with extreme complexities and dynamism with far reaching implications on the environment, health and safety. From the extant literature, scholars appear to differ on the depiction of a typical O&G supply chain. Whereas some studies adumbrate the O&G supply chain as a two-sector construct, made-up of the upstream and downstream sectors (Ahmad et al. 2016), others categorize it into a three-sector structure, consisting of the upstream, midstream and the downstream sectors (Modarress et al. 2016). Following the view of Zhao and Chen (2014) that a clear description of an O&G supply chain is necessary for an effective implementation of any supply chain

concept (strategies), Figure 1 below depicts the Nigerian O&G supply chain based on the functions and activities of the Nigerian National Petroleum Corporation (NNPC).

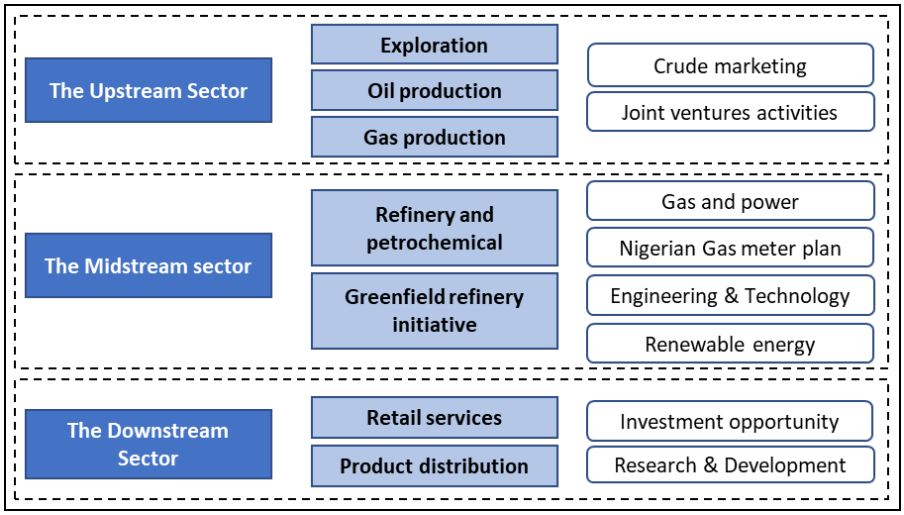


Figure 1. Nigerian O&G Supply Chain

Irrespective of the structure of the O&G supply chain adopted by authors, one point of agreement is that the entire supply chain of the industry constitutes a risk of catastrophic health, safety, economic and environmental hazards to the society. practitioners have always adopted measures to forestall the occurrences/reoccurrences of environmental, health and safety hazards in the O&G industry. However, these measures appear to be more reactive than proactive. For example, studies have suggested that new and stricter regulations, sophisticated risks measures and protective barriers are quickly adopted only after a major accident had occurred in the industry (Mendes et al. 2014). To this end, the industry has been a subject of criticism regarding its sustainability practices. Interestingly, instead of strengthening the O&G supply chain to withstand turbulence from inception, Mohammad (2008) observes that supply chain activities in the O&G industry were initially treated as a 'soft issue' by the practitioners until they realized that more than 80% of their expenses were 'burnt' on supply chain related activities. This observation is not any different in the academics where a dearth of research on SSCM in the O&G industry highlighted (Ahmad et al. 2017).

From the extant literature on O&G SSCM, key areas such as sustainability drivers (Raut et al. 2017; Yusuf et al. 2013), SSCM strategies (Lakhal et al. 2007), sustainability reporting (Ahmad et al. 2016) and sustainability-performance linkage (Ekiugbo and Papanagnou 2017) have been studied from different perspectives. However, a general overview of these studies suggests that considerable efforts have not been made to empirically compare the SSCM strategies of the O&G firms in the developed economy with those in the developing economies. For example, research by Yusuf et al. (2013) on strategy and performance is solely based on a developed country (UK). Similarly, Lakhal et al. (2007) applied data from another developed nation (Canada) to test their framework for greening refineries. In contrast, Raut et al. (2017) applied a dataset from a developing nation (India), to understand the critical success factors of the O&G SSCM. Similarly, primary data from another developing nation (Nigeria) was generated by Ekiugbo and Papanagnou (2017) to investigate the link between sustainable procurement and sustainable development in the upstream sector. As a departure from the foregoing, Ahmad et al. (2017) compared data from Europe and America with two developing nations to understand external forces that drive SSCM in the O&G industry. This study revealed how findings differ among respondents in the two regions. However, its strict focus on SSCM drivers, to the exclusion of SSCM strategies, makes the application of its findings to SSCM strategies impossible.

Since the developing nations are generally prone to weak regulations and lower stakeholders' pressure, which are crucial to sustainability adoption (Silvestre 2017), the need to compare the extent of SSCM practices in their O&G industry with those of the developed nations, reputed for stringent environmental regulations (Holt and Ghobadian 2009), cannot be overemphasized. This will afford an opportunity to understand the factors that drive sustainability in the supply chains in the two economic regions. It will also identify the differences in the specific strategies adopted in the two regions. In recognition of the above, this research compares the extent of sustainability practices in the Nigerian (developing nation) O&G industry with the UK (developed nation) O&G industry.

Methodology

This research is based on two methodological approaches. The first stage focuses on the collection and analysis of secondary data from the UK O&G industry, while the second stage is based on the collection and analysis of primary data from the Nigeria O&G industry. In the first instance, the UK O&G industry is selected for this research because of the evidence of sustainability initiatives deployed in the industry (Yusuf et al. 2013), especially after the Piper Alpha spills of 1988. An example is the 'Step Change in Safety' initiative by the industry's stakeholders, aimed at making the UK the safest place to work in the worldwide O&G industry in 1997. This initiative has been adjudged to be effective by the industry, leading to a reduction in incidences of major and fatal accidents by 97% (HM Government 2013). On the other hand, Nigeria is chosen for comparison because, despite its position as one of the major oil producing nations in the world, the O&G industry has been subjected to criticism in terms of its economic, environmental and social sustainability.

As a basis of the study, the data from the UK industry were sourced from the latest sustainability reports, Corporate Social Responsibility (CSR) reports, sustainability policies documents and data relating to health, safety and environment of firms operating in the upstream and downstream sectors of the UK O&G industry. A qualitative content analysis, adapted from Tate et al. (2010), focusing on a thematic analysis of the focal issues in the reports was carried out. Text-by-text reading and re-reading of the content of documents were carried out with a focus on establishing the themes and patterns as they emerge. The emerging themes were presented against the sustainability indicators of the International Petroleum Industry Environmental Conservation Association (IPIECA), as a basis of classifying them into the Triple Bottom-line dimensions of Elkington (1998).

This above process laid the foundation for the second stage of the methodology. In this wise, a semi-structured interview protocol was designed from the results of the findings from the previous process, to obtain the views of industry practitioners in Nigeria. The details of the firms in the industry (upstream, midstream and downstream sectors) were obtained from the Department of Petroleum Resources (DPR). Thereafter, a purposeful sampling method was adopted to select seven firms, covering all sectors of the industry. The selected firms were contacted and four agreed to participate in this research. Since sustainability is a strategic issue, the targeted respondents were the senior management staff of the selected firms. The findings from the interviews were later discussed within the context of the literature and compared with the previous findings from the secondary data obtained from the UK O&G industry. Areas of similarity and differences were noted, and recommendations were made to the Nigerian O&G industry based on the differences.

SSCM Strategies in the UK O&G Industry

Table 1 presents the findings from the UK O&G industry. Specifically, a total of ten sustainability objectives, with various sustainability initiatives, were identified in the industry. Generally, involvement of suppliers and contractors in sustainability initiatives were emphasised in all reports used for this study. Hence, an indication that intention of sustainability drive across the supply chain is intended. This agrees with the views of Russo and Fouts (1997) that organisations usually present sustainability information about supply chain to convey a positive image to stakeholders.

Cat.	Sustainability Objectives	Sustainability Initiatives	IPIECA Guideline	Area
Env	To achieve a low carbon future	Setting targets to reduce emission in operational activities	E1	Both
		Emphasis on gas production		Up
	To achieve energy efficiency	Exploring a good mix of renewable sources in energy portfolio	E2, E3	Both
	To curtail spills and gas flared	Adoption of artificial intelligence to monitor pipelines	E5	Up
	To reduce water consumption and protect marine life	Water recycling system	E6	Both
		Efficient management of produce water		Up
Eco	To reduce long-term operational costs	Investment in technology and sustainability initiatives	SE4	Both
	To prevent corruption and related activities	Transparent procedures, contractors and suppliers engagement	SE11	Both
		Employees engagement	SE16	Both
Soc	To ensure workplace safety and accident prevention	Staff training and retraining	SE17	Both
		Use of safety gadgets, use of drones instead of staff in high-risk tasks	HS5	Both
	To ensure that all employees have quality health standard	Collaborative health scheme for staff	HS2	Both
		Engagement with health officials		Both
	To ensure that human rights are upheld	Consistent review of policy on human rights	SE8, SE9, SE10	Both
		Modern slavery reviews		Both
		Engagement with supply chain partners		Both
	To ensure positive impacts on community	Contribution to social investment	SE1, SE2, SE3, SE4	Both
		Employment opportunity for the locals		Both
		Continuous transparent engagement with the communities		Both

(Env: Environmental, Eco: Economic, Soc: Social, Up: Upstream, Both: Upstream & Downstream)

Table 1: Summary of Sustainability Initiatives across the UK O&G industry

Within the environmental sustainability dimension, four objectives which include achieving a low carbon future, achieving energy efficiency, curtailing oil spills and gas flares and reducing water consumed and protecting marine life were identified. To achieve each of these objectives, our findings revealed that various initiatives are adopted across the industry. For example, to achieve the objective of low carbon future, the operators in the industry are setting specific targets for the reduction of GHG emissions within products and operational frameworks. Also, the operators in the upstream are emphasising gas production to further entrench their commitments into achieving low carbon future. This initiative can be attributed to the greener nature of gas over fossil fuel.

Two objectives which include reduction of operational cost and prevention of corruption were identified within the economic sustainability dimension. The target to reduce operational costs is channelled towards investment in technology and sustainability initiatives. Whereas SCM as a management concept is credited with the advantage of cost reduction, Tate et al. (2010) suggest that investment in technology, such as cleaner and alternative energy can be adopted as a sustainability strategy to reduce operational costs in organisations. To achieve the second economic sustainability objective which focuses on prevention of corruption, various measures including transparent procedures, anti-corruption and anti-bribery policies and employee's engagement were identified.

The results show that there are four social sustainability objectives. These include ensuring workplace safety and preventing accidents, ensuring quality health for workers, protecting human rights and making positive impacts on the communities. According to Tate et al. (2010), issues of safety is part of the risk management orientation of organisations which can be integrated as part of SSCM. Whereas

the above initiatives are very basic in all safety operations, our findings further indicate that complex technology, such as drones to work at heights, is integrated into the safety measures adopted in the upstream sector. This could be attributable to the peculiarity of the sector, which is generally reputable as the riskiest sector of the industry (Ekiugbo and Papanagnou 2017).

Stemming from the highlighted, our findings on the UK O&G industry reveal that more strategies are channelled towards the environmental and social sustainability strategies of the industry, with less focus on strategies that are peculiar to the economic sustainability. A number of factors could be responsible for the above. First, the notion that profitability cannot be sustained without environmental and social sustainability at the corporate level (Dyllick and Hocketts 2002) is fast gaining attention in the industry. Second, since the contents of most sustainability reports are majorly qualitative, it is natural for organizations to focus their attention on social sustainability which is majorly qualitative in nature. This position is consistent with the findings of Ahmad et al. (2016) that organisations in the O&G industry tend to focus their reporting more on the social sustainability dimension of the TBL.

SSCM Strategies in the Nigerian O&G Industry

Table 2 presents the findings on the sustainability initiatives adopted in the Nigerian O&G industry based on the analysis of interviews with industry experts.

Cat.	Sustainability Objectives	Sustainability Initiatives	IPIECA Guideline	Area
Env	To achieve a low carbon future	Adopting stipulated law national law and emphasis on LNQ	E1	Up Mid
		Use of Leakage detector, clean energy		Down
	To achieve energy efficiency	Energy conserving building	E2, E3	Up Mid
		Switching off all appliances		Down
	To curtail spills and gas flared	Monetizing gas instead of flaring, compliance with global standards	E5	Up
		Use of leak detector, LPG as a cleaner gas		Down
	To reduce water consumption and protect marine life	Minimising spills	E6	Up
		Use water only when necessary		Down
Eco	To reduce long-term operational costs	A dedicated team to manage sustainability issue	SE4	Up
		Budgeting		Down
	To prevent corruption and related activities	Instilling financial control, enlightening partners, gift policy	SE11	Up Mid
		Display of zero-tolerance policy, process audit	SE16	Down
Soc	To ensure workplace safety and accident prevention	Training and safety awareness, use of PPE	SE17, HS5	Both
	To ensure that all employees have quality health standard	Medical facilities for employees, annual medical check-up	HS2	Both
	To ensure that human rights are upheld	Whistleblowing policy, dedicated team on HR issues	SE8, SE9, SE10	Up Mid
		Staff engagement, compliance with national employment law		Down
	To ensure positive impacts on community	Focusing on sustainable education, Local content development	SE1, SE2, SE3, SE4	Up Mid
		Commitment to CSR		Down

Table 2: Summary of Sustainability Initiatives in the Nigerian O&G Industry

From the above table, our findings reveal that diverse sustainability initiatives are adopted across the various sectors of the O&G supply chain in Nigeria. Also, these findings reveal that many of the

initiatives are applied based on the peculiarities of the sectors. For example, while the firms in the upstream and midstream sectors rely predominantly on the extant law and global standards to reduce GHG emissions, those in the downstream sector basically rely on leakage detectors and green energy. Also, while the players in the upstream and midstream sector appear to be more creative and adaptive in their strategies on corruption elimination, those in the downstream sectors appear to focus primarily on basic control system that is based on policy framework and audit. The above may be because the firms in the upstream and the midstream sectors are bigger and more diverse than those in the downstream sector. Indeed, previous studies have suggested that organisational size influence sustainability strategies within the supply chain (Tate et al. 2010). To put the findings above in proper perspective, the results are discussed in comparison with the previous findings from the UK in the following section.

Comparative Analysis and Recommendations

This study compares the sustainability initiatives in the supply chain of the firms in the Nigerian O&G industry with those in the UK. The significant differences were noted in the initiatives adopted to achieve the four environmental sustainability objectives identified in the industry, as can be seen in Table 3. Although other areas of differences were noted in the economic and social dimensions, these are not as predominant as those within the environmental sustainability dimension.

The findings illuminate the need for the operators in the Nigerian O&G industry to review their strategies in the area of environmental sustainability. Specifically, operators should dedicate greater commitment to GHG emissions by setting achievable and measurable targets in line with the best practices as hinted by Kolk and Pinkse (2004). Furthermore, it is recommended that renewables should be adopted across all sectors of the industry to achieve energy efficiency. Operators can also innovate energy product base with renewables to foster diversification in line with the global trend. Moreover, it is highly recommended that the operators in the upstream sector should place more emphasis on technology to reduce cases of oil spills in the industry. Further to this, we recommend an adoption of water recycling system in the industry to reduce water consumed in operational activities and attending impacts on fresh water.

On the economic sustainability dimension, it is recommended that investment in technology is further entrenched within the strategies for reducing operational costs in the upstream sector. Similarly, it is highly recommended that the operators in the downstream sector should view the issues of sustainability beyond economic profitability, but lay credence on environmental and social elements in line with Tsai et al. (2009). In the area of social sustainability, we recommend that operators should also consider the use of complex technology, such as drones to minimise cases of accidents in the upstream sector. To strengthen the effectiveness of these recommendations, it is believed that the entire supply chain should be involved since effective competitiveness is enhanced through the supply chain involvement as highlighted in Seuring and Müller (2008).

Stemming from our findings that the operators in the Nigerian O&G industry consistently mentioned the position of the national law in achieving sustainability, it is highly recommended that the government and policy makers in the Nigerian O&G industry should review the extant regulations on sustainability practices in the Nigerian O&G industry and strengthen the enforcement of these laws regulations. Of a great importance here is the need for the President of the Federal Republic of Nigeria to assent the Petroleum Information Bill (PIB) which has lingered for so long in the nation's legislative process. The DPR should also strengthen their capacity in monitoring, evaluating and enforcing sustainability issues across the supply chain of the industry. Beyond regulations, it is recommended further that operators should imbibe culture of sustainability in their operations, in consideration of its positive impacts on the performance outcome of firms in the O&G industry (Yusuf et al. 2013). This is in agreement with the position of Dyllick and Hockerts (2002) that socially responsible organisations are those that integrate social, environmental and ethical concerns within their operational activities beyond legal requirements.

Sustainability Objectives	Initiatives in the UK	Initiatives in Nigeria	Recommendations for Nigeria
Environmental Sustainability Dimension			
Achieving low carbon future	Specific targets on GHG emissions reduction	Incorporation of law at the upstream and gas monetisation	Set achievable targets and show more commitments to GHG emissions reduction at the upstream sector
Energy efficiency	Use of renewables	Powering-off appliances (not in use) in the downstream sector	Develop policy towards adoption of renewables in the downstream
Curtailment of oil spills and gas flares	Adoption of technology in the upstream	Compliance with regulations	Place more emphasis on technology. Government to also strengthen enforcement of regulations
Reduce water consumption and protect marine life	Water recycling in the upstream and downstream sectors and managing produce water in the upstream	Minimising spills in the upstream and reducing waste of water in the downstream	Both the upstream and downstream to place emphasis on water recycling
Economic Sustainability Dimension			
Reduce operational costs	Investment in technology and sustainability initiatives in both upstream and downstream sectors	Use of sustainability team in the upstream and strict budgeting in the downstream	Emphasis on cost reduction in the upstream is necessary. Interpreting sustainability beyond profitability in the downstream is required.
Social Sustainability Dimension			
Accident prevention and workplace safety	Use of drones to work in heights in the upstream	Creating safety awareness and use of PPE	Emphasis to be placed on complex technology to maintain safety

Table 3: Core Differences and Recommendations

Conclusions

This study has a number of implications for academics and managers. Firstly, it has contributed to the applicability of the TBL concept in the O&G industry. It has also deepened the understanding of differences in the approaches to sustainability issues across the developed and developing nations. Furthermore, the review of the findings of the study can serve as the fundamental basis of reviewing the specifics of sustainability initiatives in the Nigerian O&G with a view to strengthening the supply chain performance. The findings are also a challenge to the policy makers in the Nigerian O&G industry to strengthen enforcement and identify the key areas of the industry that require enforcement attention across the TBL dimension.

Notwithstanding the above, this study has limitations. First, its reliance on company sustainability documents as a basis of depicting sustainability practices in the UK O&G industry might not really depict the real practices in the industry. Indeed, other studies have found that sustainability reporting in the O&G industry is prone to the risk of under-reporting and inconsistency. To this end, we believe that future research could be enhanced with a validation of the secondary data with primary data from the UK O&G industry. Second, the generalisability of the study could also be enhanced with higher number of participants in the interview conducted among practitioners from the Nigerian O&G industry. Furthermore, in line with other studies, establishing a linkage between the adopted initiatives and organisations performance in the two countries could further enhance the value of the study and create a clearer direction. The above therefore constitute grey areas to be explored in future studies.

References

- Ahmad, W. N., Rezaei, J., Sadaghiani, S., and Tavasszy, L. A. (2017) 'Evaluation of the External Forces Affecting the Sustainability of Oil and Gas Supply Chain using Best Worst Method'. *Journal of Cleaner Production*' 153, pp.242-252.
- Ahmad, W. N., Rezaei, J., Tavasszy, L., and deBrito, M. P. (2016) 'Commitment to and Preparedness for Sustainable Supply Chain Management in the Oil and Gas Industry'. *Journal of Environmental Management*, 180, pp.202-213.
- Dyllick, T. and Hockerts, K. (2002) 'Beyond the Business Case for Corporate Sustainability'. *Business Strategy and the Environment*, 11(2), pp.130-141.
- Ekiugbo, I. and Papanagnou, C. (2017) 'The Role of the Procurement Function in Realising Sustainable Development Goals: An Empirical Study of an Emerging economy's Oil & Gas Sector'. *European Journal of Sustainable Development*, 6(3), pp.166-180.
- Elkington, J. (ed.) (1998) *Cannibals with Forks: The Triple Bottom Line of the 21st Century*. 1st edn. Gabriola Island/Stoney Creek, CT.: New society publisher.
- HM Government (2013) *UK Oil and Gas: Business and Government Action (Industrial Strategy-Government and Industry Partnership)*. UK: Department for Business, Innovation & Skills and Department of Energy & Climate Change.
- Holt, D. and Ghobadian, A. (2009) 'An Empirical Study of Green supply Chain Management Practices Amongst UK Manufacturers'. *Journal of Manufacturing Technology Management*, 20(7), pp.933-956.
- Kolk, A. and Pinkse, J. (2007) 'Towards Strategic Stakeholder Management? Integrating Perspectives on Sustainability Challenges such as Corporate Responses to Climate Change'. *Corporate Governance: The International Journal of Business in Society,* 7(4), pp.370-378.
- Lakhal, S.Y., H'Mida, S., and Islam, M.R. (2007) 'Green Supply Chain Parameters for a Canadian Petroleum Refinery Company'. *International Journal Environmental Technology Management*, 7, pp.56-57.
- Meckenstock, J., Barbosa-Póvoa, A.P., and Carvalho, A. (2015) 'The Wicked Character of Sustainable Supply Chain Management: Evidence from Sustainability Reports'. *Business Strategy and the Environment*, 25(7), pp.449-477.
- Mendes, P.A., Hall, J., Matos, S., and Silvestre, B. (2014) 'Reforming Brazil' s Offshore Oil and Gas Safety Regulatory Framework: Lessons from Norway, the United Kingdom and the United States'. *Energy Policy*, 74, pp.443-453.
- Modarress, B., Ansari, A., and Thies, E. (2016) 'Outsourcing in the Persian Gulf Petroleum Supply Chain', *Strategic Outsourcing: An International Journal*, 9(1), pp.2-21.
- Raut, R. D., Narkhede, B., and Gardas, B. B. (2017) 'To Identify the Critical Success Factors of Sustainable Supply Chain Management Practices in the Context of Oil and Gas Industries: ISM Approach'. *Sustainable and Renewable Energy Reviews*, 153, pp.242-252.
- Russo, M. V. and Fouts, P. A. (1997) 'A Resource-Based Perspective on Corporate Environmental Performance and Profitability'. *Academy of Management Journal,* 40(3), pp.534-559
- Seuring, S. and Müller, M. (2008) 'From a Literature Review to a Conceptual Framework for Sustainable Supply Chain Management'. *Journal of Cleaner Production,* 16(15), pp.1699-1710.
- Silvestre, B.S., Gimenes, F.A., and Neto, R.S. (2017) 'A Sustainability Paradox? Sustainable Operations in the Offshore Oil and Gas Industry: The Case of Petrobras'. *Journal of Cleaner Production*, 142, pp.360-370.
- Tate, W.L., Ellram, L.M., and Kirchoff, J.F. (2010) 'Corporate Social Responsibility Reports:A Thematic Analysis Related to Supply Chain Management'. *Journal of Supply Chain Management*, 46(1), pp.19-44.
- Tsai, W., Chou, W., and Hsu, W. (2009) 'The Sustainability Balanced Scorecard as a Framework for Selecting Socially Responsible Investment: An Effective MCDM Model'. *Journal of the Operational Research Society,* 60(10), pp.1396-1410.
- Yusuf, Y.Y., Gunasekaran, A., Musa, A., El-Berishy, N.M., Abubakar, T., and Ambursa, H.M. (2013) 'The UK Oil and Gas Supply Chains: An empiric Analysis of Adoption of Sustainable Measures and Performance Outcomes'. *International Journal of Production Economics*, 146, pp.501-514.
- Zhao, C. and Chen, B. (2014) 'China's Oil Security from the Supply Chain Perspective: A Review'. *Applied Energy*, 136(1), pp.269-279.

HOW CORRECT WERE THEY? – A COMPARISON OF LOGISTICS/SUPPLY CHAIN PRACTITIONER AND EDUCATOR VIEWS OF NEAR-TERM OIL PRICE WITH THE ACTUAL OIL PRICE

Yongmei Bentley[1], Guangming Cao[1], Ramakrishnan Ramanathan[1] and **Roger Bentley[2]**
[1]University of Bedfordshire, Luton, UK
[2]Petroleum Analysis Centre, Ireland

1. Introduction

This research focusses on the impact of oil price on the logistics and supply chain (SC) industry, and initially examined two research questions:

(1) What have been views of logistics and SC managers, and those that teach these disciplines, of the impact of the fall in oil price, from greater than $80/bbl for nearly all of 2007 to 2014 (and around $120/bbl for a considerable part of this period!), down to around $35/bbl at the start of this research, and subsequent increase up to ~$60/bbl at the last survey date? (And with this price, at the time of writing in June 2018, now around $75/bbl.)
(2) What did these professionals expect will be the future price of oil over the near and medium term, and hence the consequent impacts on their industries?

To answer these questions, a semi-structured questionnaire survey was designed and handed out to the target audience by the lead author at a range industry logistic and SC events and conferences. The audience comprised middle and senior managers in logistics and SC companies, and in other companies where logistics and SC activities are a significant part of the total business, as well as academics at senior lecturer level and above in universities who teach logistics and SC topics. Three rounds of survey were conducted, covering the period from February 2016 to the end of 2017, with a total of 70 valid responses being analysed.

Given that time has now passed, and current and recent actual oil prices are known, in this paper we look at how well the groups surveyed were able to forecast the price of oil, and hence to expect the impacts on the logistics and SC industries of the oil price changes that have resulted. Note that a widely-held view among many analysts, not only in the logistics and SC industries, is that the oil price is too complex to forecast reliably. This view is not well founded, and the Annex sets out the fundamental drivers for oil price change; and, as importantly, explains how people's *expectations* of future oil price have evolved over time.

In this paper we include forecasts from the IEA of oil price out to 2040. These show that the price of oil is expected to continue climbing in real terms, to again reach levels above $120/bbl in the not too distant future. Such oil prices are likely to have significant impacts across all of society that need to be understood, including within the logistics and SC industries.

2. Literature Review

It might seem obvious that the price of oil has a significant impact on the logistics and supply chain industries. This is because a high oil price adds directly to the fuel bills of much of the transport involved, and also to most other costs by way of the embedded fuel costs of nearly all activities. But surprisingly, while general reference is often made to this linkage, we have found relatively few studies that have looked at this in an analytical or quantitative way.

In terms of quantitative impacts, one study for example is that by Ronen (2011) on the effect of oil price on containership speed and fleet size. Among more broadly-based studies is that by Christopher and Holweg (2011) who point out that generally for logistics 'variability is detrimental to performance' (Page 63) and argue that: 'in the light of increasing turbulence [which in their view includes oil price shocks, as well a global recession] a different approach to SC management is needed'. These authors hold that 'most current SC management models emanate from a period of relative stability' and that 'there is considerable evidence that we will experience increasing turbulence in the future'.

More recent papers include that by Ramanathan (2016), who explored energy characteristics across the world, and highlighted logistics costs to businesses in the current outsourcing scenario. And an excellent recent paper is that by Busse et al. (2017), who write: 'Because of the major contribution of logistics to the greenhouse gas effect, logistics research has begun to address the topic of energy, but it has not yet targeted the role of energy within logistical decision-making processes.' This agrees with our findings, that overall there appears to be a rather limited literature examining the energy logistics/SC linkages in any detail (let alone vs. oil price), suggesting a useful avenue for research.

3. Research Objectives

The primary objectives of this research have been to understand the impacts of oil price on logistics / SC activities, primarily through the views of managers and educators involved with these industries. The research recognised three main considerations: Firstly, that the anticipated impact of oil price on logistics and SC activities is likely to be a function of time-horizon. For example, a high fuel cost is likely to reduce profitability in the short term, but over the longer term is likely to encourage adoption of more efficient vehicles, their more efficient use (e.g., 'reverse logistics'), and fuel switching (e.g. to compressed natural gas). Secondly, that the period of high oil price from 2007 to 2014 placed stress on many economic activities, including on logistics and SCs, and led to wide-spread discussion of 'peak oil' (Bentley, 2016). And finally, the recent period of low oil prices (below 50/bbl) caused many to reappraise this view.

4. Research Methodology

To answer these research questions a series of questionnaire surveys were targeted at experts in the field: primarily middle and senior managers in logistics and SC companies; those in other (usually large) companies such as major retailers, where logistics and SC activities are a significant part of the total business; and senior researchers and academics in the logistics and SC discipline, to know where academia stands on the topic. The research followed the 'key informant' approach to data collection, by choosing respondents because of their specialized knowledge of the topic (Bagozzi, et al. 1991).

The semi-structured questionnaire asked about the impacts of the recent changes in the oil price on the logistics and SC activities within their own organisations (if managers); or of their understanding of such changes more generally (if lecturers). The questionnaire also asked respondents of their views of the likely price of oil over various future periods out to 10 years' hence, and of the consequent changes they anticipated on logistics and SC activities. The survey included a number of 'open-ended' questions, as well as space for wider comments, to allow respondents to amplify their views.

To obtain a good response rate and to ensure that replies were received only from the target groups, the questionnaires were individually handed out and collected by the lead author, at a range industry logistic and SC events, and at related UK and international conferences. In addition, the survey form was kept short (10 questions), and anonymous, to assist the high response rate; in the event, of over 90%. In addition to the target group, a small number of professionals within the oil industry were also surveyed to gain a more informed 'insider view' of the likely future evolution of the oil price over the time-frame considered. To-date three main survey rounds of have been conducted, covering the period from February 2016 to December 2017.

5. Research Findings

Research findings from the first survey round are given in Bentley et al. (2016); and from the second in Bentley et al. (2017). Responses were analysed using both qualitative and quantitative methods (via SPSS). Questions 1 to 3 asked about the category of organisation of the respondent, the organisation's size, and the respondent's role within the organisation. Of the respondents, 38% were in senior managerial positions in logistics and SC companies, and a similar percentage were academics within universities. About two-thirds of the respondents were from large organisations having >250 employees. Overall, the sample of respondents were diverse in terms of industries covered, organization sizes, and positions held; in line with the research goals.

Questions 4 to 6 focussed on the recent changes in oil price, from > $80/bbl for most of the period from 2007 up to 2014, down to ~$35/bbl at the time of the first survey round, and back up to ~$45 to $50/bbl by the second round. Analysis of these responses are given in Bentley et al. (2016; 2017). Questions 7 to 9 focussed on the future price of oil, and asked respondents:

- Q7: Their expectations of this price at six future dates, see Table 1 below.
- Q8: Their reasons underlying these price expectations.
- Q9: How their predicted oil prices would impact future logistics and SC activity.

Table 1 shows that respondents' views on likely future oil prices exhibited a general trend that oil price will be similar or lower in the short-term, but higher in the long-term. However, as shown, price expectations were diverse, and quite polarised between high vs. low prices.

Length of time	***<$30/bbl***	***$30-40/bbl***	***$40-60/bbl***	***$60-90/bbl***	***$90-120/bbl***	***>$120/bbl***
3 months	13.5%* (7^)	30.8% (16)	51.9% (27)	3.8%(2)	-	-
6 months	14.3% (7)	16.3% (8)	61.2% (30)	8.2%(4)	-	-
1 Year	7.8% (4)	21.6% (11)	39.2% (20)	27.5% (14)	3.9% (2)	-
2 years	6.4% (3)	8.5% (4)	29.8% (14)	42.6% (20)	10.6% (5)	2.1% (1)
5 years	10.6% (5)	0%	21.3% (10)	31.9% (15)	27.7% (13)	8.5% (4)
10 years	12.8% (6)	0%	17% (8)	27.7% (13)	19.1% (9)	23.4% (11)

*Valid percentage calculated excluding missing values. ^ Frequency. $/bbl: US $ per barrel

Table 1: Respondents' expectations of the oil price in the near-term, and longer-term

As mentioned, several of the questions were 'open-ended' in that they allowed respondents to give details of their views. On future oil price these views were fascinating, and help explain the wide range of oil price estimates given in Table 1. A view of a low price 10 years' hence (of <$30/bbl) followed logically from the explanations; for example: "*More and more new energy sources will be introduced*"; while a view of a high price estimate 10 years' hence, of >$120/bbl, also followed logically from the view that: "…*oil will become more of a scarce resource*." More generally, where a low oil price 3 to 10 years out was envisaged, this was due to an expectation of a very significant rise in low-carbon non-oil transport. Conversely, those seeing a high oil price 3 to 10 years out pointed to the world's increasing appetite for oil, coupled with anticipated constraints on its production.

Now we turn to the specific question raised in this paper: How good have respondents' views on future oil prices been so far? Results from the earliest survey (those in June 2016) are shown in Table 2.

	June 2016 prediction	**Actual oil price**
Sep-16	42.92	49.07
Dec-16	38.27	55.13
Jun-17	49.13	50.19

Table 2: Respondent views of future oil price, vs. actual price. (Reflects 27 answers)

In Table 2, the column 'June 2016 prediction' gives the average of respondents' June 2016 predictions for the oil price at the future dates shown. For example, these predictions made in June 2016 were for the oil price 3-months (thus Sept. 2016), 6-months (Dec. 2016), and 1-year (June 2017) ahead. The column 'Actual oil price' gives approximately monthly average prices for Brent oil, taken from http://www.livecharts.co.uk/MarketCharts/brent.php. The 2, 5 and 10-year forecasts are not included as at the date of this analysis so far there are no actual oil price data to compare. These data (i.e., forecasts made in June 2016) are shown top left in Figure 1, with subsequent forecast shown similarly. It is clear from this Figure that the respondent views of the oil price three months, six-months, and 1-year ahead were consistently lower than the actual oil prices.

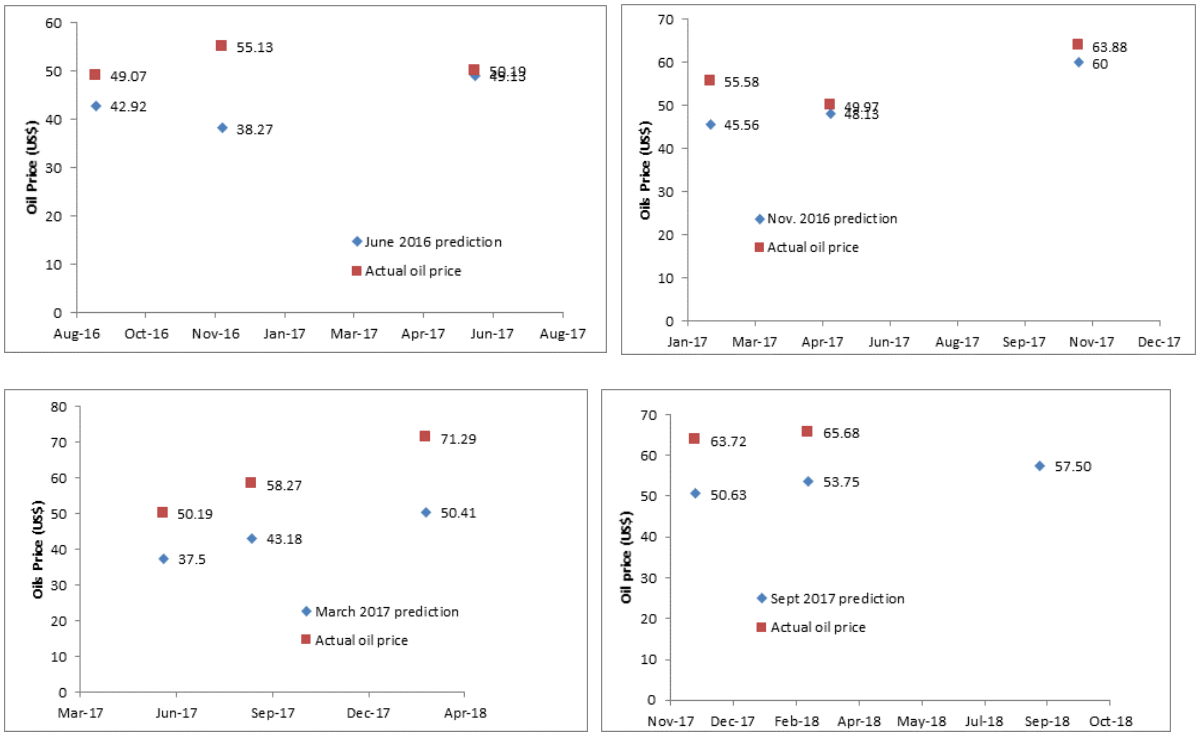
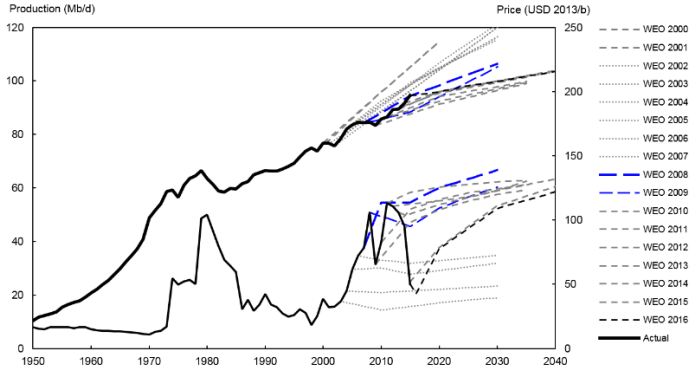


Figure 1: Comparison of respondents' views made at four different dates of the oil price for 3 months, 6 months and 1 year ahead, with the actual prices at these dates

6. Discussion and Conclusions

6.1 Discussion

In underestimating the rise in oil prices, these professionals managing, and teaching about, the logistics and SC industries are in good company. As Figure 2 shows, one the world's foremost oil forecasting bodies, the IEA, consistently under-forecast the price of oil over the period 2004 to 2007. During this period, they simply extrapolated the oil price at about the then-current price to the end of their forecast horizons. The Annex explains the constraints in global production of *conventional* oil that drove the prices rises from about the year 2004. But due to limitations in the IEA's modelling at that time, these drivers of the price rise were not adequately understood. This situation changed in 2008, after the IEA had carried out detailed analysis of oil field decline rates. With these decline rates now in their model, the difficulty of meeting future demand for oil without significantly increasing oil prices became clear. This is shown in Figure 2, which since 2008 consistently gives an expectation for the real-terms oil price by 2030 to be in the $115 to 140/bbl range.



Source: Wachtmeister et al. (2018)

Figure 2: Historical world oil production and price from 1950 to 2015, and projections for world oil supply and oil prices from central scenarios of WEO 2000-2016.

However, little in oil forecasting is simple. The advent of light-tight ('shale') oil caught just about everybody by surprise, though the rapid increase in production of this class of oil is now incorporated in nearly all modelling (including in the IEA's, in Figure 2). But the new uncertainty is whether reductions in oil *demand*, driven by the need to avoid too-serious climate change and other reasons, will trump the supply constraints built into the models of the IEA and others. Quite a number of respected organisations now hold this view of 'peak demand as the driver for peak production, before peak supply', including DNV-GL, the World Energy Council, Citi Bank etc. But the more 'mainstream' modellers, such as the IEA, ExxonMobil, BP, as well as most of the 'independents' such as Rystad Energy and Globalshift Ltd., maintain that while light electric vehicles will indeed see rapid increases in the market, overall oil demand will continue to increase, due to increased oil demand from heavy transport, ships, planes, and petrochemicals.

Who will be right is a fascinating topic for discussion. But it would seem wise for the logistics and SC industries to be at least prepared for the significantly higher oil prices that are forecast both by the 'mainstream' organisations and a number of the 'independents'.

6.2 Research limitations

We recognise that the research reported here has limitations. It would benefit from a larger number of respondents and drawn from a wider spectrum of organisations. The research also has the intrinsic problem that the surveys were carried out at different dates, and hence prices of oil. The research started at what was a particularly low point in the recent trajectory of oil prices (at ~$35/bbl), and hence, importantly, at a time when expectations from a range of 'expert commentators' were for the price to go lower still; with $20/bbl and even less being widely mentioned! By contrast, currently (June 2018) the oil price has climbed back to ~$75/bbl, and there is far less talk of lower prices. These 'market expectations' naturally affect the replies of respondents.

6.3 Conclusions

The main conclusions from this whole research project have been:

(1) A wide range of expectations of the future price of oil emerged from the earlier part of this study, from both senior practitioners and educators; with estimates for the price 10 years hence ranging from below $30/bbl to over $120/bbl.
(2) Explanations for this wide range were generally logical. Those that foresaw a low oil price expected that new energy sources would come on-stream significantly over this timeframe, while those that foresaw much higher prices held the view that these new sources were not likely to be especially significant, coupled with a view that oil supply itself was likely to be constrained.
(3) An important finding was the proportions of respondents that supported these various views of future oil price. While nearly a quarter saw the oil price in a decade's time as likely to be very low (<$30/bbl), the majority saw this price as being in the $60-$90/bbl range, i.e., *lower than the price* for most of the period 2007 to 2014! Only a quarter of respondents thought the oil price 10 years hence likely to be >$120/bbl.
(4) It was noticeable that no respondent suggested that the oil price could go high enough to *reduce* logistics and SC activity overall.
(5) When comparing oil price views of respondents to the prices that have since occurred, the respondents consistently under-estimated the price rises that have taken place.

To set the findings into context, we note that virtually all current 'mainstream' oil forecasts, from organisations such as the IEA, the US EIA, oil majors and consultancies, see the global supply of *conventional oil* as being increasingly constrained from now on, with the result that most of any additional 'liquids' global supply that is required in future must come from the intrinsically expensive non-conventional oils; or from 'other liquids', such as coal-to-liquids or biofuels. This - absent 'peak demand before peak supply' - suggests higher oil prices into the future, combined with the possibility of significant constraints on supply.

By contrast, the results of the surveys reported here suggest that the likelihood of such constraints are not yet in the thinking of most of those managing, and teaching, logistics and SCs. It is hoped therefore that this paper can help inform industry and academia of the possible oil price risks ahead; and in particular, contribute to the planning that will be required for the medium and longer term oil supply challenges that companies may well face.

References

- Bagozzi, R.P., Youjae, Y. & Phillips, L.W. (1991), 'Assessing Construct Validity in Organizational Research', *Administrative Science Quarterly*, vol. 36, pp. 421-458.
- Bentley, R.W. (2016). *Introduction to Peak Oil*. Lecture Notes in Energy, Vol. 34; Springer.
- Bentley, Y., Cao, G., Ramanathan, R. & Bentley R.W. (2017), 'Impact of Recent and Anticipated Changes in Oil Price on Global Logistics and Supply Chain Activity – Further Findings on Practitioner and Educator Opinions.' *Proceedings of Logistics Research Network Conference,* 6-8 September 2017, Southampton Solent University, UK.
- Bentley, Y., Bentley, R. and Cao, G. (2016), 'The Impact of Oil Price on Global Logistics and Supply Chain Activities – A Survey of Practitioner and Educator Opinions'. *Proceedings of Logistics Research Network Conference*, 7-9 September 2016. University of Hull UK.
- Bentley, R.W. & Bentley Y. (2015a), 'Explaining the Price of Oil 1861 to 1970 - The Need to Use Reliable Data on Oil discovery and to Account for 'Mid-point' Peak'. *The Oil Age*, Vol. 1 (2): 57-83. Available at: www.theoilage.org
- Bentley, R.W. & Bentley Y. (2015b), 'Explaining the Price of Oil 1971 to 2014 - The Need to Use Reliable Data on Oil discovery and to Account for 'Mid-point' Peak'. *Energy Policy*. Vol. 86: 880-890.
- Busse, C., Regelmann, A., Chithambaram, H. & Wagner, S.M., (2017), 'Managerial perceptions of energy in logistics: An integration of the theory of planned behavior and stakeholder theory', *International Journal of Physical Distribution & Logistics Management*, Vol. 47, Issue 6: 447-471.
- Campbell, C. J. and Bentley, R. W. (2016). 'Observations on the present low price of oil'. *The Oil Age*, Vol. 2, No. 1, pp 1 – 8.
- Christopher, M. & Holweg, M. (2011), 'Supply Chain 2.0: Managing Supply Chains in the era of Turbulence'. *International Journal of Physical Distribution & Logistics Management*, 41 (1), 63–82.
- Inman, M. (2016). *The Oracle of Oil – A Maverick Geologist's Quest for a Sustainable Future*. W.W. Norton & Co. Inc.
- Ramanathan, R. (2016), 'Energy and environmental issues in international business.' *Journal of Contemporary Management and Development Studies*, 4(1), 44-60.
- Ronen, D. (2011), 'The effect of oil price on containership speed and fleet size'. *Journal of the Operational Research Society*, Volume 62 (1), 211-216.
- Wachtmeister, H., Henke, P. & Höök, M. (2018), 'Oil projections in retrospect: Revisions, accuracy and current uncertainty'. *Applied Energy*, No. 220 (2018) 138-153.

Appendix. The Drivers of Oil Price: An Historical Perspective

Here we look briefly at the fundamental drivers of oil price, and set these in an historical perspective. For the half-century from 1920 to 1970 large volumes of *conventional* oil were discovered globally (Bentley, 2016). These volumes were *much in excess* of demand, even though the latter was growing rapidly. Consequently, despite widespread attempts at market support, the price of oil fell steadily from about $30/bbl (in current real-terms) in 1920 to close to $10/bbl (real-terms) in 1970. This long price decline helped support major increases in many forms of economic activity, including in the transport associated with logistics and SC activities. But then came the first 'oil shock' in 1973, with its sharp rise in price (Figure A1). When coupled with the second price shock in 1978, the view developed among most analysts, and also the general public, that global oil supply was likely to 'run out' fairly soon. This view was supported by the size of the global proved ('1P') oil reserves at that date; and was

expressed most dramatically by President Carter's 1977 speech, where he described tackling the energy crisis as the 'Moral Equivalent of War'.

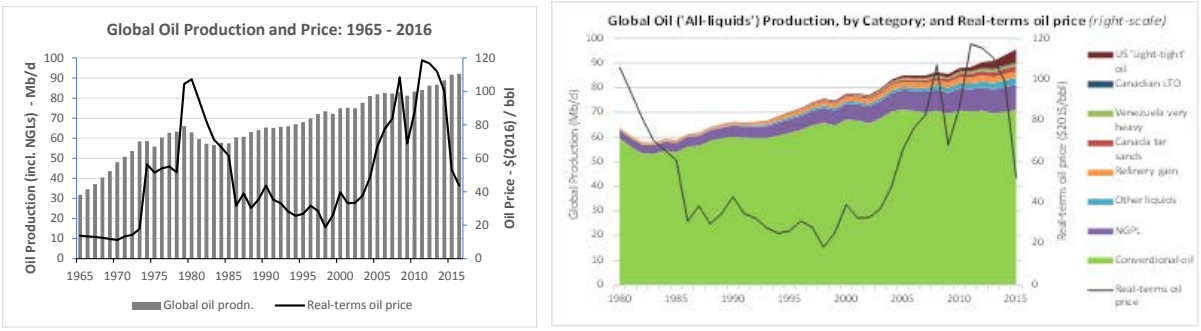


Figure A1: Left-hand graph: Global oil production, and oil price: 1965 – 2016. Price averaged >$80/bbl for most of 2007 to 2014 (and >$100/bbl for a considerable part of this period.)
Vertical bars (left-hand scale): Global 'all-oil' production, in millions of barrels/day. Solid line (right-hand scale): Annual-average real-terms oil price, in 2016$/bbl. Source: BP *Statistical Review 2017*; based on an original plot by E. Mearns.
Right-hand graph: Global production of 'All-liquids'. Global production of conventional oil has been on-plateau since 2005 despite an on-average high oil price.
Data from US EIA (crude-plus-condensate, NGPLs, other liquids, and refinery gain); other categories from Laherrère et al. 'Oil Forecasting – Data Sources and Data Problems, Part-1', *The Oil Age* (2) 3; 2016. Real-terms oil price: BP *Stats. Review*.

However, an oil price shock around 1970 had in fact *long been correctly anticipated* by those analysts (mostly scientists) that used 'resource-based' oil forecast models. These showed that US would reach its peak of *conventional* oil production between about 1965 and 1970, and since the US was then the major oil supplier outside of OPEC, short-term global supply constraints were to be expected. Moreover, the general view in the late-70s to early-80s that global oil would '*run out*' soon was itself at variance with similar 'resource-based' oil forecast models for the world as a whole. These showed that enough oil had been discovered *globally* for total conventional oil production to continue to increase rapidly up until around the year 2000, before only then starting to decline.

These global 'resource-based' models were indeed correct (Figure A1, left-hand graph), and after the 1970s price shocks, large volumes of new oil came on-stream from *already discovered* provinces, including Alaska, Mexico, the North Sea and elsewhere. In face of this new supply, OPEC initially cut production to maintain price, but Saudi Arabia, who took the bulk of these cuts, gave up the game in about 1985, and the price of oil fell dramatically.

Unfortunately, on the basis of the new - and sustained - low price for oil after 1985, and hence the realisation that the widely-accepted 'oil running out' view had not been correct, the majority of analysts switched instead to an 'oil cornucopia' view, driven by the concept that oil reserves were simply inventory that could be replaced as needed. Despite the continued warnings from the global 'resource-based' models that supply difficulties of global *conventional oil* production were to be expected from about year 2000, this 'cornucopia' view dominated, and thus the rapid rise in oil price after 2003 (back to the 1978 real-terms levels of $100/bbl and above) came as a shock to most. The widely-cited reason for this rise in price was the increased demand for oil, particularly in Asia, rather than the correct reason of global resource constraints on the supply of conventional oil (see Figure A1, right-hand graph).

The above an important narrative and is given as background to the oil price expectations investigated in the research described above. For further detail on these changes in oil price, and the public expectations of price, see Bentley & Bentley (2015a, 2015b), Campbell and Bentley (2016), Bentley (2016), and Inman (2016).

HOW SUSTAINABLE IS LOGISTICS EDUCATION: A RESEARCH AGENDA FOR EDUCATING LOGISTICIANS IN A.D. 2100

John Dinwoodie
Department of International Shipping, Logistics and Operations, Plymouth Business School

Introduction

"In developing and updating the Key Knowledge Areas (KKA) it is important to ensure that the KKA do not date too quickly. They are written in a manner which can accommodate the rapid speed of change within the world of transport and logistics and the external factors which may impact on the profession…. The KKA must also reflect our global community and our international values". (CILT, 2017, p.3)

This paper aims to question what sustainable logistics education might entail and to posit an agenda for research to identify and address issues that may influence strategies and policies to educate logisticians in A.D. 2100. Some conflicting views of current logistics education are reviewed, before presenting a positivist philosophy within which to postulate some possible future changes in logistics systems and educational requirements. The analysis proceeds by selecting a sample of the CILT Core Generic Areas and Specialist KKAs perhaps most likely to require adaptation, comparing them against possible future requirements, and noting some of the differences. Implications of the findings are noted including a need for ongoing research to explore not only likely changes in logistics processes, but also research to explore what implications these changes might have for developing logisticians' personal skills to manage them. Social implications will require research to optimize responsibilities within the triple-helix of industry-university-government relationships (Yoon et al., 2015) concerning syllabus setting, educational provision and educational funding. The extent to which the analysis implies a need to revise KKAs, and when, remains a moot point. We conclude by noting that the clients of future logistics education will need to be engaged in defining and executing future research agendas to define the skills they will need and the future syllabi they will study.

Logistics skills and their development

Some views of logistics skills development

The skills or competencies which successful logistics or supply chain (SC) managers need are relatively well researched (e.g. Dinwoodie, 2000; Thai et al., 2012; Barnes & Liao, 2012; Murphy & Poist 2007). Distinct schools of thought have emerged which classify the various competencies which future international managers may require.

Early this century, a popular Western "BLM" framework (Murphy and Poist, 2007) was identified to classify logistics skills, comprising competencies related to business, logistics and management. Within this framework, business skills span business know-how for example in manufacturing and purchasing. Logistics skills span inventory, transport, facility location and the like. Finally, management skills relate to either traditional skills such as planning, motivating and organising or non-traditional such as time management, or personal skills, such as integrity.

By contrast, working in Singapore, Thai et al. (2012) proposed several new skills and traits which logisticians would require. These included new business skills such as strategic planning with knowledge of risk management, multiculturalism and quality management. New logistics skills required knowledge of outsourcing, and knowledge of integrated logistics including multimodalism and green logistics. Finally, management skills included an ability to implement, to manage performance, and non-verbal communication skills. Traits of innovation and dynamism were also required.

Emphasising competencies, Barnes & Liao (2012) assessed linkages between individuals, network and inter-organizational competencies, involving investment in strategic partnership and firm performance in SCs. Individual competency in the form of organizational awareness, and organisation competency as a supply network competency, were both found to impact collaborative awareness. Finally, inter-organizational competencies are supported by collaborative awareness, which impacts investment in strategic planning.

The issue of dealing with other cultures is fundamental to trade and globalisation. Nardon and Steers (2008) explained that managers must learn **how** to learn to deal with other cultures and how to make sense of varied environments. This process involves learning cultural fluency, developing a global mind-set, and learning cultures "on the fly". Cultural fluency involves learning the cultures and language of relevant countries though going on training programmes, learning to expect and cope with stress and anxiety and "culture shock" involves being immersed in a foreign culture. A "global mindset" involves "an ability to develop and interpret criteria for personal and business performance that are independent of the assumptions of a single country, culture, or context, and to implement those criteria appropriately in different countries, cultures, and contexts" (p.49). Managers develop knowledge structures which allow them to interpret situations using multiple cultural frameworks and then select the most appropriate action for each particular situation. Learning cultures on the fly is required when time is limited. All learning involves a cycle of concrete experience, abstract conceptualization, reflective observation and active experimentation. If you come from a culture which values direct communication, and ask a direct question to a person in a culture which values indirect communication, you may feel embarrassed or surprised. This is a concrete experience. Because what is happening does not match what you expected, you will then begin to observe very carefully how people act and react, and eventually you will reflect on what you are observing. You try to make sense of the situation by looking for explanations: perhaps the person did not hear you very clearly, or they do not speak English very well. When you think you have found a plausible explanation, where perhaps a person was embarrassed, you test your explanation perhaps re-phrasing the question in a different way to test the implications of your concept. Through a cycle of trial and error, you eventually learn to adopt successful strategies for communication.

Other theories say that learning may be a social, interdependent process. The ability to negotiate at each stage includes negotiation of identity which involves engaging in concrete experiences; meaning, which requires an ability to reflect and observe together; new rules by developing new theories; and new behaviours which involve taking appropriate actions. Identity involves self-awareness of who I am and who the other person is relating to empathy and what the other person is feeling? We search for cultural explanations before judging a person, question for example whether it is acceptable for work to be late. Successful managers are open-minded and suspend judgement. To negotiate, you must be willing to inquire "how did I/you perceive the situation", and then to advocate clearly what you want, and why. You must be able to gather information from what is said, body language and subtle cues. Individuals must be able to transform new information into action, and to negotiate new styles which requires flexibility in style.

Preparing logisticians to operate globally required a redefinition of the concept of leadership (Sanchez-Runde et al., 2011). Is leadership a universal global behaviour, a normative approach involving a global mind-set shaped by cultural intelligence, or a contingency approach enacted by acting only as a local manager?

Study in the UK has offered an excellent preparation for global logisticians, in a non-threatening environment within which to learn to develop personality traits; to enhance linguistic skills in English; to understand UK business and cultural environment; and to convince potential future employers that you can survive in an international business environment. More recently, preparation of logisticians for overseas assignments has focussed on understanding the meaning of leadership as a cultural

construct and the variations in local expectations of leader behaviour. Apparent non-comital and indecision by Chinese managers can be conceived of as poor leadership by Western managers, simply because they do not understand the cultural constructs (ying and yang, create the conditions for success, let events come to you and so on). Success depends on analysing personal expectations, realising that success is very complex and difficult, and understanding the uniqueness of the local situation.

Current benchmarking of logistics skills

Nearly two decades into the 21st century the Chartered Institute of Logistics and Transport (CILT) proposed "Driving knowledge, delivering quality" (DKDQ) as the benchmark for educating logisticians who will manage logistics systems perhaps until 2060. As such, KKA are explicitly designed to be resilient over time to rapid changes internally within the profession, and to external factors, and also to reflect a global community with international values (Table 1; CILTUK 2017). Within this paper, KKA are used as a base framework against which to compare possible changes engendered by logistics system developments and their implications for educating logisticians are considered.

Customer Centric and Continuous Improvement Principles	
Core Generic Areas	Specialist KKAs
A. Integrated strategic planning, management and systems thinking	S1: Supply Chain Management
	S2: Operations Management
B. Efficiency, quality and risk	S3: Procurement and Supplier Management
	S4: Logistics Systems
C. Technology, analysis, adoption and monitoring	S5: Transport Infrastructure and Network Planning
	S6:Passenger movement
D. Society, sustainability, and the global community	S7: Freight movement
	S8: international Trade and Transport

Table 1. Key Knowledge Areas Framework Source: "DKDQ", CILTUK, 2017 p.3.

Methodology

Adopting a positivist philosophy, we posit some possible changes in logistics systems to A.D. 2100 and consider their implications in terms of the DKDQ framework (CILTUK, 2017). By A.D. 2100 major changes are likely both internally and externally in logistics systems spanning, technology, economy and society. Some possible (and necessarily highly speculative) scenarios may include:

- Climate change which engenders Northern Sea routes through the Arctic; global warming that raise temperatures in the Sahara; inter-regional conflicts for water; significant sea level rises.
- Population rises (20B?) drive a desire for food, mineral and energy security which favour long term contracts and increased supply chain integration. Scarce resources suit a circular economy.
- Rising energy costs which favour local sourcing and pipeline development.
- Technological change shifts the units of motive power towards hydrogen based fuel cells; wind and solar powered vehicles; LNG; equipment with increasingly complex technical designs.
- New production processes drive 3-D printing and dematerialisation implies reducing material inputs per unit output.
- Autonomous vehicles and automated supply and fulfilment chains.
- Integrated digital payment and information exchange systems.
- Extra-terrestrial movements induce tough biosecurity controls.

The nature and location of production will change. Ships may already offer "floating warehouses" particularly with slow steaming, but on long inter-planetary missions, production will take place within the unit of carriage, or we will require systems in which inventory can evolve ad hoc in a circular fashion into other products as they are required.

Flows of information and money will be critical even if physical goods are not transported relating to for example production rights; construction, use and disposal regulations; template negotiation and exchange systems.

Perhaps trade and transport will become interplanetary, inter-stellar or inter galactic? This will still require physical components perhaps including "the way, the terminal, the unit of carriage and unit of motive power"; operations management; infrastructure; procurement and supplier management. The "time-related positioning of resource" may need to be revised if worm holes ever allow time travel but the basic principles of inter-animate relationships with whatever physical form new trading partners exhibit; efficiency, quality and risk; corporate social responsibility, "society" and inter-stellar responsibility, will remain.

A next step is to assess what changes (if any) may be needed to the CGA and KKA to prepare researchers to manage these shifts in logistics processes. Speculatively, "freight movement" and "international trade and transport" are selected as the KKAs most likely to require updates. Finally this work suggests a possible agenda of items which will require further research.

Analysis

How sustainable are CGAs to benchmark logistics education in 2100?

By their nature, most CGAs are sufficiently generic to cover most eventualities. CGA C refers to selection of methods and techniques, data collection and analysis, setting of performance measurement, and applications of modelling and simulation and technology. Over time the techniques, measures and technologies will change, but aside from a criticism that perhaps skills in setting aims and objectives needs to be more explicit rather than implicit within performance measurement, the basic processes and skills will surely remain in 2100. Similarly CGA B, the principles of skills required to manage efficiency, quality and risk will change little. In CGA D, the nomenclature within which to frame society, sustainability and the "global community" will change if an extra-terrestrial or regionalised environment attains, but the frameworks set by responsibility, resilience, regulation, sustainability and integration will not.

Interestingly, CGA A, related to integrated strategic planning, management and systems thinking is perhaps the CGA likely to be least resilient to change. Only one aspect, namely "people development, leadership and strategic change management" really relates to softer people skills. Within complex geopolitical global environments, likely to include regionalisation, localisation or de-globalization, interpersonal skills involving diplomacy and intercultural competence need to be explicit and extend beyond "people development". It is under two decades since successful logisticians depended on such skills, as business became international (Lu and Dinwoodie 2004; Pyne et al. 2007). Within extra-terrestrial logistical contexts survival extending far beyond simple trade may depend on an ability to display such skills at very high levels of competence with whatever life form is encountered in whatever environment, and should surely be prioritized in a logistics education. Within both the geopolitically hostile environment of regionalisation, and extra-terrestrial physically hostile environment, an ability to quickly and independently sense and develop business opportunities may also determine whether a business survives. Such entrepreneurial skills development surely goes beyond "leadership", and should be explicit.

How sustainable are KKA's to benchmark logistics education in 2100?

Freight movement (FM)	**Comment**
1. Services types of operation and interoperability	Complex
2. Intermodal integration and operations	Inter-chain
3. Transport of dangerous, oversize and hazardous freight	
4. Freight transport, fleet operations, forward planning	
5. Scope, capability, and efficiency of urban freight transport operations	High density
6. Freight forwarding and management of partners and subcontractors	
7. Local, national and international distribution network and regulations	Extra-terrestrial
8. Models, modal choice and multimodal freight transport	
9. Transport scheduling, routing, back loading and optimisation models	
10. Reverse logistics	Circular logistics
International trade and transport (ITT)	
1. International modal choice, inter-modality and security	Extra-terrestrial
2. Incoterms and contractual obligations	Inter-chain
3. Customs tariffs, processes, procedures and insurance	Biosecurity
4. Import, export, bonding and carnet procedures	Complex services
5. Freight forwarding, contracts of carriage, documentation and certification	Complex services
6. Specialist requirements for the carriage of different types of cargo	Ambient conditions
7. Insourcing, outsourcing, and offshoring	Off-planeting
8. International trade facilitation, treaties, finance, and settlement	Inter-planetary
9. Trade compliance, licensing and quotas	Inter-planetary
10. Facilities (port, airport) operations	Tank farms

Table 2: KKAs for freight movement and international trade and transport in A.D.2100

Table 2 outlines two KKAs which prima facie appear least sustainable, and adds commentary relating to whether skills affecting freight movements (FM) and international trade and transport (ITT) are likely to remain valid. Relatively few changes in kind are expected for most aspects of FM (including FM1, FM3, FM4, FM6, FM8 and FM9), excepting that the complexity of systems is likely to increase significantly. In particular, if extra-terrestrial systems develop, the type and range of services will increase, and thus problems of interoperability, freight with irregular characteristics, increasingly complex business relationships as specialist new functions emerge (such as designing and providing packaging for ambient zero gravity environments), and associated modelling and transport management issues.

Other aspects of FM pose interesting issues for future research. If the expected dramatic shifts in production methods and inventory management ensue, FM2 intermodal integration and operations are likely to shift to "inter-chain" systems embracing novel templates, data exchange systems and financing regimes. Within future mega cities, urban distribution centres may be replaced by district scale fulfilment centres, within which 3-D printing facilities operate to manufacture products to meet local demands. Whether suburban delivery systems will supplant final distribution involving private household vehicles is debateable. FM7 will require new nomenclature if extra-terrestrial systems develop perhaps engaging interplanetary, interstellar and intergalactic systems. On earth, if de-globalization and protectionism create regionalisation, then management of global systems involving "inter-regional" flows could involve major cultural and geopolitical dimensions, demanding that logisticians acquire skillsets which extend far beyond traditional logistics skills. Circular logistics are inevitable for extra-terrestrial movements, and indeed, as populations increase and available land reduces, pressures to implement a circular economy will redefine FM10.

Similar issues are likely to impact ITT. If extra-terrestrial systems develop, new nomenclature for ITT1 might engender concepts of inter-planetary and related movements; if regionalization ensues, inter-regional centres, inter-regional flow mode choice, intra-regional-modality may become significant. The principles of ITT2 will remain, but again if vertical supply chain integration increases to counter supply chain risks, "inter-chain" obligations will require a complete new nomenclature. ITT3 will become much tougher but extra-terrestrial systems will require specialist biosecurity and quarantine arrangements. The complexity of ITT4 and ITT5 will increase significantly as the range of specialist services and functions burgeons, as will ITT6 as the increased range of ambient temperatures create more challenging environments for storage, and handling. ITT7 may spawn phrases like "off-planeting", "in-chaining" or "out-chaining". Similarly, ITT8 and ITT9 may also become inter-planetary, inter-chain or inter-regional within which specialist processes may also evolve. Within ITT10, assuming that gravity can be harnessed to enhance motive power, mandatory skills for terminal operators might include tank firm management, perhaps as increasing proportions of liquid flows engage pipelines rather than movement by various tankers.

Similar shifts in processes and nomenclature could be attempted for all KKAs, perhaps having particularly radical implications for supply chain and operations management and logistics systems. However, unless a scenario based model is built, in which assumptions about particular technology and process developments are made, an infinite variety of possible future systems and their combinations emerges which denies generalisations. The findings presented here have implications for future research in logistics, society and policy.

Discussion

Research implications

As a benchmark to guide logistics education most aspects of DFDQ appear to be remarkably resilient, offering a sustainable basis for benchmarking logistics education. Ongoing future research will be required to test this resilience and to identify and address developing issues ad hoc as inputs to formulating strategies and policies to educate logisticians in A.D. 2100. It was noted earlier that CGA A requires explicit reference to a range of soft, "inter-animate" skills development, possibly to include non-human life forms. Within complex geopolitical global environments, regionalisation, localisation or de-globalization will demand interpersonal skills involving diplomacy and intercultural competence which need to be explicit and extend beyond "people development". An ability to quickly and independently sense and develop business opportunities should explicitly include entrepreneurial skills development which extends beyond "leadership". Extra-terrestrial logistics environments would demand both inter-animate and entrepreneurial skills.

Regarding KKAs, future research needs to extend beyond the engineering and economic aspects of de-materialisation, autonomous vehicles, off-globing, circular manufacturing, and dynamic supply chain processes. Ongoing research is essential relating to how educators can best foster personal adaptability, reliability, integrity and ingenuity to prepare logisticians to manage process change dynamically. Prima facie, the least sustainable KKAs were posited to be freight movements and international trade and transport, but even here most aspects appear robust aside from increasingly complex business relationships as specialist new functions emerge. More interesting issues for future research include training to design and manage "inter-(supply)-chain" systems embracing novel templates, data exchange systems and financing regimes; suburban district scale fulfilment centres and circular (economy) logistics. New nomenclature will be required to embrace extra-terrestrial systems or "inter-regional" rather than global or international systems. Regarding ITT, vertically integrated supply chains, "inter-chain" obligations, specialist biosecurity arrangements, and an increased range of ambient temperatures will create challenging environments within which to undertake storage, and handling. New nomenclature may include "off-planeting", "in-chaining" or "out-chaining". Scenario based planning will be required to handle specific combinations of system and process developments to pinpoint specific logistics skills issues.

Social implications

In an increasingly over-populated and interdependent world, soft human skills are increasingly likely to drive the skills demanded of logisticians rather than hard technical skills. Extra-terrestrial developments will demand both soft and hard skills, and increasingly "logistics and transport" will become an overly narrow conception of the field within which key skills will be fostered. As supply chains under threat increasingly integrate vertically, logisticians will require practical communication and leadership skills, involving not only effective interactions with different nationalities, but also differing regional value-systems and even co-operation with unknown and complex life-forms. Ongoing research will be required to optimize responsibilities within the triple-helix of industry-university-government relationships which underpin syllabus setting, educational provision and educational funding to ensure effective and practical skills development for logisticians.

Policy implications

The clients of future logistics education, given their long term career commitment (Dinwoodie et al., 2014) , will need to be engaged in both defining and executing future research agendas to define the skills they will need, future syllabi and the means which will be appropriate to shape their future educational experiences. However, future educational provision must reflect increasing trends towards circularity in which the same physical resources may constitute different products over time, trends towards chain management rather than management of particular processes such as logistics or transport, and 3D printing which reconfigures the traditional supply chain. Perhaps logisticians will select particular educational modules ad hoc, at different stages in their career, from a diverse set of management skills, which extend far beyond logistics and transport, to prepare them for their upcoming business role. Research will be required to identify precisely what skills each role will require, how many people will need to prepared to undertake each role, and to ensure a good fit between the requirements of each role and the aspirations of their incumbents.

References

- Barnes, J. & Liao, Y. (2012), 'The effect of individual, network, and collaborative competencies on the supply chain management system', *International Journal of Production Economics*, Vol. 140, No. 2, pp.888-899.
- CILTUK, (2017) 'Driving Knowledge, Delivering Quality. Our key Knowledge areas', Chartered Institute of Logistics and Transport, Corby, Northants, UK
- Dinwoodie, J. (2000), *Management Careers and Education in Shipping and Logistics*. Ashgate, Aldershot, England, 290 pp.
- Dinwoodie, J., Landamore, M. & Rigot-Muller, P. (2014), 'Dry bulk shipping flows to 2050: Delphi perceptions of early career specialists', *Technological Forecasting & Social Change,* Vol. 88, pp. 64-75.
- Lu, Y. & Dinwoodie, J. (2002), 'Comparative Views of International Freight Forwarders in China', *Transportation Journal*, Vol. 42, No. 2, pp.17-27.
- Murphy, P.R. & Poist, R.F. (2007), 'Skill requirements of senior-level logisticians: a longitudinal assessment', *Supply Chain Management: An International Journal*, Vol. 12, No. 6, pp.423-431.
- Nardon, L. & Steers, R.M. (2008), 'The New Global Manager: Learning Cultures on the Fly', *Organizational Dynamics*, Vol. 37 No. 1, pp.47-59.
- Pyne, R., Dinwoodie, J. & Roe, M. (2007), 'Enhancing the Intercultural Competence of Postgraduate Logisticians', *International Journal of Logistics Research and Applications*, Vol. 10 No. 3, pp.1-13.
- Sanchez-Runde, C., Nardon, L. & Steers, R.M. (2011), 'Looking beyond Western leadership models: Implications for global managers', *Organizational Dynamics*, Vol. 40, No. 3, pp. 207-213.
- Thai, V., Binte, K., Ibrahim, R.V. & Huang, H-Y. (2012), 'Competency Profile of Managers in the Singapore Logistics Industry', *The Asian Journal of Shipping and Logistics*, Vol. 28 No. 2, pp.

161-182.
- Yoon, J., Lee H.Y. & Dinwoodie, J. (2015), 'Competitiveness of container terminal operating companies in South Korea and the industry–university–government Network', *Transportation Research Part A,* Vol. 80, pp.1-14.

MARITIME CYBER SECURITY: THE EMERGING VIRTUAL THREAT TO SHIPPING

Kelvin Pang
Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University, Hong Kong

Introduction

According to Wienberg (2017), the leading container shipping company A.P. Moller Maersk had suffered a complete disruption of its IT systems in June 2017 that caused a significant financial loss to the business. Further to this, the PC system of BW's Groups, a large tanker-shipping corporation, was being hacked by a global ransomware, namely as NotPetya (Sameer, 2017). On other hand, with reference to Groll (2017), the collision between US destroyer USS John S. McCain and an oil tanker was caused by an unknown source of cyberattack, in which the hacker had infiltrated into the PC system of the destroyer and altered the navigational signal.

In recent years, the awareness of maritime cyber security was regarded as the level between low to absent (ENISA, 2011). In relevance to Brattas (2015), cyber-security is prevalently considered as a technical problem in the IT department of the organizations. Cyber security was viewed as one of the major areas demanding for better collaboration in Arabian Gulf territory (Defense Daily, 2014). Inmarsat (2016) adverted that the importance of conserving information on vessel regarding all kinds of cyber intrusion becomes indispensable. Currently, maritime industry relies densely on high-level Internet technology and it makes their systems easily to be hacked (Walsh, 2015). .

Regarding to the emerging trend of shipping digitalization, the escalation of cyber-incidents has exposed the lacking awareness in the maritime sector, and numerous issues concerning the cyber-security strategies deployed by shipping companies and collaboration between key players have aroused the interest all the stakeholders in the maritime industry.

There are six sections, including this introduction. Section two comprises of a literature review which aims to integrate theoretical support for key issues in maritime security. Section three describes the methodological approach to the research issues. The fourth section presents the findings of the research. The fifth section provides an analysis and discussion of the results. The last section provides a conclusion with suggested recommendations and areas for further research.

Literature Review

Cyber security refers to a set of events and various measures destined to prevent computer, network, hardware, software and any forms of information from being attacked and interrupted (Fischer, 2016). In accordance with ENISA (2017), digital security contains all actions essential to ensure the safety of Internet, its users, and involved parties. In order to counter the cyber risks and protect the cyber security, it involves a number of characters, covering public and private divisions and the society as an entity (Robinson et al., 2013).

Maritime cyber security is defined as actions taken to secure computer network and assets both on vessels, ports, terminals and all electronic hardware supporting sea activities (Hayes, 2016). International Maritime Organization (2018) illustrated maritime cyber security as a measure of the magnitude to which an electronics device could be debilitated by a latent condition or incident, which may contribute to the breakdown of maritime-related transaction, safety or protection as a result of system or information being perverted, disoriented or imperiled. In accordance with Sen (2016), cyber-incidents have begun to become trend in commercial maritime sector for intelligence assembling by numerous country states.

Current awareness of cyber security in shipping companies

The recent trend of cyber-attacks demonstrated that the complexity of modes of system invasions are skyrocketing, leading to the severity of cyber-attacks elevating simultaneously (Krask & Pedrozo,

2013). According to Kinthaert (2018), there are increasing incentives for the following individuals to grasp the potential impact of cyber-attack in the maritime sector: *activists*, *criminals*, *opportunists*, *sponsored organizations / terrorists*. The complexification of modes of attack alongside with these increasing incentives for attackers has put the sector in a dangerous condition.

ENISA (2011) noted that the level of awareness concerning cyber security elements within the shipping industry was found apparently low, this situation can be applied to all layers. According to Franke & Brynielsson (2014), awareness consists of willful thinking and understanding the intentions of attackers. According to Amoroso (2011), there is a lack of awareness of the industry in terms of having detail kowledge of their vulnerability. CyberKeel, a maritime cyber-security service provider, approached management layers in many maritime corporations inside the first half of 2014 on the subject of cybersecurity, finding many of the shipping companies put forth that the threats appeared to be more theoretical than real, linking to their doubts in the existence of genuine incentives for anyone to attack their industry (Cyberkeel, 2014).

Sen (2016) stated maritime cyber security has become a critical factor in shipping industry as their shipping business and the related sectors were being attacked increasingly while none of them had established contingency plans with respect to cyber-threats (O'Hanlon, 2017). Moreover, many cyber incidents like the Maersk case underline the fact that majority of the organizations, especially in the maritime sector, still lack a comprehensible approach in terms of cyber security management in relation to their systems over the decade (Bothur et al., 2017). Kott (2014) emphasised that effective defense can reflect their level of awareness towards cyber security.

Vulnerability of shipping companies towards cyber-threats

According to Bothur et.al. (2017), vulnerabilities infer the flaws in a network or system that can be exploited potentially by vicious individuals or parties. In terms of technological vulnerability, the systems being deployed in vessels and ports are increasingly automated and reliant on information technology systems in which the computer-based operations and communications systems are exceptionally vulnerable to malicious attack (Sen, 2016). According to Marsh (2014), scholars from University of Texas discovered that vessels are highly susceptible targets as hackers are able to alter the navigations of vessels by the way of emitting fake GPS signal and countermand the authentic signal. For instance, almost 280 vessels in South Korea needed to go back to port after their navigation systems were disrupted in 2016 (Graham, 2017). Also, there is a common problem for the systems on ships lacking updated or basic antivirus software, which contribute to the vulnerability of ships towards cyber-threat (BIMCO et al., 2017). Attackers may possibly connect with shipboard networks and systems associated to them and misapprehend it for ECDIS and AIS (NCC Group, 2014). There was a case about a tanker ship's navigation system being infected by virus at Asian port, resulting in delayed departure (Baraniuk, 2017). Apart from this, there can be a greater chance for companies that depend on internet suffering from cyber incidents (Byres & Lowe, 2004). Meanwhile, cyber incidents related to personal and sensitive date stealing has been popular, posing threat to company's information security (Kuypers et al., 2016).

Despite the aspect of technology, improper behavior of staff can also contribute to cyber threats for organizations (Parsons et al., 2014). While technology which is directly related to cyber security, the people who access and utilize the system can also pose impact to the security level to a great extent (Bowen et.al., 2011). Cyber insufficient training of staff and crew results in the problem of unsatisfactory execution of protocols leading to vulnerability against cyber-attacks (Reilly & Jorgensen, 2016). According to Parsons et al. (2014), staff are often being responsible for data breaches during handling sensitive information. Malicious access to the company's network system could be unconsciously allowed by staff as social attacks has been a common mode of attacks (Manworren et.al., 2016).

Research methodology

The scope of the research focused on the awareness of cyber security in the shipping industry. Qualitative interviews were carried out on two groups of experts – academic and industry. Seven semi-structured interviews were conducted using a variety of ways including face-to-face, telephone conversations and videoconference. Each interview duration lasted between 1 to 1.5 hours. The interview questions were sent to the interviewees prior to the interviews in order to allow them to think and prepare the answers. It also helped to ensure the interview flowed smoothly. The interviews were transcribed immediately after to get clarity and feeling for the data. Noted and comments were made for each interview, after which to compare against each other. Statements were compared with the literature to develop meaningful conclusions. The composition of the interviewees is as follows:

- One interview with academic ;
- Three interviews with shipping companies (Expert A, B, C);
- One interview with marine insurer (Expert D);
- One interview with information security -maritime sector (Expert E);
- One interview a Hong Kong government agency (Expert F).

Findings

Current situation of the shipping companies

Interviewees were asked about how cyber threats affect their companies' awareness. The three shipping companies interviewed stated that none of their companies have encountered cyber-attacks on a massive scale, which results in data and financial loss, but instead they came across minor cyber-attacks, ranging from viral attacks, malicious emails to fake cargo bookings. These interviewees expressed confidence in their companies' defence system and believed that they will not fall prey to cyber security attack.

In terms of malicious actors' incentive, Expert F opined that the shipping industry does not provide a strong incentive for hacker to organize impactful cyber-attacks. The reasons for hackers to conduct a cyber-attack stems from person monetary motives or financial benefits received from third parties. This is in agreement with the academic expert and three other industry experts, who thinks that the shipping industry does not have high value assets or information to attract hackers; therefore shipping companies are not frequent targets of hackers.

Changes in expenditure to combat cyber-threats

Some interviewees prefer reviewing the existing cyber-security protocols and training courses for employees to investing new security technology and systems. Expert A, Expert B and Expert F said that expenditures of shipping companies are unlikely to elevate since normal anti-virus software and firewall are able to defend numerous of virus, spyware, worms and malicious emails. Expert C held similar opinion and stated that companies will not increase their expenditure before experiencing successful attacks.

Vulnerability of the maritime sector towards cyber threats.

In the technological level, Expert F in the governmental perspective stated that most shipping companies are using ordinary and universal defense mechanisms since they are already sufficient to defend viral attacks. In terms of staff trainings, Expert B, Expert C and Expert D said that they provided security trainings and guidelines to employees to enhance their awareness and difficulties of being attacked, such as encryption of sensitive data and clean desk. Expert C further supported that they tried to increase security awareness on employees and keep reminding them the seriousness of cyber-attacks. Despite that, Expert F held a pessimistic perspective on the effectiveness of training and stated that even though guidelines and code of conduct were given by companies, they usually do not monitor if the policies and guidelines were fully complied with, this constitute the shipping companies to be more vulnerable to cyber-attacks.

Analysis and Discussion

From the results, we found that the shipping industry's awareness on cyber security remains low while the expenditure for cyber security is unlikely to change. The possible reason could be their perception on the attackers' motivations. Since the transactions in the shipping industry do not involve high-value assets, it is believed that there are no explicit reason luring attackers to target them. In fact, as mentioned in the literature review, there are several reasons for the criminals to initiate attacks against the shipping industry, thus the purpose of the attackers may not be as unsophisticated as respondents thought. Their singular view on the purpose reveals that they do not consider themselves under the worsening cyber security situation, and therefore do not find themselves going to be affected by the rising attack rate. This perception resulted in low awareness of the industry and their protection not strengthened.

In the literature review, the biggest vulnerabilities within the companies were identified as human element and technology. Human element is regarded as the most vulnerable source as most cyber-attacks occur because of human error. In addition to the phishing scams, incidents may also occur due to vulnerable document processing by people. The documents for daily business operations are usually highly confidential, and that improper printing, keeping and emailing these documents can pose cyber risks to organizations. All of these problems can be corrected through training, education and policy, and therefore it is important for the companies to have right measures in place to avert damage. Although the interviewees opined that they are not particularly vulnerable to cyber-attacks, they still emphasize staff training. This may be caused by the fact that they regard security system is only a tool and the security level actually depends on how people make use of it. Therefore, they paid attention to human element through providing more training to reduce vulnerability. But the result of training may need to be assessed and monitored so as to ensure its effectiveness.

Conclusions

This paper investigated into the current cyber security situation in the maritime industry by looking the current awareness and vulnerability of shipping companies towards cyber-threats. The research has found that there was and increasing cyber-attack rate in the industry and most of the companies has experienced attacks successively in these two years. However, they have a common problem to perceive their actual defence ability and the state of the circumstances that they were locating in, the general cyber awareness was therefore proved insufficient. It is suggested that individual shipping companies could formulate their cyber-security training programme based on their particular employee needs, in which the factor of different role and working years could be taken into consideration. For example, a tailor-made cyber-security training programme could be made for offshore employees, address their differences between offshore and onshore company such as the IT reporting system. By eliminating individual uncertainty, it can help to ensure the awareness level of employee.

Reference

- Amoroso, E. G. (2011), 'Cyber Attacks: Awareness', *Network Security*, Vol. 1, pp. 10-16.
- Baraniuk, C. (2017), 'How Hackers are Targeting the Shipping Industry', Retrieved from http://www.bbc.com/technology-40685821.
- BIMCO, CLLIA, ICS, INTERCARGO, INTERTANKO, OCIMF and IUMI (2017), 'The Guidelines on Cyber Security Onboard Ships', Retrieved from http://www.ics-shipping.org/docs/default-source/resources/safety-security-and-operations/guidelines-on-cyber-security-onboard-ships.pdf?sfvrsn=16
- Bothur, D., Zheng, G. & Valli, C. (2017), '*A Critical Analysis of Security Vulnerabilities and Countermeasures in a Smart Ship System*', The Proceedings of 15th Australian Information Security Management Conference, 5-6 December, 2017, Edith Cowan University, Perth, Western Australia, pp.81-87.
- Bowen, B.M., Devarajan, R., & Stolfo, S. (2011), 'Measuring the Human Factor of Cyber Security', Technologies for Homeland Security (HST), 2011 IEEE International Conference, pp. 230-235.
- Byres, E., & Lowe, J. (2004), 'The Myths and Facts Behind Cyber Security Risks for Industrial Control Systems', The Proceedings of the VDE Kongress, Vol. 116, pp. 213-218.
- CyberKeel (2014), Maritime Cyber-Risks: Virtual Pirates at Large on the Cyber Seas', Retrieved from http://www.cyberkeel.com/images/pdf-files/Whitepaper.pdf.
- Defense Daily (2014), 'Maritime, Cyber Security Ripe For Greater Cooperation In Persian Gulf, DoD Official Says'. Retrieve from
- http://www.defensedaily.com/maritime-cyber-security-ripe-for-greater-cooperation-in-persian-gulf-dod-official-says/.
- ENISA (2011), 'Analysis of Cyber Security Aspects in The Maritime Sector', Retrieved from https://www.enisa.europa.eu/publications/cyber-security-aspects-in-the-maritime-sector-1
- ENISA. (2017), 'ENISA Overview of Cybersecurity and Related Terminology', Retrieved from https://www.enisa.europa.eu/publications/enisa-position-papers-and-opinions/enisa-overview-of-cybersecurity-and-related-terminology.
- Franke, U. & Brynielsson, J. (2014), 'Cyber Situational Awareness – A Systematic Review of the Literature', *Computers & Security*, Vol. 46, pp. 18-31.
- Fischer, E. A. (2016), 'Cybersecurity Issues and Challenges: In Brief', Retrieved from https://fas.org/sgp/crs/misc/R43831.pdf.
- Graham, L. (2017), 'Shipping Industry Vulnerable to Cyber attacks and GPS Jamming', Retrieved from: https://www.cnbc.com/2017/02/01/shipping-industry-vulnerable-to-cyber-attacks-and-gps-jamming.html.
- Groll, E. (2017), 'U.S. Navy Investigating if Destroyer Crash Was Caused by Cyberattack', Retrieved from http://foreignpolicy.com/2017/09/14/u-s-navy-investigating-if-destroyer-crash-was-caused-by-cyberattack/.
- Hayes, C. R. (2016), 'Maritime Cybersecurity: The Future of National Security', Doctoral dissertation, Monterey, California: Naval Postgraduate School. Retrieved from https://calhoun.nps.edu/bitstream/handle/10945/49484/16Jun_Hayes_Christopher.pdf?sequence=1&isAllowed=y.
- Inmarsat (2016), 'Singtel, Inmarsat Partner to Strengthen Maritime Cyber Security Capabilities', Retrieved from https://www.inmarsat.com/press-release/singtel-inmarsat-announce-strategic-partnership-strengthen-global-maritime-cyber-security-capabilities/.
- International Maritime Organization. (2018), 'Maritime Cyber Risk', Retrieved from http://www.imo.org/en/OurWork/Security/Guide_to_Maritime_Security/Pages/Cyber-security.aspx.
- Kinthaert, L. (2018), '8 Experts Weigh In on Cybersecurity in Shipping & Maritime', Retrieved from https://knect365.com/maritime/article/56554e0a-1356-42ac-88cd-564a389bcd1e/cybersecurity-shipping-maritime.

- Kott, A., Cliff, W. & Erbacher, R.F. (2014), 'Cyber Defense and Situational Awareness', *Advances in Information Security*, Vol. 62, pp. 29-45.
- Kraska, J. & Pedrozo, R. (2013), '*International Maritime Security Law'*, Martinus Nijhoff Publishers, Boston, U.S.
- Kuypers, M.A., Maillart, T. & Pate-Cornell, E. (2016), 'An Empirical Analysis of Cyber Security Incidents at a Large Organization', Working Paper, Stanford University, Retrieved from https://fsi.stanford.edu/publication/empirical-analysis-cyber-security-incidents-large-organization.
- Manworren, N., Letwat, J., & Daily, O. (2016), 'Why You Should Care About the Target Data Breach', *Business Horizons*, Vol. 59, No. 3, pp. 257-266.
- Marsh (2014), 'The Risk of Cyberattack to the Maritime Sector', Retrieved from http://me.marsh.com/NewsInsights /ID/41615/The-Risk-of-Cyber-Attack-to-the-Maritime-Sector.aspx.
- NCC Group (2014), 'Preparing for Cyberbattleships: Electronic Chart Display and Information System Security', Retrieved from https://www.nccgroup.trust/uk/our-research/preparing-for-cyber-battleships-electronic-chart-display-andinformation-system-security/.
- O'Hanlon, M. E. (2017), 'Cyber Threats and How the United States Should Prepare', Retrieved from https://www.brookings.edu/blog/order-from-chaos/2017/06/14/cyber-threats-and-how-the-united-states-should-prepare/.
- Parsons, K., McCormac, A., Butavicius, M., Pattinson, M., & Jerram, C. (2014), 'Determining Employee Awareness Using the Human Aspects of Information Security Questionnaire (HAIS-Q)', *Computers & Security*, Vol. 42, pp. 165-176.
- Reilly, G., & Jorgensen, J. (2016), 'Classification Considerations for Cyber Safety and Security in the Smart Ship Era', In Proceedings of the International Smart Ships Technology Conference, pp. 26-27.
- Robinson, N., Gribbon, L., Horvath, V., & Robertson, K. (2013), 'Cyber-Security Threat Characterisation - A Rapid Comparative Analysis', Retrieved from https://www.rand.org/pubs/research_reports/RR235.html.
- Sameer, M. C. (2017). Shipping: BW Group's computer systems hacked; steps up cyber security. Retrieved from https://www.platts.com/latest-news/shipping/singapore/shipping-bw-groups-computer-systems-hacked-steps-26820691.
- Sen, R. (2016), 'Cyber and Information Threats to Seaports and Ships', in McNicholas, M.A., '*Maritime Security'*, 2nd Ed, Butterworth-Heinemann, Oxford, UK.
- Walsh, D. (2015), 'Maritime Cyber Security: Shoal Water Ahead?', *U.S. Naval Institute Proceedings*, Vol. 15, no. 7, pp. 88.
- Wienberg, C. (2017), 'Maersk Says June Cyberattack Will Cost It up to $300 Million', Retrieved from https://www.bloomberg.com/news/articles/2017-08-16/maersk-misses-estimates-as-cyberattack-set-to-hurt-third-quarter.

DEVELOPOING A CONCEPTUAL FRAMEWORK FOR SUSTAINABLE 'LAST-MILE' DELIVERY FOR CHINESE ONLINE RETAILING MARKET

Boyong Zhang and Yongmei Bentley
Business School, University of Bedfordshire, Luton, UK

1. Introduction

This study aims to develop a conceptual framework for sustainable last-mile delivery for China's online retailing market via systematic literature review (SLR) and semi-structured interviews. Based on our SLR, European academia is the most productive and creative region regarding last-mile delivery research. Unfortunately, many projects and studies have failed or remained at preliminary stages. Nevertheless, European researchers and practitioners are very vigorous to implement new ideas into operations. They have introduced and developed different models, alternative solutions, new vehicles, regulatory suggestions, along with some inspiring frameworks and reviews. In the Chinese context, last-mile research remained at a theoretical level. Scholars are still trying to explain the relationship between e-commerce and last-mile delivery (Chen and Lin, 2013; Wang and Xiao, 2015), few have entered the innovative stage of research. Chinese scholars rarely mention terminologies such as sustainable last-mile, smart-cities, or smart logistics. They are in dire of need a roadmap which can provide guidance for last-mile decision-making process.

2. Literature Review

There are some literature reviews completed by other scholars. Oliveira et al. (2017) have conducted a systematic literature review for last-mile city logistics from 2007 to 2016 (157 papers with 46 selected articles). But they mainly focused on the vehicle choices of last-mile delivery and ignored other types of last-mile solutions and initiatives. Apart from this, Wolpert and Reuter (2012) have examined the city logistics systematically (with a review of 92 selected articles) to confront infrastructure and domestic changes. In this research, developing a conceptual framework for sustainable last-mile delivery for Chinese online retailing market requires a comprehensive understanding of this field. Therefore, we launched our systematic literature review focusing on last-mile solutions, constraints, and sustainability issues. Based on the SLR protocol, this research has found 1,008 journal papers regarding last-mile from the year 2013 to 2018 (with the searching keywords of city logistics, urban logistics, urban freight, and city freight), and a total of 173 papers are selected concerning our focuses. Additionally, this on-going research also includes the review of other reliable resources, such as company reports, and reports from 3rd party consultancies. The following sub-sections will summarise some of the key areas in the literature reviewed for our research. These include innovative vehicles, last-mile solutions, European leading last-mile projects, and sustainability awareness/interests.

2.1 Innovative Vehicles

This section provides a summary of the literature on innovative vehicles.

- *High-Performance Freight vehicles* (HPFVs): Thompson and Hassall (2014) conducted a study about how HPFVs could help couriers to reduce cost while improving safety and cut down emission. A Performance-Based Standards (PBS) framework was used to support the analysis of the implementation of HPFV in Australia urban areas (Thompson and Hassall, 2014). According to the authors, HPFVs are large lorries with multiple containers. The simulation result showed that the delivery company's productivity could increase by 20% to 50% (Thompson and Hassall, 2014).

- *Mobile depot*: Verlinde et al. (2014) launched a pilot test of the mobile depot which is an electrically powered trailer hocked with a loading dock, a small warehouse, and an office. Their test result showed both decrease in distance travelled and emission release. Foltynski (2014)

analysed the electric urban freight mobility with the consideration of technological, legal, and social factors for small and medium-sized cities. The result showed that gas emission reduction had been achieved. However, collaborations between stakeholders are the most crucial condition for the green fleet initiative to be implemented (Foltynski, 2014).

- *Electric bicycles (E-Bikes) and E-scooters*: Electric bicycles and E-scooters have been tested under several projects within many European cities (Gruber and Kihm, 2016; Nocerino et al., 2016). The pilot test proved E-Bikes and E-scooters could reduce last-mile CO2 emissions and save urban transport energy (Gruber and Kihm, 2016; Nocerino et al., 2016). Meanwhile, projects about cargo bikes and cargo tricycles also showed promises of creating social and environmental values for stakeholders (Koning and Conway, 2016; Conway et al., 2017).

- *Aerial vehicles* (UAVs): Studies about drone deliveries have surfaced in recent year. The focus of projects concerning aerial vehicles is the comparative case studies of CO2 emissions between drones and traditional delivery vehicles (Goodchild and Toy, 2017). Studies have proved that the efficiency and carbon footprint of using them are heavily depend on the energy requirements of the drone as well as the travel distance (Goodchild and Toy, 2017; Hong et al., 2018). However, drone delivery is not in commercial use due to various constraints such as route problem, range restrictions, and refueling stations, etc. (Hong et al., 2018l; Yoo et al., 2018).

Most projects above have examined the potential of different innovative vehicles, but few have discussed the feasibility of implementation, regulations, and stakeholder reactions. Therefore, for a new innovative vehicle to be successful practically, not only the technology embodied with the vehicle, but also other elements such as local government policy, end users attitude, courier companies' acceptance, and even the opinion of delivery force must be considered (Quak et al., 2016).

2.2 Last-Mile Solutions

This section discusses some of the most popular last-mile delivery solutions.

(1) *Attended home delivery* (AHD): While Attended home delivery (AHD) is the most popular way of last-mile delivery. Morganti et al. (2014) explicitly articulate that AHD is also the most problematic section of the last mile since online orders have made city logistics more fragmentized. Issues in relation to home delivery have also been mentioned: (1) failed delivery, such as not on time, customer not at home etc.; (2) expensive delivery, long waiting time, and forced to stay at home; (3) 12% deliveries required redeliver (Visser et al., 2014). Visser et al. (2014) also stated that development of online shopping and increasing demand for high-quality home delivery services by the customer had fragmentized the city logistic sector.

(2) *Pick-up points and parcel lockers*: Morganti et al. (2014) discussed the impact of e-commerce on last mile deliveries focusing on pick-up points and parcel lockers. The result of their research showed that pick-up points and parcel lockers could increase the numbers of successful first-time deliveries; optimising delivery routes; and further reduce delivery cost (Morganti et al., 2014). Iwan et al. (2016) confirmed in their pilot research of alternative solution utilization that parcel lockers are the future direction of city delivery services. Lemke et al. (2016) conducted a qualitative study to understand customer perspective towards alternative last-mile delivery solutions. Their research reveals that most customers trust parcel locker service with an eco-friendly attitude (Lemke et al., 2016). Vakulenko et al. (2017) examined values created for customers by implementing the parcel lockers via focus group method. Vakulenko et al. (2014) indicate that parcel locker is a double edge sword with a possibility to destroy

customer value. They also confirmed that financial benefits could be generated for customers when they use parcel lockers for delivery and return (Vakulenko et al., 2014)

(3) *Collection and delivery points* (CDPs): Another popular delivery solution is collection and delivery points (CDPs) which is a third-party location (usually a local shop of any kind) to help people receive and send parcels for a slim financial income. According to Kedia et al. (2017), CDPs have been successful in increasing last-mile delivery efficiency and reduce failed delivery and multiple deliveries in many European countries. However, Kedia et al. (2017) also warn companies who are going to adopt CDPs be careful with some factors such as parking availability near CDPs, locations, distance to home or office, and safety. Yuen at al. (2018) believes that by integrate CDPs into customers' lifestyle, values, and needs will enhance their positive intention to use such delivery solution.

(4) *Crowdsourcing*: Crowdsourcing is a new concept/solution of last mile parcel delivery. Crowdsourcing is a participative activity assigned by a crowdsourcer to an individual or a group of individuals via a flexible open call (Arolas and Guevara, 2012). Based on the nature of crowdsourcing, the individual usually voluntarily answers the call, and get a reward in return (Arolas and Guevara, 2012). In city logistics, crowdsourcing contains both first-mile collection and last-mile delivery (Akeb et al., 2018). Kunze et al. (2015) state that crowdsourcing for last-mile delivery can crate win-win-situation for end receivers and crowd members. But it requires advanced ICT-solution, trust between stakeholders, and a feasible business model (Kunze et al., 2015). Punel et al. (2018) investigated the determinants for using crowdsourcing: male and young people with full-time jobs are more open towards crowdsourcing ideas; Urban areas hold more potential for crowdsourcing implementations; medium-distance is the most favourited delivery distance among the users. Frech et al. (2017) evaluated the nature and characteristics of the crowdsourcing model and suggested that companies should be aware of long-term negative return on investment, and be careful with local regulations, meanwhile build-up the crowd network as fast as possible.

Nowadays, parcel lockers and CDPs are very common in our daily life. However, in China, these alternative solutions are facing different kinds of issues due to the reality of Chinese cities' high population density. Most parcel locker companies in China are losing money while some customers are complaining about their parcels been delivered to parcel lockers and CDPs without their approvements (XinHua, 2018). Information about crowdsourcing last-mile is also scarce in China. Our secondary data revealed that none of the parcel locker providers in China is making profit due to high installation cost and maintenance cost (XinHua, 2018). Thus, it is necessary to investigate the current performance of last-mile solutions provided by Chinese couriers.

2.3 European Leading Last-Mile Projects

This section summarises some recognizable last-mile project initiated by European Commission and European countries.

(1) *The STRAIGHTOL project and SMARTFUSION project*: The European Commission has launched many projects regarding smart city development. The STRAIGHTOL project aims to test the feasibility of mobile depot Verlinde et al. (2014). The Dutch courier TNT has implemented this project. However, the cost has been doubled compared to traditional van deliveries. The pilot test showed the mobile depot (MD) was at 40 percent of its loading capacity which means there is a possibility to overcome the increased cost with proper optimizations (Verlinde et al., 2014). Within the project STRAIGHTOL, Macharis et al. (2014) developed an evaluation framework based on stakeholder perspectives. This framework allows decision makers to be involved at each stage of the decision process of city distribution projects (Macharis et al., 2014). The outcome of this framework can assist European authorities to make right decisions

on future logistics investment and transfer the knowledge across among European countries (Macharis et al.,2014).

(2) *SMARTFUSION PROJECT*: The SMARTFUSION PROJECT aims at four key aspects: green vehicles, UCC, planning and telematic delivery, and regional urban freight policies (Balm et al., 2014). All related projects were tested in the UK, Germany, and Italy. The purpose of SMARTFUSION project is to find new city freight solutions with less operational cost and less environmental impact (Balm et al., 2014).

(3) Other last-mile projects: There are many innovative last-mile initiatives in recent years that were successful, but the implementation of large-scale operations has mostly failed (Balm et al., 2014). For instance, there are 53 innovative urban freight solutions proposed and implemented in European cities under the project CIVITAS (Rooijen & Quak, 2014). From the year 2015, more and more project started to focus on the implementation and utilization of Urban Consolidation Centres (UCCs), which is a city logistic facility can separate the distribution into activities inward and outward (Clausen et al., 2016). For example, the LaMiLo project (last mile logistics) is promoted to enable environmental friendly UCC operations to achieve a sustainable last mile and transfer useful business models (Clausen et al., 2016).

2.4 Stakeholder Sustainability Awareness and Sustainability Interests

Stakeholders' sustainability awareness, mutual sustainability interests, and sustainability knowledge are the fundamental conditions for achieving sustainable development (Horisch et al., 2014). Freeman et al. (2010:24) have categorized stakeholder into primary stakeholder and secondary stakeholders. Regarding last-mile delivery, the primary stakeholders include carriers, end-receivers, and local authorities (Bjerkan et al., 2014).

The different interests and perspectives of primary stakeholders over the implementation of last-mile solutions such as Mobile Depot and night deliveries were examined by Bjerkan et al. (2014). Their finding shows that different stakeholders hold different preference over last-mile solutions. However, it is crucial to locate the mutual sustainability interests, which was described by Bjerkan et al. (2014) as 'common ground' in his project. But, specific method to identify the 'common ground' was not given explicitly.

There are only a handful of projects focus on last-mile delivery with considerations of stakeholders' perspective. One group of publications have aimed at enhancing stakeholders' involvement regarding last-mile policy and decision making (Kunze et al., 2015; Marciani et al., 2016; Nesterova and Quak, 2016). The other group has investigated the stakeholders' impact and interaction effect on the implementation of sustainable last-mile initiatives (Marcucci et al., 2017; Kin et al., 2017; Estrada and Roca-Riu, 2017). As above mentioned, successful implementation of last-mile initiatives/solutions requires a comprehensive consideration of all stakeholders' sustainability interest.

The literature review has identified many inspiring journal articles tackling different aspect of the last-mile delivery including solutions, policies, constraints, and stakeholder sustainability awareness/interests/knowledge. Few have mentioned the last-mile issues in China's online retailing market with a sustainable perspective. We believe by synchronizing the findings from the West, plus the future data collected from interviews, our research could add a pinch to the body of knowledge to help emerging market to confront last-mile challenges.

3. Methodology and Preliminary findings

Apart from the systematic literature review, this research uses both primary data and secondary data. The primary data is going to be collected via semi-structured interviews with Chinese managers who work for last-mile carrier companies.

The research question is:

- RQ1: What are the current delivery solutions provided by Chinese last-mile couriers?
- RQ2: What are the concerns of Chinese couriers regarding sustainable development?
- RQ3: What are the current level of sustainability knowledge/awareness among Chinese couriers?

To test research questions, five preliminary interviews were conducted via online video chat with last-mile logistics managers from different carriers. Our preliminary findings showed that the following:

(1) Most managers interviewed lack of sustainability knowledge/awareness.
(2) Attended Home Delivery is the primary delivery method, lockers and CDPs are being used only when customer not at home in most circumstances.
(3) The communication regarding sustainability issues between the carrier and other stakeholders in China's last-mile market is inefficient due to the contract abuse of 3PLs by online retailers.
(4) Reduce last-mile cost is the primary target of carriers.

Secondary data include a continuous information gathering from major Chinese news agencies to categorize sustainability-related last-mile issues/incidents via cloud map technique. The finding shows that stealing and robbery conducted by deliverymen are prevalent and severe problems in China. Besides, the wrapping paper for home delivery is the most pollutive waste generated by China's last-mile delivery. For the other part of the secondary data collection, we have reviewed three major Chinese carriers' annual reports of the year 2016 with focus on sustainable last-mile solutions and policies (ShenTong, YuanTong, and Shunfeng). Unfortunately, none of these companies have on-going sustainable last-mile projects. ShenTong only mentioned its plan to reduce CO2 emission to become a completely green logistic company without giving any details (Shentong Annual Report, 2016). All three companies have emphasized stakeholder profit maximization in the annual report.

4. Next step of the research

The SLR has identified the key stakeholders and other major elements of the intended framework such as policies, solutions, constraints, and knowledge/awareness/interests. The next step of the research is to collect data from 30 to 50 Chinese managers who work for Chinese last-mile carriers via semi-structured interview. The expecting outcome should be able to generate new (Chinese specific) elements to the conceptual framework. The framework will be one of the first to address the sustainability issues in China's last-mile delivery for the online retailing market. It is also the first comprehensive conceptual framework with the consideration of the concept of sustainability in the Chinese context. It should help managers identify key stakeholder, major sustainability impact, available delivery solutions and sustainable practices to plan future sustainable activities and improve last-mile performance. Most importantly, online retailers and last-mile couriers can refer to this framework to enhance sustainable development collaboratively.

5. Conclusions

This is an on-going doctor's research project aimed to create a comprehensive conceptual framework for China's last-mile delivery for Chinese online retailing market. As China has become the number one online shopping market in the world, the booming e-commerce has also boosted the last-mile delivery service in this country. Due to the unhealthy expansion of the home delivery market in China, sustainability issues regarding people, environment, and capital have become inevitable challenges for all stakeholders in this market. This research has examined state-of-the-art last-mile delivery literature about the last-mile practices of developed countries and identified the essential elements of the intended framework. It needs further data collections to compare, verify and validate the preliminary findings. Once completed, this research project could potentially contribute to the body of knowledge

by providing the conceptual framework as theoretical support not only to Chinese practitioners but also to managers and scholars in other emerging markets. It could aid managers to identify sustainable last-mile constraints and implementable solutions.

Reference

- Akeb, H., Moncef, B., and Durand, B. (2018), 'Building a collaborative solution in dense urban city settings to
- enhance parcel delivery: An effective crowd model in Paris', *Transportation Research Part E*, https://doi.org/10.1016/j.tre.2018.04.007.
- Arolas, E. E., and Guevara, F. (2012), 'Towards an integrated crowdsourcing definition,' *Journal of information science*, vol.32(2), p.189-200.
- Balm, S., Browne, M., Leonardi, J., & Quak, H. (2014), 'Developing an Evaluation Framework for Innovative Urban and Interurban Freight Transport Solutions', *Social and Behavioral Science*, vol.125, p.386-397.
- Bjerkan, Y.K., Sund, B.A., & Nordtomme, E. M. (2014), 'Stakeholder responses to measures green and efficient urban freight,' *Research in Transportation Business & Management*, vol.11, p.32-42.
- Chen, X.L., & Lin, H. (2013). 'Research on e-commerce logistics system informationization in China', *Social and Behavioural Science*, Vol.96, p.838-843.
- Clausen, U., Geiger, C., & Poting, M. (2016), 'Hands-on testing of last mile concepts', *Transportation research procedia*, Vol.14, p.1533-1542.
- Conway, A., Cheng. J., Kamga. C., & Wan. D. (2017). 'Cargo cycle for local delivery in New York City: performance and impacts,' *Research in Transportation Business & Management,* vol. 24. P.90-100
- Devari, A., Nikolaev, G. A., and He, Q. (2017). 'Crowdsourcing the last mile delivery of online orders by exploiting the social networks of retail store customers', *Transportation Research Part E*. vol. 105.p.105-122.
- Estrada, M., & Roca-Riu, M. (2017). 'Stakeholder's profitability of carrier-led consolidation strategies in urban goods distribution', *Transportation Research Part E*, vol.104, p.165-188.
- Foltynski, M. (2014). 'Electric fleets in urban logistics', *Social and Behavioral Science*, vol.151, p.48-59.
- Freche, V., Mehmann, F., & Teuteberg, F. (2017). 'Understanding and assessing crowd logistics business models – using everyday people for last mile delivery', journal of business & industrial marketing, vol.30(1), p.75-97.
- Freeman, E.R. Harrison, J. Wicks, A, Parmar, B., and Colle, S. (2010). Stakeholder Theory: The state of the art, *Cambridge: Cambridge University Press*, p.24
- Gevaers, R., Voorde, E., & Vanelslander, T. (2014). 'Cost Modelling and Simulation of Last-mile Characteristics in an Innovative B2C Supply Chain Environment with Implications on Urban Areas and Cities', *Social and Behavioral Science*, vol.125, p. 398-411.
- Goodchild, A., and Toy, J. (2017). 'Delivery by drone: An evaluation of unmanned aerial vehicle technology in reducing CO2 emissions in the delivery service industry', *transportation research part D*, feb, 2017.
- Hayashi, K., Nemoto, T. & Nakaharai, S. (2014), 'The development of the Parcel Delivery Service and its Regulations in China', *social and behavioral sciences*, Vol.125, pp. 186-198.
- Hong, I., Kuby, M., & Murray, T. A. (2018). 'A range-restricted recharging station coverage model for dronedelivery service planning', *Transportation Research Part C*, Vol.90, p.198-212.
- Horisch, J, Freeman. E.R. and Schaltegger, S. (2014). 'Applying Stakeholder Theory in Sustainability Management: Link, Similarities, Dissimilarities, and a Conceptual Framework', *Organization & Environment*, Vol.27(4), pp.328-346.

- Iwan, S., Kijewska, K., & Lemke, J. (2016). 'Analysis of parcel lockers' efficiency as the last mile delivery solution – the results of the research in Poland', Transportation Research Procedia, vol.12, p.644-655.
- Karakikes, I. & Nathanial, E. (2017). 'Simulation techniques for evaluating smart logistic solutions for urban distribution', Procedia engineering, vol.178. p. 569-578.
- Kin, B., Verlinde, S., Mommens, K., & Macharis, C. (2017), 'A stakeholder-based methodology to enhance the success of urban freight transport measures in a multi-level governance context', Research in Transportation Economics, vol.65, p.10-23.
- Koning, M., & Conway, A. (2016). 'The good impacts of biking for goods: Lessons from Paris city', Case Studies on Transport Policy, vol.4, p. 259-268.
- Kunze, O., Wulfhorst, G., & Minner, S. (2015), 'Applying systems thinking to city logistics: A qualitative (and quantitative) approach to model interdependencies of decisions by various stakeholders and their impact on city logistics', *Transportation Research Procedia*, vol.12, p.692-706.
- Lemke, J., Iwan, S., Korczak, J. (2016). 'Usability of the parcel lockers from the customer perspective – the research in Polish Cities', Transportation Research Procedia, vol.16, p.272-287.
- Macharis, C., Milan, L., & Verlinde, S. (2014), 'A stakeholder-based multicriteria evaluation framework for city distribution', Research in Transportation Businss & Management, vol.11, p.75-84.
- Marciani, M., Cossu, P., & Pompetti, P. (2016), 'How to increase stakeholders' involvement while developing new governance model for urban logistic: Turin best practice', Transportation Research Procedia, vol.16, p.343-354.
- Marcucci, E., Pira, L. M., Gatta, V., Inturri, G., Ignaccolo, M., & Pluchino, A. (2017), 'Simulating participatory urban freight transport policy-making: Accounting for heterogeneous stakeholders' preferences and interaction effects', *Transportation Research Part E*, Vol.103, p.69-86.
- Malik, L., Sanchez-Diaz, I., Tiwari, G., and Woxenius, J. (2017). 'Urban freight-parking practice: the case of Gothenburg and Delhi', *Research in Transportation Business & Management.* Vol.24. p.37-48.
- Morganti, E., Seidel, S., Blanquart, C., Dablanc, L., & Lenz, B. (2014). 'The impact of e-commerce on final deliveries: alternative parcel delivery services in France and Germany', *Transportation Research Procedia*, vol.4, p. 178-190.
- Nesterrova, N., & Quak, H. (2016), 'A city logistics living lab: a methodological approach', *Transportation Research Procedia*, vol.16, p.403-417.
- Nocerino, R., Colorni, A., Lia, F., & Lue, A. (2016). 'E-bikes and E-scooters for smart logistics: environmental and economic sustainability in pro-E-bike Italian pilots', *transportation research procedia*, vol14, p.2362-2371.
- Oliverira, M.C., Bandeira, M.R., Goes, V.G., Goncalves, S.N.D., and D'Agosto, A.M. (2017). 'Sustainable Vehicles-Based Alternatives in Last Mile Distribution of Urban Freight Transport: A Systematic Literature Review' Sustainability, vol.9(1324).
- Punel, A., Ermagun, A., & Stathopoulos, A. (2018), 'Studying determinants of crowd-shipping use', *Travel Behaviour Society*, vol.12, p.30-40,
- Quak, H., Nesterova, N., Rooijen, V. T., and Dong, Y. (2016). 'Zero emission city logistics: current practices in freight electromobility and feasibility in the near future', *Transportation Research Procedia*, vol.14, p.1506-1515.
- Wang, J. J., * Xiao. Z. (2015). 'Co-evolution between etailing and parcel express industry and its geographical imprints: The case of China', *Journal of Transport Geography*, Vol.46, p. 20-34.
- Thompson, G. R., & Hassall, K. (2014). 'Implementing High Productivity Freight Vehicles in Urban Areas', *Social and Behavioral Science*, vol.151, p.318-332.

- Vakulenko, Y., Hellstrom, D., & Hjort, k. (2017). 'What's in the parcel locker? Exploring customer value in e-commerce last mile delivery', *Journal of Business Research*, https://doi.org/10.1016/j.jbusres.2017.11.033
- Verlinde, S., Macharis, C., Milan, L., & Kin, B. (2014). 'Does a mobile depot make urban deliveries faster, more sustainable and more economically viable: results of a pilot test in Brussels', *Transportation Research Procedia*, vol.4, 361-373.
- Visser, J., Nemoto, T., & Browne, M. (2014). 'Home Delivery and the Impacts on Urban Freight Transport: A Review', *Social and Behavioral Science*, vol.125, p.15-27.
- Wolpert, S., & Reuter, C. (2012). 'Status Quo of City Logistics in Scientific Literature: Systematic Review' *Transportation Research Record: Journal of the Transportation Research Board*, no.2269. p.110-116.
- Yoo, W., Yu, E., & Jung, J. (2018). 'Drone delivery: Factors affecting the public's attitude and intention to adopt', *Telematics and Informatics*, April 2018.
- Yuen, F. K., Wang, X., Ting, L., & Wong, D. Y. (2018), 'An investigation of customers' intention to use self-collection service for last-mile delivery', *Transport policy*, vol.66, p.1-8.
- Xiao, Z., Wang, J.J., Lenzer, J., and Sun, Y. (2017). 'understanding the diversity of final delivery solutions for online retailing: a case of shenzhen, China', *transportation research procedia*, vol.25. p.985-998.
- 'the future of parcel lockers', XinHua News, [online], available at: http://www.xinhuanet.com/tech/2018-05/15/c_1122832518.htm, accessed:16/06/18. In Chinese.
- 'Annual report of Shentong 2016', *ShenTong,* [online] available at: http://disclosure.szse.cn/finalpage/2017-04-18/1203315264.PDF, accessed: 20/05/2018, in Chinese.

LINKING THE PACKAGING INNOVATION PROCESS TO LOGISTICS AND SUPPLY CHAIN PERFORMANCE IN THE FOOD INDUSTRY

Henrik Pålsson and Daniel Hellström
Department of Design Sciences, Packaging Logistics, Lund University, Sweden

Introduction

Packaging has a major impact on supply chain performance, as it affects all activities in logistics. It has both economic and climate impacts. Packaging affects the climate directly, e.g. packaging material, and indirectly, e.g. amount of product waste and transport efficiency. The World Economic Forum recognize the high impact packaging have for sustainable development throughout supply chains and in transport systems. In its report entitled Supply Chain Decarbonization (Doherty and Hoyle, 2009), they assessed the possible commercial opportunities to lower the CO_2 emissions in supply chains. They concluded that new packaging initiatives is a top three area with high impact and implementation potential among all various supply chain decarbonization options.

Any effort to mitigate the climate impact of packaging must apply a systems approach acknowledging the complexity of packaging (Hellström et al.; 2017; Verghese et al.; 2012). Packaging design involves the consideration of numerous needs, requirements and constraints; several of them often go beyond the packaging itself. The complexity of packaging design involves (Pålsson, 2018): 1) the multiple roles of packaging and its functions, 2) packaging as a system of components, 3) the intra- and inter- organisational requirements and needs, 4) the dynamic diversity of requirements from the end consumers or users, 5) the variety of distribution channels, and 5) extending the packaging lifecycle beyond the initial use. Moreover, all these needs and requirements are constantly in transformation. New materials, methods, technologies and market opportunities are continuously changing and evolving.

Companies that cope with the complexity of packaging in a dynamic manner can improve supply chain performance. To do so, an effectual packaging innovation process is key. Current research has put emphasis on packaging development and concept development processes, but only to limited extent addressed the packaging innovation process. The purpose of this paper is to first develop a conceptual framework that links the packaging innovation process to logistics and supply chain performance. The second part of the purpose is to examine to what extent brand owners in the food industry consider these links.

Methodology

A conceptual framework linking the packaging innovation process to logistics and supply chain management performance is developed from innovation, packaging and performance literature. To capture the need and characteristics among brand owners regarding packaging innovation, we have collected empirical data from and analysed the food industry where packaging has significant environmental impacts. We have previously conducted a case study at a global company in home furnishing, but this paper focuses on the food industry. A survey of six companies in the food industry. This industry represents approximately 50% of the money spent on consumer packaging, was carried out. The survey instrument was developed by the two researchers based on theory and expertise. The instrument was tested on two industry representatives, and then refined. The aim of the survey was to capture the current packaging practices as well as the needs, characteristics and potential of packaging innovation. To complement the survey, a semi-structured interview was carried out with one represent of a large food company. The use of a survey of the food industry was chosen because of the vast number of food companies with a variety of characteristics (size, type of products, etc.).

Conceptual framework of the packaging innovation process

Packaging is handled and managed in all logistics and transport activities, which means severe economic and environmental impacts on supply chain performance. Since the packaging innovation process determines the packaging solutions in a firm, this process should be carefully designed to obtain high logistics and supply chain management performance. In this paper, we apply a model for innovation from Chiesa et al. (1994) to packaging innovation. This model includes four core processes, three enabling processes, and their outcomes in terms of impact on competiveness and climate (Figure 1). The core processes are defined as those in which the firm transforms its packaging innovation capability into customer value. *Concept generation* is the organisational capability to generate new packaging concepts. It involves the level of inventiveness and creativity in the organisation. *Packaging development* is the processes and the organisational capabilities to develop effective and efficient packaging solutions, and transfer new solutions to manufacturing and distribution. *Process innovation* is about continuous improvement and creating and implementing innovative processes related to packaging. *Technology acquisition* refers to capabilities to source, implement and discover innovative technologies, which can improve the packaging.

The enabling processes supports the core processes. They are defined as those that convert resources and strategic visions into guidance for innovation. *Leadership* affects innovation goals and determines the culture and innovation climate in a firm, which is essential for all processes related to generating and implementing packaging innovation. *Resourcing* includes human resources and funding opportunities for new ideas for packaging. Finally, *systems and tools* refer to the infrastructure of IT systems and tools of the firm that can support packaging innovation. The outcome of these seven innovation processes determines the packaging performance in terms of packaging innovation, climate impact and competitiveness, which are essential parts of the supply chain performance.

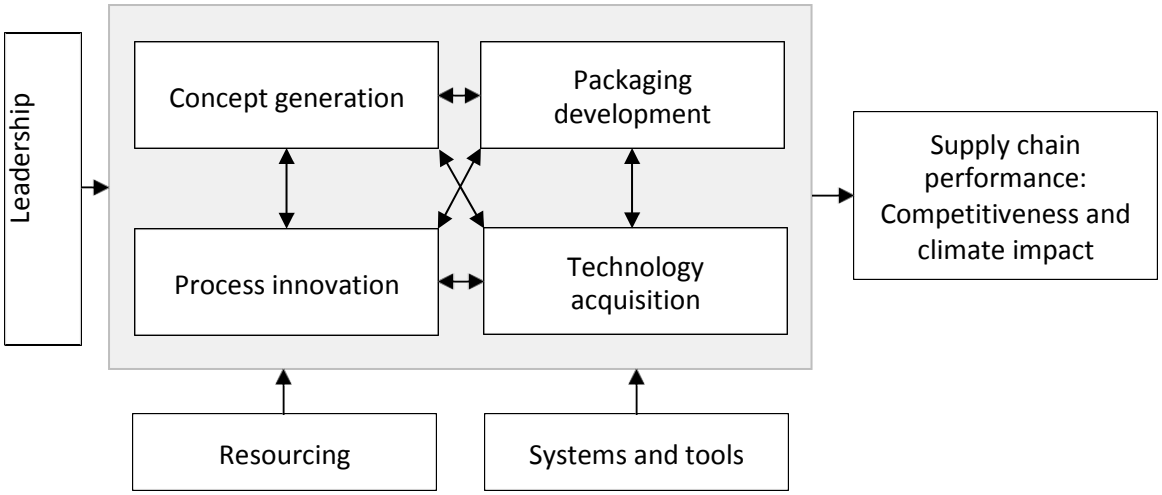


Figure 1: Core (grey area) and enabling processes in packaging innovation, and their outcome

As the model shows, the climate performance and competitiveness of the firm depend on the outcome of seven processes and their interactions. Thus, we link the processes and their sub-processes to the climate performance, which helps us to explain and improve the climate performance of packaging. In other words, by improving the different processes and sub-processes related to packaging innovation, the impact on the climate and competitiveness from packaging can be improved. The impact on the climate from packaging is measured by packaging material, product waste and damage, and logistics and transport efficiency. Each of the processes in Figure 1 should be measured, which requires an understanding of their sub-processes.

Packaging innovation practices of the brand owners

A survey of six brand owner companies of varying size in the food industry was conducted to capture an overall view of the packaging innovation practices, and the their environmental impact. The respondents were selected to have packaging and environmental knowledge in the companies. In the smaller firms, the CEO or a business development manager answered, while the large companies were represented by a packaging developer, packaging development manager and a project manager. Table 1 shows background data of the companies and the respondents. All companies have their head office in Sweden. The two largest companies use packaging in all materials in Table 1, but they did not specify the proportion of each material. Among the other four companies, plastic and corrugated board dominated, followed by carton board, and some metal and wood packaging.

Position	Employees	Turnover (billion SEK)	Plastic	Corrugated board	Carton board	Metal	Wood	Glass
Project Manager	10 000	37	Yes	Yes	Yes	Yes	Yes	Yes
Packaging Development Manager	1500	5	Yes	Yes	Yes	Yes	Yes	Yes
Packaging Developer	1000	3.5	80%	10%	5%	5%	0	0
CEO	300	1	75%	15%	10%	0	0	0
Business Development Manager	120	0.5	92%	1%	5%	0	2%	0
CEO	34	0.054	35%	45%	30%	0	0	0

Note: Percent of number of packages in different materials

Table 1: Background information of the respondents

Core processes

There are four core processes for packaging innovation. The empirical data related to the core processes from the survey and the interview focus on the packaging development process. As a result, the practices related to concept generation, process innovation, and technology acquisition are only addressed briefly. In the packaging development practices, a majority of the companies (80%) develop a packaging solution in parallel to the product development, whereas 20% do it afterwards. In this packaging development process, 50% of the companies outsource the entire packaging development and 33% parts of it, whereas only 17% have mainly in-house packaging development. This means that practices outside the food companies (i.e. those of the packaging providers) have impacts on the packaging's climate performance. Thus, to improve the supply chain performance of packaging would require both updated specifications from the food companies and from the involvement of the packaging providers.

Packaging affects the climate directly by the packaging material and indirectly in the usage phase. The latter refers to the effects of packaging on transport and handling efficiency, and on product waste (INCPEN, 2003). Figure 1 shows the share of companies that consider the different climate effects of packaging. Currently, the companies tend to focus on the direct impact of the packaging material, particularly the amount of packaging material used. They also consider the fact that different materials have different environmental characteristics and different recycling characteristics. However, it is less common to consider effects in the usage of packaging. These effects are often greater than the direct effects. The areas measured also seem to be lacking details, such as modularisation, stackability, and a reduction in the use of mixed materials. Accordingly, these insights indicate a challenge for the firms to establish the total climate impacts of packaging. Thus, they seems to be struggling with getting detailed measures of packaging impacts and to link the measures to actions for improvement in their current packaging innovation processes.

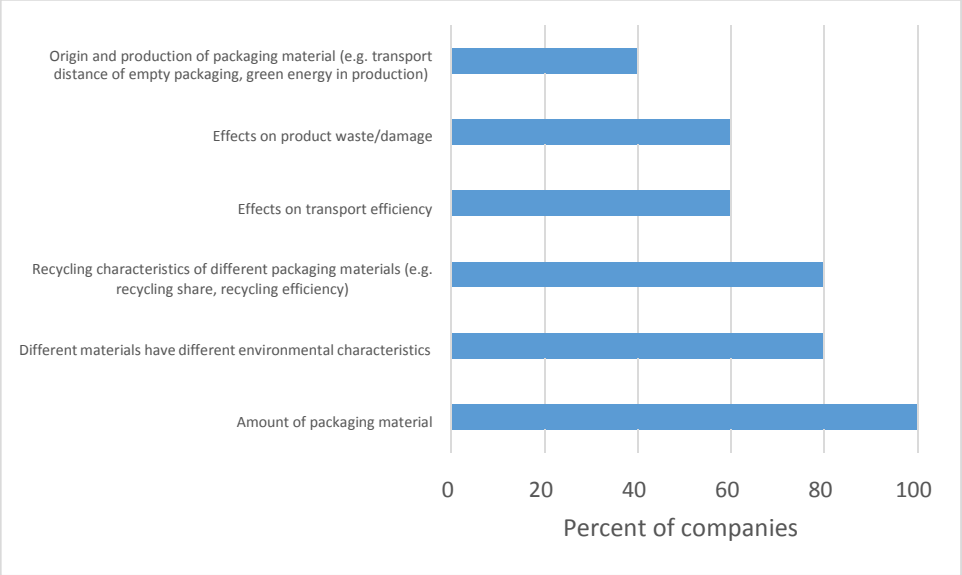


Figure 2: Areas that the companies consider when analysing the environmental impact of packaging

Enabling processes

Leadership for packaging innovation sets overall innovation goals and creates the culture and innovation climate. To capture the willingness for innovation climate for sustainable packaging solutions, we surveyed the motives for climate-effective packaging in the food industry. Figure 3 shows the different motives. The companies stated the following motives for climate-effective packaging, in the order of importance: 1) Improved brand, 2) Improved competitiveness, 3) More satisfied customers, 4) More satisfied co-workers, 5) Increased sales, 6) Increased market share, and 7) Reduced costs.

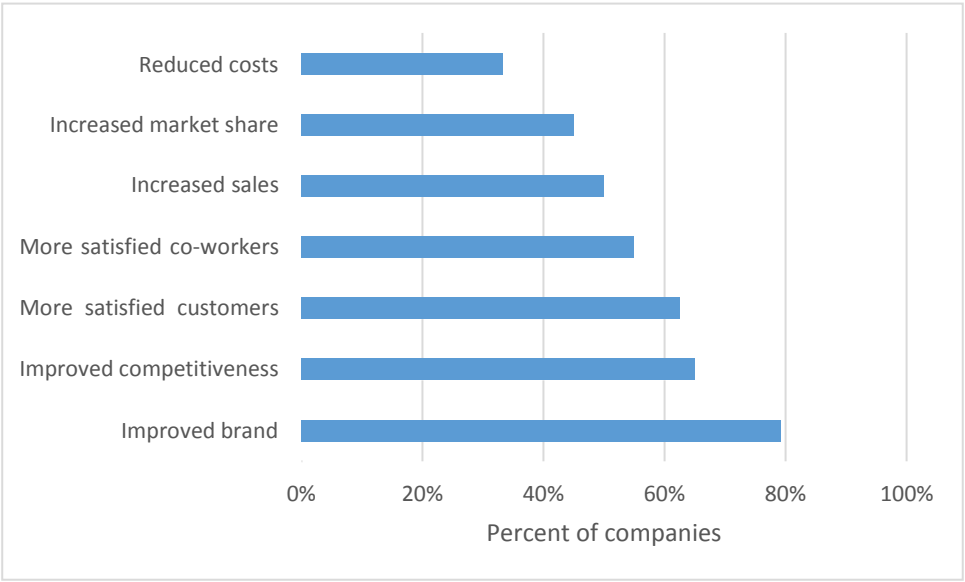


Figure 3: Motives for the companies to reduce the climate impact of packaging

The motives indicate that the food companies are driven by branding, incentives from co-workers and customers, and economic measures. According to one respondent, the environmental impact of packaging is very important and, "*We look at how this can be communicated outward in different ways. The packaging is part of the product and the consumer wants to know [the environmental impact of packaging]. It is part of the brand. There is value to communicate this.*" Several motives refers to the economic performance of the company, which can be interpreted as a need to combine the climate and economic measures of packaging innovation.

The enabling processes *resources* as well as *systems and tools* have a number of barriers. The results show that it is important for the companies to reduce the climate impact of packaging, but they clearly lack analysis tools for this purpose. They are also hindered by limited resources, lack of packaging knowledge and climate data (Table 2). However, none of the companies perceive that they need more knowledge about how to calculate the environmental impact from packaging in order to evaluate its environmental impact. The companies (67%) in the study would prefer to combine climate and economic packaging evaluations to improve the innovation process of packaging.

Employees	Resources (time)	Packaging knowledge	Management support	Information/data
10 000	x			
1500	x	x		x
1000	x	x		x
300		x		x
120	x		x	
34	x			

Table 2: Barriers for addressing the climate impact of packaging in the packaging innovation process

Outcome

The food companies in the study emphasised that it is increasingly important for them to reduce the climate impact of packaging. An indication is that the medium-sized and big companies (>300 employees) have ongoing projects related to the environmental impact of packaging. The interview respondent described the situation as, "*Historically, there has been a lot of focus on the product's environmental impact. In the last three years, packaging has become more important. It will be more important in the future.*"

According to the food companies in the survey, detailed measures should include packaging material-related issues, and to some extent the usage phase. Currently, the food companies tend to focus on the packaging material. This focus is related to the fact that the companies already are doing so when it comes to analysing the climate impacts of packaging. On a regular basis, the companies would like to analyse hazardous substances, resource depletion, and human health, and to some extent climate change and air pollution. In the interview, the respondent emphasised that, "*Climate change is the type of measurement we are interested in.*" The inclusion of the essential usage phase in the measures requires clear explanations and descriptions of its importance for the food industry.

Conclusions and implications

This paper has developed a conceptual framework, which describes and links seven sub-processes within packaging innovation to logistics and supply chain performance. The analysis shows that by carefully designing the packaging innovation process and understanding its impact on logistics and supply chain performance, firms can strategically address and operationally design and select packaging solutions to minimise their cost and climate impacts – directly from the packaging material and indirectly from transport and product waste. The empirical analysis shows that awareness of the sub-processes in packaging innovation, their internal linkages, and linkages to logistics and supply chain performance have considerable potential to affect firms positively early in the developing phase and increase performance. However, the current awareness in the investigated firms is limited and even less implemented.

The conceptual framework developed in this paper links the packaging innovation process to logistics and supply chain management performance. The framework increases the understanding of an underdeveloped part of supply chain management. The empirical data support the need for more research on this topic.

The initial understanding of the sub-processes within the packaging innovation process, and their linkages to logistics and supply chain performance create a structure for firms to consider these innovation opportunities. The empirical data in this paper are limited to a survey of six food companies and one complementary interview. While the enabling processes and the outcome in the innovation model were well covered in the study, the empirical data related to the core processes focused on the packaging development process. Future research should address the other three processes further.

References

- Chiesa, V., Coughlan, P. and Voss, C. A. (1994), 'Development of a Technical Innovation Audit', *Journal of Product Innovation Management*, 13(2), pp. 105-136.
- Doherty S. and Hoyle S. (2009), 'Supply Chain Decarbonization: The Role of Logistics and Transport in Reducing Supply Chain Carbon Emissions', World Economic Forum, Geneva.
- Hellström D. and Olsson A. (2017), 'Managing Packaging Design for Sustainable Development: A Compass for Strategic Directions', John Wiley & Sons, Oxford, UK.
- INCPEN (2003), 'Responsible packaging code of practice for optimising packaging and minimising waste', The Industry Council for Packaging and the Environment, Reading, UK.
- Verghese K, Lewis H, Fitzpatrick L. (2012), 'Packaging for Sustainability', Springer Verlag, London, UK.
- Pålsson, H. (2018). 'Packaging Logistics: Understanding and managing the economic and environmental impacts of packaging in supply chains', Kogan Page, London, UK.

SUPPLY CHAIN DISRUPTION: ALIGNING BUSINESS STRATEGY AND SUPPLY CHAIN TACTICS

Steve O'Sullivan[1] and Claudia-Maria Wagner[2]
[1]Dublin Institute of Technology, Ireland
[2]Cork Institute of Technology Research, Ireland

Introduction

The topic of **engaging in the process of dynamic business-supply chain strategic alignment** sits within the academic domain of supply chain management, a sub-discipline of operations management (Holweg and Helo, 2014:230), defined as 'any combination of processes, functions, activities, relationships and pathways along which products, services, information and financial transactions flow in and between enterprises, in both directions, end-to-end' (Gattorna, 2015:9). The complexity of this discipline has been compounded by globalisation along the dimensions of replenishment, time and distance (Christopher and Towill, 2002:1), and vulnerabilities to disruptions have increased as supply chains 'become more lengthy and complex due to globalisation and vertical integrations' (Rajesh and Rao, 2015:238). Recent events have promoted supply chain management to critical importance. 'During 2008 the world changed in a precipitous way as the global financial crisis (GFC) hit and the ensuing global recession affected people around the world' (Gattorna, 2009:1). This has led to a volatile operating environment, 'fraught with greater demand uncertainty, higher risk, and increasing competitive intensity' (Roh, et. al., 2014:198). 'Increasingly, organisations are finding themselves at the center of un-plannable events (crises, disasters, breakdowns) that interrupt and threaten their global supply chains' (Gattorna, 2015:340). The context of this paper is disruption across the full spectrum of supply chain management domains and how the supply chain strategic response is aligned to business goals. The research is part of the early stages of a doctoral thesis. In order to explore strategic alignment issues identified in organisations, the Irish Defence Forces and several transportation organisations have been chosen as initial in-depth case studies to demonstrate this organisational challenge.

Literature review

The literature review demonstrates that strategy is a continuous process of power mobilisation within the senior leadership team in relation to dilemmas facing the organisation (Pettigrew, 1977:80). The strategic renewal process can take the form of several journey types such as *directed*, and the response to disruption has a phased approach. There is a degree of *shaping* or *re-framing* of strategies to resolve challenges and to align with situational needs, without moving outside the boundaries of the organisation's core competencies (Floyd and Lane, 2000:154). Furthermore, the history of globalisation reveals that policy is a(the) source of disruption and introduces the concept of strategic friction, which has not been explored since 1832. This latter strand is the **dominant contribution** of the paper.

The nature of strategic renewal within the top management team: Strategic renewal includes the 'perennially unfinished' and 'ongoing journey of activities a firm undertakes to alter its path dependence' (Iszatt-White, 2010:409; Volberda, et. al., 2001:160) or alternatively the 'process, content, and outcome of refreshment or replacement of attributes of an organisation that have the potential to substantially affect its long-term prospects' (Agarwal and Helfat, 2009:281). Strategic formulation is therefore a process of political decision-making whereby strategic demands are 'politically feasible only if sufficient power can be mobilised and committed to it' (Pettigrew, 1977:80). How the TMT responds to the tensions of competing demands through their actions, rhetoric and decisions can create organisational context and they must also simultaneously balance strategic exploitation and exploration, profit maximisation and social welfare, integrating globally and adapting globally (Smith, 2014:58). Strategy has also been described as a process, that is both continuous (Pyburn, 1983:3) and dynamic, operating in an open system (Mintzberg, et. al., 1976:263) and this view has remained a constant to the present day.

Strategic response to supply chain disruption: Phases such as planning, preparedness, mitigation, detection, response and recovery (Kovács and Spens, 2007:101) necessitate different supply chain management practices (Heaslip and Barber, 2014:61) as organisations urgently mobilise to reduce the 'gap of pain'. These events are largely un-plannable, but a preparation phase incorporates five supply chain elements of: implementing a disaster management framework, establishing logistic operations and process management, human resource management, knowledge management and preparing financial resources (Heaslip and Barber, 2014:63). The immediate response phase is determined by the nature of the event but should involve structured command and control systems coupled with appropriate asset capabilities. The reconstruction phase aims to bring the disaster under control and return all systems to a normal or better state (Heaslip and Barber, 2014:68). Gattorna (2015:350) describes a prequel phase of '*hedge and deploy'* by prepositioning supplies at strategic global locations before any catastrophic event', the adoption of a fully flexible supply chain during survival phase, an agile supply chain operating in an emergency response phase 'in the face of extreme disruption' and re-establishing organisations during the rebuilding and restoration phase. It can therefore be concluded that the response to disruption is a phased and dynamic process. However, being responsive to supply chain disruptions requires strategies that are closely aligned to corporate strategy (Roh, et. al, 2014:200). Multi-dimensional integrations, including socio-technical collaboration with strategic suppliers and customers, and techno-process integration such as advanced manufacturing technologies, all 'toward time-based outcomes' represent the most important characteristics of a responsive supply chain strategy (Roh, et. al, 2014:207).

The nature of strategic alignment: Borrowing from business-information systems strategic alignment literature, due to an apparent absence of a corresponding perspective in the supply chain management academic domain, the author notes that functional alignment of strategy and enterprise systems operates within the dynamic and complex internal and external confines of this physical, social and political process. One significant challenge in Business-IS strategic alignment is that an information system is 'not an external object, but a product of ongoing human action, design, and appropriation, which, *over time*, becomes imbricated, embedded, entangled and intertwined', (Wilson, et. al., 2013:3) subject to social negotiation and sensemaking, 'materialising through anchoring and objectification' (Dulipovici and Robey, 2013:107). There is a process of user improvisation and adjustment, due to perception and understanding of technology features that demonstrates that strategic plans are 'resources for situated action that do not in any strong sense determine their course' (Iszatt-White, 2010:409; Dulipovici and Robey, 2013:104). A first stage of adjustment is decoupling, whereby organisational members form personal views and interpretations of IS strategies based on their own local context. According to their situational needs, users then reframe the technology, and when the adjusted practices become repackaged and stable, these are then recognised as strategic in relation to the formal strategy (Wilson, et. al., 2013:2).

The nature of globalisation: It has been described that the forces of globalisation, technology, climate change, and terrorism, are all accelerating beyond our ability to adapt. However, as leading economists point out, technology is not exogenous, determined by the Gods. Rather, it is endogenous, determined from within the economic and social system. Technological advances have reflected a global race between the demand for educated workers and the expansion of an educated population (Atkinson, 2016), **all determined by policy**. Consider the fact that technology development is localised to production techniques and this is within our power to control. Consider also this notion of acceleration beyond our ability to adapt, true in the sense of the planet's resources being finite, but all development is relative. Were we ever able to adapt without the risk of dramatic disruption? The 2008 GFC was not new. Friedman (2016) asked, 'what the hell happened in 2007', but, what the hell happened in 1800, the period when true globalisation was established? Antoine-Henri Jomini and Carl von Clausewitz founded modern strategy at this time, through first-hand observations of Napoleon's art of war, influenced by developments in physical infrastructures, logistics and cartography. Also founded was the discipline of

economics, or political economy as it was known then, when Adam Smith published the seminal Wealth of Nations in 1776, later supported by David Ricardo (1772-1823) with the introduction of comparative advantage theory, further enhanced by Marx (1818-1883), who advocated accelerating global expansion to increase value, the development of multinational companies, and the promotion of imperialism so that governments could protect indigenous organisations. The policy of Capitalism and Free Trade was consequently established and replaced feudalism in Great Britain, and the dynamism of this policy led to pressure to expand beyond borders (Michie, 2017), enabled by a transportation revolution that emerged in the early 1800s when American Robert Fulton (1765-1815) launched the first steamboat for commercial use, almost simultaneously as the British engineer Richard Trevithick (1771-1833) constructed the first railway steam locomotive. Long-distance international integration was now possible, and further policy changes to break-down monopolies were implemented. Steamboats and railroads made it so much easier to trade and move bulk goods across continents cheaper than domestic prices. This brought other nations such as Russia, India, West Africa and the Ottoman Empire into the global economy, and of course the importance of economic forces led to the 1839-1860 Opium Wars between Britain and China, not just for the opium trade, but for trade rights in general. This gave Hong Kong to Britain. Britain was the dominant power and the international monetary system was based on the gold standard linked to the British pound. A huge increase in global trade, a highly complex age of revolution in Europe, and a scramble for Africa ensued. A great war was the result.

Clausewitz developed several principals: war is a continuation of policy by other means; politicians have an authority over the military; policy is shaped by a trinity of primordial violence, hatred and enmity; strategic plans are based on a series of connected steps; flexibility must be maintained, opportunities seized as they arise; a calculated culminating point of victory must be kept in mind. This is restrained by **Friction**, minor unforeseen incidents causing delays and confusion, resulting in management being doomed to disappointment. For a TMT without personal knowledge or experience, everything in SCM is simple, but 'through the influence of an infinity of petty circumstances, which cannot be properly described on paper, things disappoint us, and we fall short of the mark' (Verlag, 1940). The SC network is comprised entirely of individuals, each of whom is faced with their own friction in all directions. The author projects that SCM 'is movement in a resistant medium. Just as a man immersed in water is unable to perform with ease and regularity the most natural and simplest movement, that of walking, with ordinary powers one cannot keep even the line of mediocrity'. The TMT are swimming masters who teach dry land movements but have never 'plunged in themselves'. The TMT must know friction and triumph over it and must learn not to expect a precision in results accordingly. Friction cannot be learned theoretically, but experience and tact will enable the SC manager to make decisions based on situational needs, whereby they 'decide and determine suitably to the occasion'. This warns 'against excessive strategic ambition', and Clausewitz acknowledged the impact of policy as a particular form of friction. The 'strategists chessmen do not have the kind of mobility that is essential for stratagem. Accurate and penetrating understanding is a more useful tool and essential asset for the TMT than any gift of cunning' (Freedman, 2015). Clausewitz describes the challenge of a 'positive theory' on strategy given that the 'fog of war puts a veil of uncertainty over all information'. Clausewitz also sees strategy as 'a socio-political mechanism that can be used to educate the mind of the future leader but cannot accompany him on the battlefield' (Kornberger, 2013).

Research problem and research approach

This paper aims to both increase our understanding of SC manager's engagement in the process of dynamic business - supply chain strategic alignment, within the context of SC disruption, and contribute to the broadening of SCM to an integrated perspective across the TMT rather than a uni-dimensional and dichotomous view. In exploring the research question of *how supply chain managers engage in the process of dynamic business-supply chain strategic alignment*, these aims are expanded to include specific

objectives: Determine how SC managers operationally identify, predict, cope and recover from SC disruptions; Identify which phases in the supply chain disruption process require engagement with the TMT to implement strategic solutions aligned to business goals; Consequently, determine whether a categorisation of supply chain strategy exists, such as a tier consisting of strategies that can be implemented autonomously by the supply chain division, and a tier(s) that requires 'negotiation' across the TMT prior to implementation; Determine how supply chain managers engage with the TMT in the process of aligning business and supply chain strategies, thereby identifying key enablers and inhibitors; Develop a process model that establishes the phases of supply chain manager engagement in dynamic business - supply chain strategic alignment; Test, refine and validate developing theories in a real case 'laboratory' setting, thereby demonstrating the value creation potential of dynamic business-supply chain strategic alignment. The author is in the early stages of a doctoral programme and as the main body of research progresses, grounded theory methodology will enable the author to determine how supply chain managers strategically align to business goals in response to disruption. An initial study was carried out of the Irish Defence Forces and the logistical challenges faced as part of their participation in the Nordic Battle Group and UNIFIL operation in Lebanon, both global strategic responses to the threat of disruption. A second phase includes organsations from the transportation industry, who physically respond to supply chain disruption. To study the full spectrum of our discipline, field research will conclude with humanitarian, corporate and China-based participants, the latter being at the geographical center of globalisation.

Case Studies: Nordic Battle Group and UNIFIL: *ad omnia paratus - prepared for anything*

The Logistics Branch of the Irish Defence Forces successfully re-framed and aligned *business* strategy to operational readiness as part of Ireland's rotation of the **Nordic Battle Group**, headquartered in Enköping, Sweden, the objective of which was the capability to set up a theatre of operation anywhere in the world within a seventy-two-hour notice period from its base in Collins Barracks Cork. It was demonstrated how a **senior management strategy** underwent an extensive period of preparation, shaping and re-framing to align with situational needs, while simultaneously maximising stakeholder value and ensuring actions taken were to the benefit of future rotations and missions. However, this preparation phase took many months to complete (gap of pain) due to the fact that strategy was directed by a TMT that did not engage with the Logistics Branch during strategic formulation. The IDFs most recent **UNIFIL** operation in Lebanon was faced with significant disruption due to their strategic partner and joint-battalion of several years, Finland, withdrawing from the mission when their mandate expired, the **strategic renewal** of which was taken for granted. This was a loss of serious operational capability: a mechanised company of 130 Finnish personnel including an integrated Estonian platoon of 38 soldiers, which provided a manoeuvering element that conveyed presence in the area of operation; a 15-tonne armoured personnel carrier fleet of 11 vehicles, a critical asset in the event of threat levels increasing, weapons systems (including ammunition and storage) and ancillary equipment; infrastructure, barrack services, welfare facilities to keep up morale, and a SEPURA communications system with substantial coverage of the area of operation.

Case Studies: Transportation and Logistics Industry

This section is not so much about business-supply chain strategic alignment, as it is about sources of policy-driven disruption at an industry level, and how logisticians respond through their art of movement.

Morrison Express Corporation: The Regional Director of U.S.A. and Mexico, described a top-three automotive manufacturer in the U.S.A., with a significant divisional operation in Colombia, who implemented an internal policy of holding two weeks of production materials at any one time, and heavy penalties for late shipments were imposed on its logistics partners as a form of risk avoidance. When an ocean container from India to Colombia arrived two weeks late the plant stopped production and the supply chain disruption caused by the transportation delay attracted a penalty. However, a highly detailed standard operating procedure revealed that Indian holiday schedules were included in the planning

process and consequently it was the **lean inventory policy** without redundancy that caused the production disturbance. The Netherlands District Manager discussed the Hanjin Shipping Company of South Korea, which was declared bankrupt in February 2017, with a total debt of USD$10.5 billion, due to an **EU policy** to abolish the conference system, under which shipping lines formed alliances and pricing agreements to protect the industry, subsequent to the 2008 GFC, which reduced global demand, forcing shipping costs to fall.

Woodland Group: The Managing Director of Ireland described recent disruptions that continue to directly impact his customer network. There is an increasing trend of **manufacturing plant closures** and forced business holidays in China ahead of major events to ensure the subsidence of emissions so that visiting dignitaries can enjoy blue skies. Woodland Group has assisted clients with an alternative solution of sourcing from India, and this has resulted in a new and more desirable state. **Dangerous goods** also threaten our global supply chains. There was a series of catastrophic explosions in August 2015 at Tianjin, the largest man-made port in China, tragically causing the recorded death of 173 people. Government **policy for damage control rather than prevention** led to this situation. Quite often how a government responds is the main cause of disruption rather than the actual event, such as closing borders, shutting down air traffic, or evacuating areas (Sheffi, 2001). The immediate response was to ban the loading and discharging of all DG materials at Tianjin, and the ports of Qingdao, Lianyungang, Dalian, Fuzhou and Xiamen also implemented new regulations to restrict the handling of certain hazardous goods. Woodland observed such disruption at the Port of Ningbo, the busiest in the world in terms of cargo tonnage, due to a change in **government legislation** to reduce the number of licensed DG facilities from eight to one.

Royal Rotra: The Netherlands Sales Manager continues the discussion of disruption in international waters. In response to the EU abolishment of the conference system, the industry moved to create **multiple strategic mergers** that were legally posited with the United States Federal Maritime Commission and the European Antitrust Policy. A further significant measure to achieve economies of scale has been the introduction of **super carriers** such as the 400-meter long MV CSCL Globe, which can take 19100 twenty-foot containers, and arising from this, and of particular concern to Dutch 3PLs like Rotra, is that congestion in Rotterdam has escalated in recent months. The Benelux Logistics Manager discussed e-commerce as a force of disruption. Global e-commerce sales are expected to increase from 1.3 trillion in 2014 to 4.5 trillion in 2021 (Forsey, 2018). When you consider that the major organisations in this industry have a **policy of free shipping** to influence consumer purchases, this puts an incredible strain on warehouse and logistics providers, and indeed the environment.

Kuehne & Nagel: The Global Senior Vice President of Logistics raises the topic of **protectionism** and a recent policy implemented by U.S.A. President Trump. On 14 June 2018, the office of the U.S. Trade Representative published a list of Chinese origin goods to be subjected to a 25% tariff under Section 301 of the U.S. Trade Act of 1974, becoming effective on 6 July. This represents a charge to the value of USD$34 billion on Chinese imports related to 818 tariff items and USD$16 billion on a further 284 items to be announced later in 2018, a punishment for IP infringements, and a request by Trump to the USTR to 'address the acts, policies, and practices of China that are unreasonable or discriminatory, and that burden or restrict U.S. commerce'. This is reminiscent of the Smoot-Hawley Tariff Act of 1930, which turned a recession into a Great Depression. **Non-tariff policy measures** are another concern: 'all non-price and non-quantity restrictions on trade in goods, services and investment. This includes border measures as well as behind-the-border measures flowing from domestic laws, regulations and practices' (Berden, et. al., 2009). Global trade has also seen an increase in the number of ocean containers arriving at port with internal harmful gases. This can be a cause of random disruption due to customs inspections of contamination levels, but the issue has a much more serious side, with several reported fatalities.

Crane Worldwide Logistics: The Regional Logistics Manager brings our attention to Calais in northern France. For almost two decades this port city has been a controversial staging area for refugees seeking asylum in the U.K. This was the coming together of two policies to create supply chain disruption, the **2003 Treaty of Le Touquet** and Syrian governmental policy that produced both terrorists and residents of the Calais Jungle. At the height of the Calais crisis, Crane had been contracted to transport goods from Hungary to a major U.K. technology distributor. Failure to deliver within a three-day transit-time attracted penalties. Similar performance targets became a huge challenge for all road hauliers as **migrants secretly stowed away** on trucks. They came together to move in convoys and use only certain secure stops, ensuring no diversions, and security monitors were attached to vehicles.

Aramex: The Country Manager for Ireland considers a changing business model in the oil and gas industry due in part to the **socio-economic movement** of battery-powered electric automobiles, which reduces demand for oil. Consumer demand is increasing on the premise that they are making a positive impact on the environment, but their focus is local usage and a decrease in global warming potential. This is 'problem-shifting'. Electric vehicles exhibit the potential for significant increases in human toxicity, freshwater eco-toxicity, freshwater eutrophication, and metal depletion impacts, largely emanating from the vehicle supply chain. Their production phase has proven to be substantially more environmentally intensive' (Hawkins, et. al., 2013). Brent crude oil pricing, the industry benchmark, plunged in 2014 reaching a low in December 2016. OPEC then implemented a production-cut quota of 1.2 million BOPD, which doubled prices. Today, **OPEC's reversing of this decision** in June 2018, when its technical committee recommended a supply increase of one million BOPD, will send pricing soaring again, simply on the basis that new measures will not create a surplus (Mazodila, 2018). Such political, economic and socio-economic volatility is creating significant bunker fuel surcharges for Aramex and a parallel demand unpredictability that challenges long-term pricing agreements with the now-consolidated shipping lines.

Conclusions

A new and eclectic approach to the review of academic literature demonstrates that policy has been a source of major disruption since the establishment of true globalisation in 1800. This theory can be applied to SCM. **Contribution One:** Policy causes supply chain disruption. These can be external policies such as political, economic, social, technological and climatic, or internal policies within the supply chain industry, all of which have adversely affected the transportation and distribution companies that have been empirically researched. **Contribution Two:** This paper also introduces the concept of supply chain strategic friction, which was acknowledged in a militarily strategic sense by Carl von Clausewitz in 1832 but not since explored. The TMT must know friction and factor it into the strategic renewal process in order to triumph over it. Otherwise it will be prone to disappointment. **Contribution Three:** Supply chain disruption can be caused by the misalignment of TMT and supply chain strategies. Consider the Irish Defence Forces alone. Significant logistical challenges were faced during two missions and *at no time was an enemy engaged*. This paper borrows from dynamic business-IS strategic alignment literature in the apparent absence of a corresponding perspective in the SCM academic domain. The transference of certain concepts has already been empirically validated within this research. The IDF successfully re-framed and aligned *business* strategy to operational readiness and it was demonstrated how a senior management strategy underwent an extensive period of preparation, shaping and re-framing to align with situational needs. **Contribution Four:** A 2-tier categorisation of supply chain strategy was evidenced and the author further proposes that the autonomous category exhibits supply chain tactics and the TMT negotiation category is introduced when an investment threshold has been reached and exhibits supply chain network re-design strategies. Negotiation was found to be within the response and recovery phases. The disruptive events empirically discussed were un-plannable. Policy matters.

References

- Agarwal, R. and Helfat, C.E., 2009. Strategic renewal of organizations. Organization science, 20(2), pp.281-293
- Atkinson, A.B., 2016. Inequality-What can be Done? PANOECONOMICUS, 63(3), pp.385-394
- Balhareth, H., Liu, K. and Manwani, S., 2012, March. Aligning Business and IT from Multi-level Learning Perspectives. In UKAIS (p. 36)
- Benbya, H. and McKelvey, B., 2006. Using coevolutionary and complexity theories to improve IS alignment: a multi-level approach. Journal of Information technology, 21(4), pp.284-298
- Berden, K.G., Francois, J.F., Thelle, M., Wymenga, P. and Tamminen, S., 2009. Non-Tariff Measures in EU-US Trade and Investment. An Economic Analysis. Netherlands: ECORYS Nederland BV
- Burn, J.M., 1993. Information Systems Strategies and the Management of Organizational Change–A strategic alignment model. Journal of Information Technology, 8(4), pp.205-216
- Christopher, M. and Towill, D.R., 2002. Developing market specific supply chain strategies. The international journal of logistics management, 13(1), pp.1-14
- Dulipovici, A. and Robey, D., 2013. Strategic alignment and misalignment of knowledge management systems: A social representation perspective. Journal of MISs, 29(4), pp.103-126
- Floyd, S.W. and Lane, P.J., 2000. Strategizing throughout the organization: Managing role conflict in strategic renewal. Academy of management review, 25(1), pp.154-177
- Forsey, Caroline, 2018. [online] Available at: https://blog.hubspot.com/marketing/ecommerce-trends. [Accessed 15 June 2018]
- Freedman, L., 2015. Strategy: A history. Oxford University Press
- Friedman, T.L., 2016. Thank you for being late: An optimist's guide to thriving in the age of accelerations. Farrar, Straus and Giroux
- Gattorna, J., 2009. Dynamic Supply Chains: delivering value through people. FT Prentice Hall
- Gattorna, J., 2015. Dynamic supply chains. London: Pearson Education Limited
- Hawkins, T.R., Singh, B., Majeau-Bettez, G. and Strømman, A.H., 2013. Comparative environmental life cycle assessment of conventional and electric vehicles. Journal of Industrial Ecology, 17(1), pp.53-64
- Heaslip, G. and Barber, E., 2014. Using the military in disaster relief: systemising challenges and opportunities. Journal of Humanitarian Logistics and Supply Chain Management, 4(1), pp.60-81
- Henderson, J.C. and Venkatraman, H., 1993. Strategic alignment: Leveraging information technology for transforming organizations. IBM systems journal, 32(1), pp.472-484
- Holweg, M. and Helo, P., 2014. Defining value chain architectures: Linking strategic value creation to operational supply chain design. International Journal of Production Economics, 147, pp.230-238
- Iszatt-White, M., 2010. Strategic leadership: The accomplishment of strategy as a 'perennially unfinished project'. Leadership, 6(4), pp.409-424
- Kleindorfer, P.R. and Saad, G.H., 2005. Managing disruption risks in supply chains. Production and operations management, 14(1), pp.53-68
- Kornberger, M., 2013. Clausewitz: on strategy. Business History, 55(7), pp.1058-1073
- Kovács, G. and Spens, K.M., 2007. Humanitarian logistics in disaster relief operations. International Journal of Physical Distribution & Logistics Management, 37(2), pp.99-114
- Li, Y. and Tan, C.H., 2013. Matching business strategy and CIO characteristics: The impact on organizational performance. Journal of Business Research, 66(2), pp.248-259.
- Luftman, J., 2000. Assessing business-IT alignment maturity. Strategies for IT governance, 4, p.99
- Mazodila, Serge, 2018. [online] Available at: https://oilprice.com/Geopolitics/International/The-OPEC-Agreement-Puts-A-Floor-Under-Oil-Prices.html. [Accessed 24 June 2018]
- Menz, M., 2012. Functional top management team members: A review, synthesis, and research agenda. Journal of Management, 38(1), pp.45-80

- Michie, J., 2017. Advanced introduction to globalisation. Edward Elgar Publishing
- Miles, R.E., Snow, C.C., Meyer, A.D. and Coleman, H.J., 1978. Organizational strategy, structure, and process. Academy of management review, 3(3), pp.546-562
- Mintzberg, H., Raisinghani, D. and Theoret, A., 1976. The structure of" unstructured" decision processes. Administrative science quarterly, pp.246-275
- Pelletier, C. and Raymond, L., 2014. The IT Strategic Alignment Process: A Dynamic Capabilities Conceptualization
- Pettigrew, A.M., 1977. Strategy formulation as a political process. International studies of management & organization, 7(2), pp.78-87
- Pugliese, A., Bezemer, P.J., Zattoni, A., Huse, M., Van den Bosch, F.A. and Volberda, H.W., 2009. Boards of directors' contribution to strategy: A literature review and research agenda. Corporate Governance: An International Review, 17(3), pp.292-306
- Pyburn, P.J., 1983. Linking the MIS plan with corporate strategy: an exploratory study. MIS quarterly, pp.1-14
- Rajesh, R., Ravi, V. and Venkata Rao, R., 2015. Selection of risk mitigation strategy in electronic supply chains using grey theory and digraph-matrix approaches. International Journal of Production Research, 53(1), pp.238-257
- Rebolledo, Claudia, and Marie-Hélène Jobin. "Manufacturing and supply alignment: Are different manufacturing strategies linked to different purchasing practices?" International Journal of Production Economics 146, no. 1 (2013): 219-226
- Reynolds, P. and Yetton, P., 2015. Aligning business and IT strategies in multi-business organizations. Journal of Information Technology, 30(2), pp.101-118
- Roh, J., Hong, P. and Min, H., 2014. Implementation of a responsive supply chain strategy in global complexity: The case of manufacturing firms. International Journal of Production Economics, 147, pp.198-210
- Rose, D.S., 2014. Angel investing: The gust guide to making money and having fun investing in start-ups. John Wiley & Sons
- Schuler, Mike, 2017. [online] Available at: http://gcaptain.com/number-of-containers-lost-at-sea-falling-survey-shows/ [Accessed 22 June 2018]
- Sheffi, Y., 2001. Supply chain management under the threat of international terrorism. The International Journal of logistics management, 12(2), pp.1-11
- Smith, W.K., 2014. Dynamic decision making: A model of senior leaders managing strategic paradoxes. Academy of Management Journal, 57(6), pp.1592-1623
- Teece, D. J., Pisano, G., & Shuen, A., 1997. Dynamic capabilities and strategic management. Strategic management journal, Vol. 18, No. 7., Aug. 1997, pp. 509-533
- Volberda, H.W., Baden-Fuller, C. and Van Den Bosch, F.A., 2001. Mastering strategic renewal: Mobilising renewal journeys in multi-unit firms. Long Range Planning, 34(2), pp.159-178
- Von Clausewitz, C., 1940. On war. Jazzybee Verlag
- Wagner, H.T. and Weitzel, T., 2006. Operational IT business alignment as the missing link from IT strategy to firm success. AMCIS 2006 Proceedings, p.74
- Wilson, A., Baptista, J.J. and Galliers, R., 2013. Performing strategy: Aligning processes in strategic IT
- Wu, T., Wu, Y.C.J., Chen, Y.J. and Goh, M., 2014. Aligning supply chain strategy with corporate environmental strategy: A contingency approach. International Journal of Production Economics, 147, pp.220-229
- Sylla, C., 2014, December. Managing perceived operational risk factors for effective supply-chain management. In AIP Conference Proceedings (Vol. 1635, No. 1, pp. 19-26). AIP

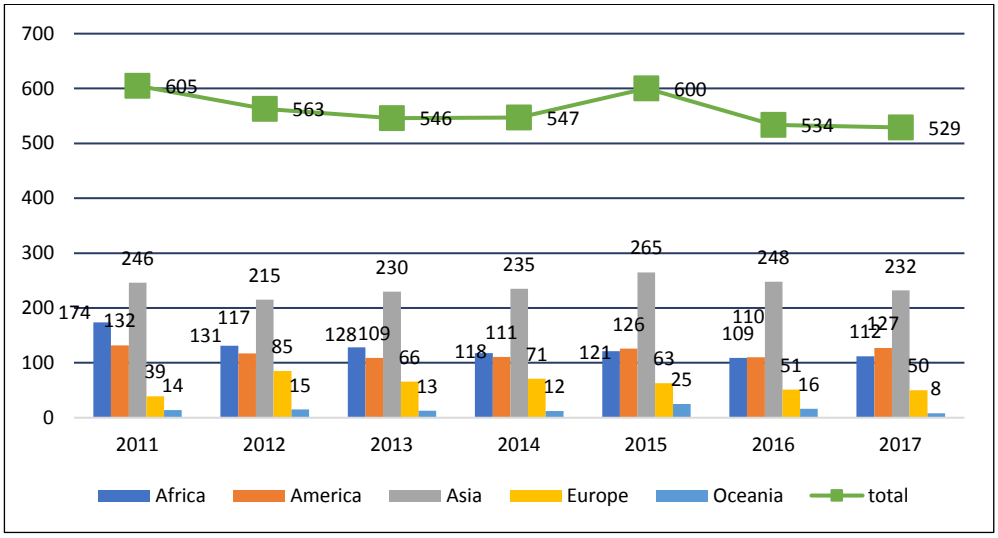
DETERMINING THE PRE-POSITIONING PROBLEM OF DISASTER RELIEF WAREHOUSES IN ASIA-PACIFIC REGION

Polin Lai and Xiao Shuang Lin
Department of International Logistics, Chung-Ang University, Seoul, Korea

1. Introduction

1.1. Background

Natural disasters frequently, such as earthquakes, floods, drought or man-made crises (civil unrest, war, political/tribal disturbance) happen in various areas around the world that seriously disrupt daily lives of people and also cause death (Roh et al., 2015). Natural disasters can occur with little or no warning and there is strong evidence that globally, natural disasters have increased in terms of both frequency and impact. Disaster-prone areas are experiencing more frequent emergencies and previously benign areas, unaffected by extremes, are now affected. Averagely, the total number of natural disasters occurring annually is around 500 times. The number of people affected by natural disasters are around 140,000 and over 500 disasters are reported death. (CREDEM-DAT, 2018). From 2011 to 2017, around 215 to 265 reported disasters occurred in Asia, the frequency was much higher than other continents. In addition, the total number of reported death toll of disasters in Asia is also at the highest level by continents (Figure 1).



Source: CREDEM-DAT, 2018

Figure 1: Total number of reported disasters, by continent

Many studies have addressed the importance of the preparedness phase and the need for pre-positioned warehouses in humanitarian relief logistics, but only a small number of papers are related to the location decision (Balcik and Beamon, 2008). Gatignon et al. (2010) illustrate the implementation of a decentralised model at the International Federation of the Red Cross (IFRC) using the pre-positioned warehouse concept. Campbell and Jones (2011) use a cost model to examine the preposition of supplies and the volume of goods in preparation for a disaster. Different regions are subject to different disaster types and while the occurrence of disasters is irregular on an annual basis, there is a trend for large scale disasters to occur in certain areas. Nonetheless, the most common major natural disasters that affect specific regions are floods, wind storms, droughts and earthquakes, giving some predictability which can assist in the preparedness phase, but timing, extent and duration of such emergencies remain unpredictable. As the characteristics of disasters around the world vary from region to region it is likely that different combinations of aid stocks could be pre-positioned in different locations. This is in part already serviced through shared facilities provided by for example the United Nations (UN) (Heaslip, 2013). In this case, how to construct an appropriate model to different region has become a major task for the recent research.

When emergencies occur, the most important thing is to supply food, drugs, or other necessities to the victims throughout the entire disaster and post-disaster without disruption. From previous researches revealed that some people died for lacking of these necessities rather than dying for a disaster. Thus, the main task of saving lives from a natural disaster is storing the relief materials in advance and distributing them effectively, which explained why the pre-positioning is significant for a rapid disaster preparedness and response.

The United Nations Humanitarian Response Depot (UNHRD) was established with the idea of pre-positioning emergency relief items for a quick response at the onset of any disaster. First UNHRD warehouse was established in the year 2000 at Brindsi, Italy. Until now, UNHRD is a network of six strategically located depots that procures, stores, and transports emergency supplies on behalf of the humanitarian community. With shift in strategic focus of relief organizations towards pre-positioning and UNHRDs attempt to expand its network, urgent need was realized to determine the pre-positioning problem of disaster relief warehouse. Comparing with great number of natural disasters and the enormous damage cost, only two depots of UNHRD (UAE & Malaysia) is obviously inadequate. There is no doubt, capacity building measuring is needed in this region which can enable to deal with aftermath of natural disaster effectively. In this case, how to identify an effective way to select the optimal location for a disaster relief warehouse in Asia-Pacific is the main purpose of this research. There are five sections in this paper. Following this introduction is a review of previous literature on humanitarian logistics and pre-positioning. The methods which are applied to undertake location choice are also reviewed in this section. Section 3 discusses the research methodology, including data analysis methods. Data construction and the results of the calculation using the developed computer calculator are presented in section 4. The discussion and conclusion drawn from the research findings and their implications for port policy-makers are discussed in the final section.

2. Literature Review

2.1. Pre-positioning problems

Pre-positioning problems is one of the most important research topics in humanitarian logistics. Kovács and Spens (2009) emphasized the importance of the location and regional presence of a humanitarian organization in disaster relief. The location and local capacity building of pre-positioning of relief items is significant in improving the performance of a humanitarian supply chain. However, there are limited researches which focus on the pre-positioning problem of disaster relief warehouses. Yong (2006) tried to select the optimal location for a plant under the main objective of minimizing the total cost and maximizing the use of resources. Chen (2001) determined a new multiple criteria group decision-making method to solve the distribution centre location selection problem. Ashrafzadeh et al. (2012) successfully apply the TOPSIS to a real warehouse location decision problem of a company in Iran. Most of these location-selection researches are target in obtaining commercial benefits. In the research, the authors provide an overview on various criteria used. And the typical criteria on the previous studies are: cost, value and benefits, environmental risks, resource accessibility and utilization, public facility accessibility, political matters and regulations, competition, economical, population, capacity, distance, and suitability.

From previous literatures, we can recognise that cost is the most important criteria in selecting an optimal location for business facility, considering the main objective of maximize the profit. However, because of the different objectives between traditional distribution systems and relief distribution systems, different criteria should be considered in location-selecting. Roh et al. (2013) suggested five critical factors considered for locating humanitarian relief warehouses. In particular, they utilized Analytical Hierarchy Process to determine the important weights of evaluation criteria. The mainly results are presented in Table 1. It shows that cooperation from the local government is the most critical factor and follows by national stability and cost. In conclusion, in spite of political factors, there are three factors influence the choice of configuration for a disaster relief pre-positioning network: 1. Up-front investment (initial inventory stocking and warehouse setup); 2. Operating costs (relief-item purchasing, transportation, and warehousing cost); 3. Average response time.

Rank	Criteria	Normalized Weight	Accumulated Weight
1	Cooperation	0.2908	0.2908
2	National stability	0.2282	0.5190
3	Cost	0.2270	0.7460
4	Logistics	0.1525	0.8985
5	Location	0.1015	1.0000
Total Weight		1.0000	

Source: Roh et al., 2013

Table 1: Critical factors for locating humanitarian relief warehouses

Another assumption which is applied in this study that the initial capital is ample and highlight the importance of average response time in location selection. This assumption is from Duran et al. (2011). The authors stated that if the initial investment is ample, the warehouse operating cost will not be very significant because of government subsidies and collaboration with the UNHRD and other humanitarian organizations. Balcik and Beamon (2008) developed a maximal-covering model to determine the number and the location of disaster relief warehouse. The inventory of supplies is also considered in their study. In this case, a mixed-integer liner program is used to solve this pre-positioning problem in this study. The gap of the previous studies is obvious that limited researches have applied a study on pre-positioning problem of disaster relief warehouse, especially in Asia-Pacific region. The possible contributions from this study can be listed as follow: 1. This study emphasizes the significance of response time on the pre-positioning problem of a disaster relief warehouse. 2. Asia-Pacific region is the key geographical region which this study focused on. 3. The newest disaster data from 1969 to 2017 is used in this study. And the research question from this study should be: Where is the optimal location for pre-positioning humanitarian aid materials in Asia-Pacific region to minimize delivery lead-time to those people who will need it.

3. Methodology

3.1. Data

This research attempts to determine the optimal location of pre-positioning warehouses for the shortest response time in Asia-Pacific region. The reported disaster data from 1969 to 2017 in Asia-Pacific are considered as the predicted demand. In total, 2707 events that resulted in at least 10 deaths between the years of 1969 and 2017 in Asia-Pacific. Grid lines were projected onto the earth's surface. When a disaster data located in that grid cell, the central of that grid cell will be assumed to represent

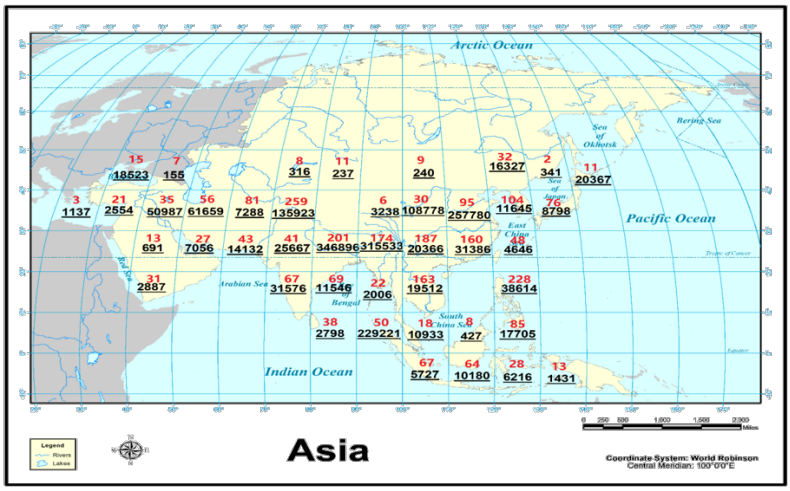


Figure 2: Potential disaster (demand) locations

the location of the demand. The grid cell dimensions were selected as 10 degrees (10◦) of latitude and

10 degrees (10◦) of longitude. If a grid cell contained a disaster that caused at least 10 deaths between the years of 1969 and 2017, the demand for that disaster will be located in that grid cell. Figure 2 illustrates the locations of potential disaster demand. The red numbers stand for the number of the disasters which the grid cell contains and the black numbers stand for the total death toll in that grid cell during 1969 to 2017.

3.2. Key assumptions of the Model

To determine the optimal location of pre-positioning warehouses in Asia-Pacific region, a mixed-integer programming (MIP) location model is applied in this research. This approach can be applied successfully to solve certain practical site location problems (Elson, 1972). Many researches also used this model to solve the facility location problem in different fields (Balcik and Beamon, 2008; Amrani, et al. 2011; Samuelsson, 2016). The model considers a set of demand instances and finds the optimal location of relief warehouse that minimizes the average response time over the demand instances.

3.3. Demand model

In most facility location and network flow optimization problems, demand is treated directly. For humanitarian supplies, demand would be measured in terms of the number of water-purification systems, the number of electrical generators, or the number of tents. To complicate matters further, operations often bring too many, or less, of any given non-consumable due to uncertainties on the ground. In other words, there is no clear direct signal of demand. Therefore, this study aims to approximate demand indirectly. The size of the operation is, in turn, proportional to the number of people being offered relief. From the data available, the best estimation for this demand is the number of displaced people, or the number of homeless. Therefore, the assumption is that the number of affected population by a hazard is proportional to the non-consumable material requirement. Therefore, the assumption is that the number of affected populations by a hazard is proportional to the non-consumable material requirement. The number of homeless is summated for each demand point over time and it is taken as an average per annum. This variable is "mean annual homeless" and is measured for every demand point being considered in the model. The variable is represented as:

H_j= mean forecasted annual homeless for demand point j

For this research, the only measure of central tendency used is the mean. Standard deviation is not relevant to location decisions.

3.4. Distance model

Pre-positioning implies that stocks are already stored in the facility, the path from vendor to facility is not time-sensitive and non-critical. For the sake of simplicity in the optimization model, and due in part to the data available for humanitarian relief activities, this delivery chain has been simplified yet again: considering only the path from source to destination. This assumes that transaction times are constant, regardless of facility location. Therefore, the model considers only the point-to-point arc from disaster relief warehouse to demand point. The variable is represented as:

d_{ij}= geographical distance from warehouse i to demand point j

The distance from a candidate disaster relief warehouse to a demand point is calculated using Haversine method. The Haversine theorem is used to calculate the lengths of two points on the surface of the earth based on longitude (φ) and latitude (λ) (Hartanto et al., 2017). It is a method of knowing the distance between two points by taking into account that the earth is not a plane but is a plane of a degree of curvature.

This algorithm is applied to establish a direct distance between points that can be stretched in a triangular form where a, b, and c are the distances to be calculated. In this case, between (φ_i, λ_i) and (φ_j, λ_j), the Haversine method assumes that the earth is spherical and uses the formula:

r = Earth's equatorial radius = 6378137 m

$$\Delta\varphi = \varphi_j - \varphi_i$$

$$\Delta\lambda = \lambda_j - \lambda_i$$

$$a = \left(\sin^2\left(\frac{\Delta\varphi}{2}\right) + \cos(\varphi_i)\right) * \left(\cos(\varphi_j)\right) * \left(\sin^2\left(\frac{\Delta\lambda}{2}\right)\right)$$

$$c = 2 * \operatorname{atan2}(\sqrt{a}, \sqrt{(1-a)})$$

$$d_{ij} = r * c$$

The actual network of airports, roads and river ways is de-emphasized, the model is under the assumption that all the demand points can be approached by air.

3.5. Formulation

A service level is the ability that the warehouse can satisfied the demand in a quick response. Therefore, the objective function for the formulations aimed at determining the sensitivity of distance to warehouse proliferation is the minimization of average distance to forecasted homeless people. From this point forward, be referred to as simply distance per capita. This implies the sum of all the arcs from the disaster warehouse to all the people forecasted to be homeless is minimized. The formulation uses the product ($d_{ij} * H_j$) as the formula for the sum of all arcs from a facility to all the people forecasted to be at risk at a given demand point. d_{ij} is the geographical distance from warehouse i to demand point j. H_j is the annual mean homeless, or in other words, the forecasted number of displaced people at demand point j. That the product of the two variables multiplies the distance by the number of people indicates the sum of all the arcs from that facility to every person at that location. Distance per capita is thus expressed as $\frac{\sum_{ij} d_{ij} H_j W_{ij}}{\sum H_j}$, where W_{ij} is the decision variable (with a value of 0 or 1) of the optimization because it determines if an arc (actually, the sum of all the arcs from a facility at point i to all the forecasted homeless people at point j) is 'active'. The formulation simply aims to identify optimal positions of n candidate warehouse locations so that distance per forecasted homeless person is minimized. And it is as follows:

$$\min \frac{\sum_{ij} d_{ij} H_j W_{ij}}{\sum H_j} \quad \forall i, j$$

Index Sets

I set of possible pre-positioning warehouses

J set of regional demand locations

Variables

$$W_{ij} = \begin{cases} 1, if\ \ the\ \ warehouse\ \ i\ \ is\ \ assigned\ \ to\ \ demand\ \ point\ \ j \\ 0, otherwise \end{cases}$$

Parameters

d_{ij} geographical distance from warehouse i to demand point j.

H_j mean of annual homeless affected by natural disasters in demand point j.

Three data sets need to be collected for the two variables of the optimization problems:

1. The mean annual homeless for every demand point (for $\mathbf{H_j}$ value).
2. Latitude and longitude coordinates for all demand points($(\boldsymbol{\varphi_j}, \boldsymbol{\lambda_j})$ values used to calculate $\mathbf{d_{ij}}$).
3. Latitude and longitude coordinates for all candidate warehouses. ($(\boldsymbol{\varphi_i}, \boldsymbol{\lambda_i})$ values used to calculate $\mathbf{d_{ij}}$).

3.6. Candidate warehouse locations

Currently, there are two depots under UNHRD which are located in Asia (UAE and Malaysia). Both of

them mainly cover west and south Asia. In this situation, the candidate locations in this research will be selected from East Asia. Due to the stability of a country has a significant influence on the sustained and effective relief supply chain, it is important to exclude the candidate warehouses from a country which hit by a civil or unrest. Thus, the geographical factor is the main factor that the author considered when choosing the candidate sites for disaster relief warehouse. The sample cities should facilitate with both good airport and seaport and low historical disaster occurrence probability (to minimize the possibility of losing a warehouse to a disaster itself). 13 potential sites are selected in this research, nine of them in China (Tianjin, Dalian, Qingdao, Shanghai, Ningbo, Xiamen, Guangzhou, Shenzhen, and Hong Kong), two of them in Japan (Tokyo and Osaka), one in Korea (Busan), and one in Taiwan (Kaohsiung).

4. Analysis and result

In the research, we used 2707 demand instances from the last 60 years worldwide, in which the warehouse was needed to respond to a disaster or a group of disasters without any replenishment. The objective function of the MIP model minimizes the average of the weighted response times over the 43 demand points. And when we ensure the demand points, the affected population of each point is ensured too. In this context, $\sum H_j$ is a constant value, so the formulation can be simplified as below:

$\min \sum_{ij} d_{ij} H_j W_{ij}$

Let SL_i(service level of candidate location i) $=\sum_j d_{ij} H_j$

$SL_1 = d_{11}H_1 + d_{12}H_2 + d_{13}H_3 + d_{14}H_4 + \cdots + d_{143}H_{43}$

$SL_2 = d_{21}H_1 + d_{22}H_2 + d_{23}H_3 + d_{24}H_4 + \cdots + d_{243}H_{43}$

……

$SL_{13} = d_{131}H_1 + d_{132}H_2 + d_{133}H_3 + d_{134}H_4 + \cdots + d_{1343}H_{43}$

According to this result, among 13 possible locations, the smallest SL value is SL (29.82, 121.47) which is Ningbo city. The result shows that Ningbo city has the minimal total distance to all affected persons. And as a result of constant $\sum H_j$ value that Ningbo city also has the minimal weighted distance to an affected person comparing other candidate locations. In order to simplify the calculation, we assume that the average maximum speed of various cargo aircrafts, is approximated to be 500 km/hr. And the transportation time is assumed to be only air transport with no consideration of refuelling stops. In order to figure out whether Ningbo has any comparative advantage in a quick response to a disaster comparing Dubai and Subang, the same method is used to collect the transportation time from Dubai and Subang to each demand point. In Table 2, the descriptive analysis of transportation time for these three locations are presented. It is obviously that Ningbo has the least average transportation time comparing with Dubai and Subang. The minimum value 0.04 (Dubai) and 0.88 (Subang) illustrates that these two warehouses are close to at least one disaster demand point. Accordingly, Ningbo is possible to have less disaster occurrence probability than Dubai and Subang. It is more unlikely for Ningbo losing a warehouse to a disaster itself. The service rates of Figure 2 illustrated that how much affected persons can be reached within certain transportation time. All the 43 demand points in Asia can be reached within 19 hours from either warehouse location. In particular, Ningbo can reach 40% of the affected persons within two hours and almost 80% within seven hours. In summary, Ningbo is the optimal location of a disaster relief warehouse in Asia-Pacific region from a geographical view out of 13 candidate locations.

	N	Range	Minimum	Maximum	total	mean	S.D.
DUBAI	43	18.45	0.04	18.49	385.06	8.95	4.83
SUBANG	43	16.30	0.88	17.18	349.98	8.14	4.13
NINGBO	43	16.12	1.28	17.40	337.73	7.85	4.36
Valid N(listwise)	43						

Table 2: Descriptive statistics

However, Ningbo city seems to be a reasonable location for a disaster relief warehouse even take other factors into consideration. Firstly, Ningbo has witnessed continuous and rapid economic development in the Chinese economic reform and has been described by the UN as the most promising city in China. The city now serves as the economic centre for the southern Yangtze River Delta. In other words, the city has a stable society and great infrastructure. Furthermore, Ningbo is in a great logistics condition. The Ningbo Lishe Airport is very large and efficient, can land all aircraft types, and handles about 0.12 million tons of cargo per year. According to the Top 50 World Container Ports announced by World Shipping Council (2017), the port of Ningbo takes the forth place of the list. As Teng (2005) observe that Ningbo port now constitutes a significant threat to Shanghai's position as the leading container port on the central eastern seaboard of mainland China.

5. Discussion and Conclusion

The pre-positioning of disaster relief warehouse is a rather complex problem due to the uncertainty and volatility of the humanitarian supply chain. Unlike general logistics, the main objective for a disaster relief system is fairness and efficiency. In other word, it is all about reducing the response time to a disaster and saving more lives. Thus, minimizing the average distance from the disaster relief warehouse to an affected person takes the priority in making the location selection decision. In this research, the objective was to characterize the pre-positioning problem for humanitarian relief chains in Asia-Pacific region. We attempt to propose an analytical method which will enable relief decision makers to make effective and efficient location and stock pre-positioning decisions for a disaster relief warehouse. A mixed-integer programming (MIP) location model is used to determine the optimal location for the warehouse out of other potential warehouse sites. However, the MIP model is based on the assumption that all the governments are willing to cooperate and support the humanitarian program to operate this warehouse in their country. And the initial capital is supposed to be ample to afford setting the warehouse in any location in Asia-Pacific region. It implies that political factors and cost factors are not significant in this research. There are also some limitations in this research. Firstly, geographical factor is the main factor considered in this study, other factors like political factor or financial factor are not taken into consideration. Secondly, the value of the demand is roughly using the average number of annual affected people instead of specific number of relief material items. Thirdly, the model ignores the connection and cooperation between the potential warehouse and the disaster warehouse that already be established.

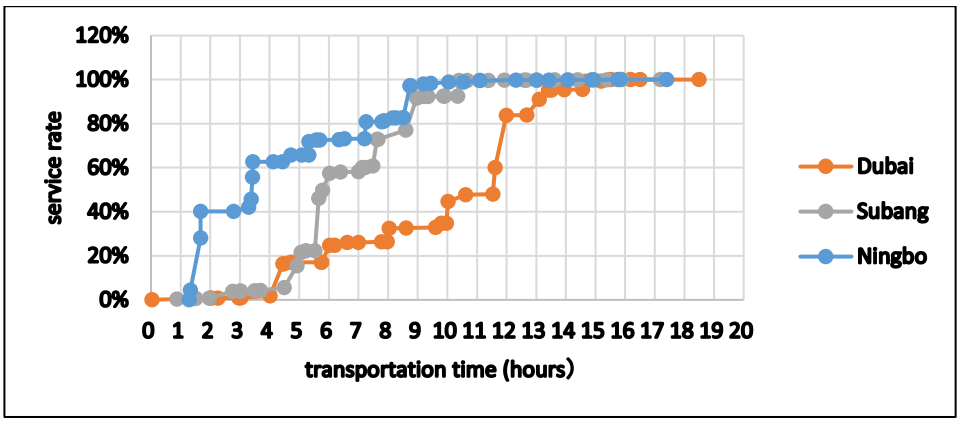


Figure 3: Service rate of Ningbo, Dubai and Subang

Reference

- Amrani, H., Martel, A., Zufferey, N., & Makeeva, P. (2011). 'A variable neighborhood search heuristic for the design of multicommodity production–distribution networks with alternative facility configurations'. *OR spectrum*, Vol. *33*, No.4, pp.989-1007.
- Ashrafzadeh, M., Rafiei, F. M., Isfahani, N. M., & Zare, Z. (2012). 'Application of fuzzy TOPSIS method for the selection of Warehouse Location: A Case Study'. Interdisciplinary *Journal of Contemporary Research in Business*, Vol. 3, No.9, pp.655-671.
- Balcik, B., & Beamon, B. M. (2008). 'Facility location in humanitarian relief'. *International Journal of Logistics*, Vol.11, No.2, pp.101-121.
- CRED EM-DAT. (2014). Centre for research on the epidemiology of disasters, EMD at The international Disaster Database. Available at (http://www.emdat.be/database). (accessed April 2018.).
- Dey, B., Bairagi, B., Sarkar, B., & Sanyal, S. K. (2016). 'Warehouse location selection by fuzzy multi- criteria decision making methodologies based on subjective and objective criteria'. *International Journal of Management Science and Engineering Management*, Vol.11, No.4, pp. 262-278.
- Duran, S., Gutierrez, M. A., & Keskinocak, P. (2011). 'Pre-positioning of emergency items for care international'. *Interfaces*, Vol. 41, No.3, pp.223-237.
- Elson, D. G. (1972). 'Site location via mixed-integer programming'. *Journal of the Operational Research Society*, Vol. 23, No. 1, pp.31-43.
- Farahani, R. Z., SteadieSeifi, M., & Asgari, N. (2010). 'Multiple criteria facility location problems: A survey'. *Applied Mathematical Modelling*, Vol. 34, No.7, pp. 1689-1709.
- Gatignon, A., Van Wassenhove, L.N., Charles, A. (2010). 'The Yogyakarta earthquake: humanitarian relief through IFRC's decentralized supply chain'. *International Journal of Production Economics,* Vol. 126, pp. 102–110.
- Hartanto, S., Furqan, M., Siahaan, A. P. U., & Fitriani, W. (2017). 'Haversine method in looking for the nearest masjid'. *International Journal of Engineering Research*, Vol. 3, No.8, pp.187-195.
- Heaslip, G., (2013). 'Service operations management and humanitarian logistics'. *Journal of Humanitarian Logistics Supply Chain Management*. Vol. 3, No.1, pp.37–51.
- Kovács, G., & Spens, K. (2009). Identifying challenges in humanitarian logistics. *International Journal of Physical Distribution & Logistics Management,* 39(6), 506-528.
- Roh, S., Jang, H. M., & Han, C. H. (2013). 'Warehouse location decision factors in humanitarian relief logistics'. *The Asian Journal of Shipping and Logistics*, vol.29, No.1, pp. 103-120.
- Roh, S., Pettit, S., Harris, I., & Beresford, A. (2015). 'The pre-positioning of warehouses at regional and local levels for a humanitarian relief organisation', *International Journal of Production Economics,* Vol. 170, pp.616-628.
- Rath, S., & Gutjahr, W. J. (2014). 'A math-heuristic for the warehouse location–routing problem in disaster relief'. *Computers & Operations Research,* Vol. 42, pp. 25-39.
- Samuelsson, B. (2016). 'Estimating distribution costs in a supply chain network optimisation tool, a case study'. *Operational Research*, Vol. 16, No. 3, pp. 469-499.
- Teng, Y. (2005). 'Port competition between shanghai and Ningbo'. *Maritime Policy & Management,* Vol.32*, No.*4, pp.331-346.
- Wassenhove, L. N. V. (2006). 'Humanitarian aid logistics: supply chain management in high gear', *The Journal of the Operational Research Society*, Vol. 57, No. 5, pp.475-489.

EVALUATION OF PROJECT LOGISTICS COMPANY SELECTION BASED ON CUSTOMERS' PERSPECTIVES

A-Rom Kim[1, 3], Keun-Sik Park[2], Young-Joon Seo[3] and Dong-Wook Kwak[4]
[1]Institute of Economics & Business Administration, Kyungpook National University, Daegu, South Korea
[2]Department of International Logistics, Chung-Ang University, Seoul, South Korea
[3]School of Economics & Trade, Kyungpook National University, Daegu, South Korea
[4]School of Strategy and Leadership, Coventry Business School, Coventry University, Coventry, UK

1. **Introduction**

Logistics management in engineering, procurement, and construction (EPC) is an emerging business area that differs substantially from manufacturing logistics management, where the emphasis is on modelling volume production. Moreover, the organization and sourcing of materials are becoming increasingly complex across EPC industries due to both global sourcing of materials and the combination of advances in transport technologies and a shortage of professionals (O'Brien et al., 2009). At the same time, EPC customers are demanding faster, more responsive logistics processes and higher quality services. These demands generally involve both more responsive transportation and closer coordination between EPC and project logistics companies. For instance, a major EPC project places enormous demand on its logistics role, as arranging and organizing workers, materials, and equipment on such large scales is an important business. Nonetheless, when the logistics function is managed correctly in project logistics, it can contribute to EPC companies' sustainable growth by affecting time, cost, quality, safety, and environmental performance among others (Mossman, 2008). Accordingly, a sound project logistics company selection can be seen as key to the successful transport of EPC cargo and to ensuring the competitiveness of EPC industries (Peng, 2012).

Despite the importance of project logistics in EPC industries, there is a lack of research on project logistics and its priority when EPC companies attempt to implement project logistics through project logistics company selection. To fill this gap, this study performs an empirical analysis focusing on the crucial factors used by EPC companies in project logistics company selection. This study seeks to help stakeholders and practitioners by analyzing the salient factors for project logistics company selection in EPC industries and draw relevant implications. The priority of project logistics company selection is analyzed using the fuzzy AHP method, after using the fuzzy Delphi method (FDM) with experts. Questionnaires are distributed to EPC companies' employees. After the selection of preemptive evaluation factors by requesting an expert group to answer a questionnaire, the paper presents directions for project logistics company selection by analyzing the importance of and preference for the various selected factors. The rest of paper is structured as follows. The second section reviews the literature, and the third section explains the methodology. The empirical analysis is presented in the fourth section. Finally, the fifth section provides a discussion and presents concluding remarks.

2. **Literature review**

In terms of project logistics, a significant body of research has explored transport scheduling and efficiency. Most scholars adopt a service perspective focused on timely delivery (e.g., time performance, accuracy of transit/delivery time) (Garcia et al., 2012) and lower cost (e.g., price, cost reduction) (Jin et al., 2018). They also examine logistics capability by focusing on flexibility (e.g., ability to meet future requirement and capacity to adjust to customers' needs) (Naim et al., 2010) and risk management (e.g., risk prevention during natural disasters, piracy, and terrorism) (Rajesh et al., 2011). Further, project logistics companies' experience, such as number of contracts (Sobotka et al., 2005) and infrastructure/equipment (Huo et al., 2008), were also analyzed. For example, according to Shi and Blomquist (2012), project scheduling is linked to the issues of resource handling, organizational structure, and behaviors of stakeholders that may affect the information split mechanism among different project partners. On the other hand, Jin et al. (2018) advanced a framework to map the

effects of project management elements on project cost, and then tested the relationships between project management element and project cost for manufacturing construction projects.

Project logistics may be related to 3PL. A large body of literature explored 3PL transport efficiency (Hamdan and Rogers, 2008), service quality measuring (Gupta et al., 2017), and service quality improvement (Baligil et al., 2011) such as network optimization, and established the framework for measuring logistics performance. Percin (2009) argued that establishing a flexible and scalable logistics outsourcing network with 3PL providers is a key element in achieving lower costs, responsiveness to market, and enhanced flexibility. The results identified the model of 3PL provider selection can help stakeholders and practitioners understand the strengths and weaknesses of potential 3PL providers using evaluation criteria and sub-criteria.

Notwithstanding the extensive body of literature on project logistics and 3PL, there is a lack of research that integrates the various factors to be considered by EPC companies selecting project logistics companies. To fill this gap, this paper conducts an analysis to determine the priorities of EPC companies in selecting project logistics partners.

3. **Methodology**

3.1 Fuzzy Delphi method

In the selection of evaluative indicators, the FDM proposed by Hsu et al. (2013) is adopted to denote expert consensus using geometric means. The process is demonstrated as follows.

Step 1: Collect expert opinions using a decision group.
After identifying the relevant factors, *n* experts (decision makers) are invited to determine the importance of factors through a questionnaire using linguistic variables. This study applies triangular fuzzy numbers (TFNs) for evaluating the factors and a geometric mean model (Ma et al., 2011) to determine the experts' group decision. The TFN $\tilde{T}_A$ is as follows:

$$\tilde{T}_A = (L_A, M_A, U_A), \qquad \textit{Eq. (1)}$$

$$where, L_A = \min\left(X_{A_i}\right), M_A = \sqrt[n]{\prod_{i=1}^{n} X_{A_i}}, U_A = \max\left(X_{A_i}\right),$$

where *i* indicates the *i*th expert, *i = 1, 2, …, n*; X_{A_i} the factor's weight of the *i*th expert for criterion *A*; L_A the bottom of all the factor's weight for criterion *A*; M_A the geometric mean of all the factor's weight for criterion *A*; and U_A the ceiling of all the factor's weight for criterion *A*.

Step 2: Geometric mean M_A of each factor's weight.
This step denotes the consensus of the expert group on the factor's weight, so that the impact of extreme values could be avoided. For threshold factor r, the 80/20 rule is adopted, with r set as 8. This indicates that, among the factors for selection, "20% of the factors account for an 80% degree of importance of all the factors" (Kuo and Chen, 2008, p. 1934). The selection criteria are:

If M_A > r = 8, this factor is accepted, *Eq. (2)*
If M_A < r = 8, this factor is rejected.

For example, the timely delivery/reliability factor was awarded by each of the 10 experts 10, 9, 10, 10, 10, 10, 10, 10, 10, and 10:

$\tilde{T}_A$=(9,9.895,10),where M_A>8, and this factor was accepted.

The other 22 factors were analyzed in the same way, with 16 factors identified by FDM ranking. The details are as shown in Table 2.

3.2 Fuzzy set and fuzzy-AHP

Relative criteria weights at the same level can be obtained using pairwise comparisons. A number of selected experts are approached to respond to questions such as "which criterion should be emphasized more in selecting a project logistics company, and how much more?." The AHP procedure consists of the following steps (Ha and Yang, 2017; Saaty, 1980; Zeng et al., 2007).

Step 1: Define the pairwise comparison matrix.

TFNs are utilized for pairwise comparisons and to determine fuzzy weights because they are intuitively easy for decision makers to use and calculate. The computational process for fuzzy-AHP is detailed as follows. A TFN can be defined by triplet (*a1, a2, a3*) and the membership function $\mu_{\tilde{A}}(x)$ is defined by:

$$\mu_{\tilde{A}}(x) = \begin{cases} (x-l)/(m-l), & l \le x \le m \\ (u-x)/(u-m), & m \le x \le u. \\ 0, & otherwise \end{cases} \qquad \textit{Eq. (3)}$$

This paper uses nine basic linguistic terms with respect to a fuzzy nine-level scale. Each membership function (scale of a fuzzy number) is defined by three parameters of the symmetric TFN—the left, middle, and right points—of the range over which the function is defined.

Step 2: Establish a pairwise comparison of decision matrix A.

Let ($C_1, C_2, \cdots, C_n$) denote the set of elements, while a_{ij} represents a quantified judgment on the pair of elements C_i and C_j. The relative importance of the two elements is rated using a measurement scale with values 1, 3, 5, 7, and 9, where 1 refers to "equally important," 3 denotes "slightly more important," 5 equals "strongly more important," 7 represents "demonstrably more important," and 9 denotes "absolutely more important." This leads to an *n*-by-*n* comparison matrix *A*:

$$A = \begin{matrix} \\ C_1 \\ C_2 \\ \cdots \\ C_N \end{matrix} \begin{matrix} \begin{matrix} C_1 & C_2 & \cdots & C_n \end{matrix} \\ \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & 1 \end{bmatrix} \end{matrix} = \begin{matrix} \\ C_1 \\ C_2 \\ \cdots \\ C_N \end{matrix} \begin{matrix} \begin{matrix} C_1 & C_2 & \cdots & C_n \end{matrix} \\ \begin{bmatrix} 1 & 1/\tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ 1/\tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/\tilde{a}_{n1} & 1/\tilde{a}_{n2} & \cdots & 1 \end{bmatrix}, \end{matrix} \qquad \textit{Eq. (4)}$$

Where,

$$\tilde{a}_{ij} = \begin{cases} \tilde{9}^{-1}, \tilde{8}^{-1}, \tilde{7}^{-1}, \tilde{6}^{-1}, \tilde{5}^{-1}, \tilde{4}^{-1}, \tilde{3}^{-1}, \tilde{2}^{-1}, \tilde{1}^{-1}, \tilde{1}, \tilde{2}, \tilde{3}, \tilde{4}, \tilde{5}, \tilde{6}, \tilde{7}, \tilde{8}, \tilde{9} & 1, i \ne j \\ 1 & i = j \end{cases}.$$

Step 3: Define the fuzzy geometric mean and fuzzy weights.

Let r_{ij}^l be the relative importance judgement on the pair of criteria C_i and C_j ($i,j=1,2,\cdots,n$) by the *i*th expert. Then, the aggregated weight comparison between C_i and C_j by *m* experts ($l \in m$) can be obtained by:

$$r_{ij} = \frac{1}{m}(r_{ij}^1 + \cdots + r_{ij}^l + \cdots + r_{ij}^m). \qquad \textit{Eq. (5)}$$

Next, the synthesized *i*th criterion weight comparison between C_i and C_j by m experts can be calculated using

$$w_i = \frac{1}{n}\sum_{j=1}^{n}\left(\frac{r_{ij}}{\sum_{i=1}^{n} r_{ij}}\right), where \ \sum_{j=1}^{n} w_i = 1. \qquad \textit{Eq. (6)}$$

Step 4: Calculate consistency.
The relative weights, which would also present the eigenvalues of criteria are calculated as

$$A_w = \lambda_{max} w, \qquad \textit{Eq. (7)}$$

$where, \lambda_{max} = \frac{\sum_{j=1}^{n} \frac{\sum_{i=1}^{n} r_{ij} w_i}{w_j}}{n}$.

Another critical characteristic of AHP is the consistency of pairwise judgements by calculating the consistency ratio (CR) in Eq. (8). When the value of CR is greater than 0.1, an inconsistency in pairwise judgements appears and the experts need to revise their pairwise judgements. Therefore, the judgements should have an acceptable CR level of 0.10 or less.

$$CI = \frac{\lambda_{max} - n}{n-1}, CR = \frac{CI}{RI}, \qquad \textit{Eq. (8)}$$

where CI is the consistency index, λ_{max} the principal eigenvalue of the comparison matrix, RI the average random index, and *n* the number of criteria.

Size (*n*)	1	2	3	4	5	6	7	8
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40

Table 1: Random consistency index

Step 5: Perform defuzzyfication and rank criteria.
The study determines the best crisp or non-fuzzy values in accordance with the center of area (COA) or center index (CI). The calculation method of the BNP value for each weight (*l, m, u*) is as follows:

$$BNP\ value = \frac{[(u-l)+(m-l)]}{3} + l. \qquad \textit{Eq. (9)}$$

Finally, the criteria are ranked using BNP values. The criterion with a larger BNP value is considered to have a stronger effect compared to other criteria.

3.3 Data collection and preparation
Extant studies pertaining to project logistics were circulated among experts to obtain better insights into the problem. Due to the absence of a single directory for the respondents' list, we crosschecked multiple directories, such as Korea Customs Logistics Association, Korea International Freight Forwarders Association, and Korea Integrated Logistics Association. Additionally, 10 experts from logistics companies, consisting of CEOs, general managers, and operations managers with professional experience, were selected. From October 15 to January 26, 2018, we interviewed 10 experts using the 23 factors obtained from the literature review. Based on the 80/20 rule, 16 detailed sub-criteria under the four main criteria (general service, logistics capability, organization characteristics, and organization resource) were identified.

The questionnaire was distributed to EPC companies that had project logistics company selection experience. From February 5 to March 9, 2018, 200 questionnaires were distributed; of these, 51 were returned. The response rate was approximately 26% and 47 valid questionnaires were used for analysis. The respondents ranged from CEOs to managers in business and logistics units. Therefore, a comprehensive and balanced view was ensured.

No	Key factors (before: 23)	Geometric value	Key factors (after: 16)
1	Corporate reputation	6.28	Corporate scale
2	Corporate scale	8.10	Customer relationship management
3	Corporate social responsibility	6.15	Engineering technology
4	Customer relationship management	8.06	Experience
5	Engineering technology	8.88	Financial stability
6	Experience	9.49	Network/partnership
7	Financial stability	8.25	Project logistics related transport vehicle
8	ISO compliance	6.08	Project logistics related unloading equipment
9	Know-how	7.35	Problem solving flexibility
10	Location	5.24	Reasonable cost
11	Loyalty	6.31	Risk management
12	Network/partnership	8.17	Skilled manpower
13	Project logistics related loading/unloading equipment	8.46	The provision of information technology
14	Project logistics related transport vehicle	8.65	Timely delivery/reliability
15	Problem solving flexibility	9.69	Transport route planner
16	Professionalism	7.74	Worldwide office
17	Reasonable cost	9.18	
18	Risk management	8.07	
19	Skilled manpower	8.31	
20	The provision of information technology	8.02	
21	Timely delivery/reliability	9.90	
22	Transport route planner	8.14	
23	Worldwide office	8.16	

Table 2: Key factors before and after Delphi analysis

The overall objective of the decision process for project logistics company selection is at the first level of the hierarchy, the main criteria on the second level, and the sub-criteria on the third level. Details are as follows.

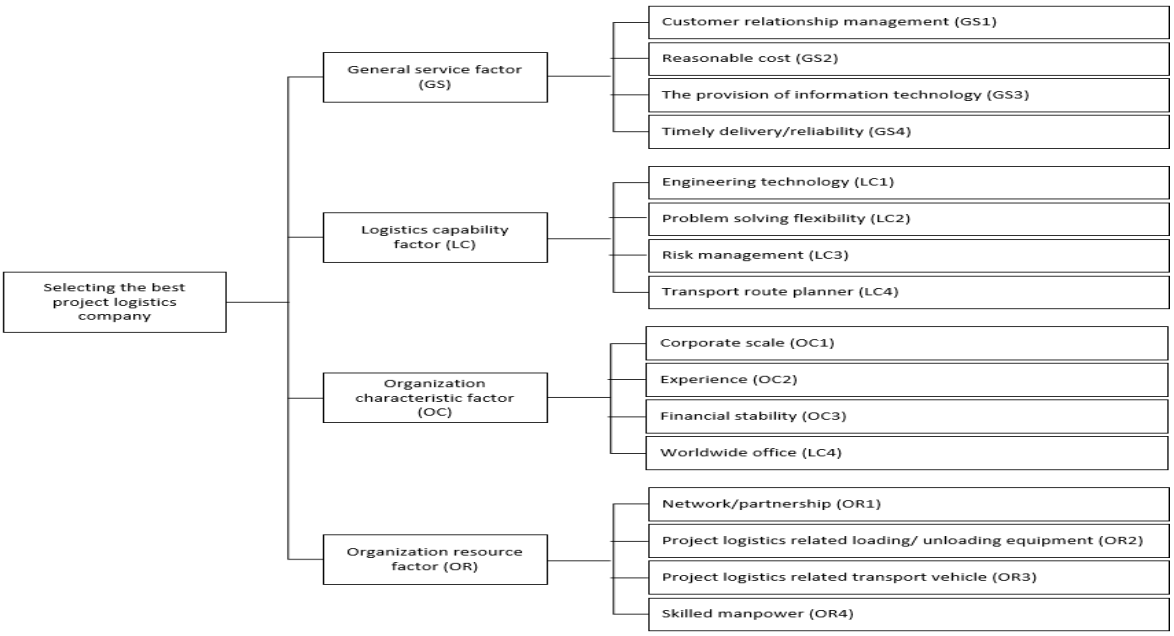


Figure 1: Hierarchical structure to selecting the best project logistics company

4. **Finding**

From the calculated criteria weight, the weighted evaluation matrix is constructed using Eqs. (3)–(9). The results are shown in Tables 3 and 4. The results of the general service criteria (M1) indicate timely delivery/reliability (GS4) is the most important factor, followed by reasonable cost (GS2), provision of information technology (GS3), and customer relationship management (GS1). In other words, decision making for project logistics company selection is made based on economic and timely accuracy when EPC companies make decisions. The results of the logistics capability criteria (M2) suggest problem solving flexibility (LC2) is the most important factor, followed by engineering technology (LC1), transport route planner (LC4), and risk management (LC3). It might be argued that factors such as the flexibility of problem solving for timely delivery and essential engineering technology are taken into consideration when EPC companies select project logistics companies in terms of logistics capability. The results of the organization characteristics criteria (M3) show experience (OC2) is the most important factor, followed by worldwide office (OC4), financial stability (OC3), and corporate scale (OC1). Project logistics company selection by EPC companies is sensitive to corporate experience for reliability of the project logistics company. Results of the organization resource criteria (M4) identify project logistics related loading/unloading equipment and transport vehicle (OR2 and OR3) are the most important factors, followed by skilled manpower (OR4) and network/partnership (OR1). Finally, the results of the priority importance of the sub-criteria (Table 10) are as follows. Table 10 shows timely delivery/reliability (GS1) is the most important factor, followed by problem solving flexibility (LC2), experience (OC2), and reasonable cost (GS2).

Major criterion	Consistency	Major criterion weight	Major criterion BNP	Ranking
General service	0.092	(0.251, 0.298, 0.349)	0.299	1
Logistics capability		(0.216, 0.254, 0.298)	0.256	2
Org. characteristics		(0.110, 0.130, 0.156)	0.132	4
Org. resource		(0.145, 0.169, 0.197)	0.170	3

Table 3: Ranking of main criteria for project logistics company selection

Sub-criterion	Consistency	Sub-criterion weight	BNP	Ranking	Total ranking
GS1	0.010	(0.081, 0.092, 0.105)	0.093	4	16
GS2		(0.251, 0.289, 0.330)	0.290	2	4
GS3		(0.137, 0.156, 0.181)	0.158	3	11
GS4		(0.289, 0.336, 0.384)	0.336	1	1
LC1	0.020	(0.233, 0.279, 0.330)	0.281	2	5
LC2		(0.265, 0.313, 0.362)	0.313	1	2
LC3		(0.090, 0.105, 0.124)	0.106	4	15
LC4		(0.127, 0.151, 0.184)	0.154	3	12
OC1	0.020	(0.128, 0.147, 0.172)	0.149	4	14
OC2		(0.256, 0.304, 0.356)	0.305	1	3
OC3		(0.151, 0.176, 0.205)	0.177	3	10
OC4		(0.194, 0.227, 0.267)	0.229	2	9
OR1	0.010	(0.127, 0.150, 0.179)	0.152	4	13
OR2		(0.201, 0.235, 0.277)	0.238	1	6
OR3		(0.196, 0.230, 0.271)	0.232	2	7
OR4		(0.192, 0.230, 0.273)	0.232	3	8

Table4: Ranking of sub-criteria for project logistics company selection

5. **Concluding remarks**

To the best of our knowledge, this study is the first to uncover the project logistics company selection of the EPC companies. This is the most powerful motivation to consider this issue. As such, this study may enhance the better grasp of the importance of project logistics company selection of EPC companies and provide the stakeholders and practitioners with meritorious insights. This paper may also provide a clear understanding of the EPC companies' needs regarding project logistics company selection. Additionally, by benchmarking the results, project logistics managers can determine how to provide efficient services and make prompt adjustments to meet their customers' needs.

The five top-ranked factors include two factors under general service criteria (GS2 and GS4), two factors under logistics capability criteria (LC1 and LC2), and one factor under organization characteristics criteria (OC2). These results might help decide the direction of decision making for project logistics company selection. As the criteria in general service (M1) are considered to be the most important factors, the more involute and difficult the problem, the more the number of analytical and rational factors that need to be considered. Because the problem with project logistics is in managing the time factor, which represents a set of constraints for logistics (Sandhu, 2006), the most important factor is timely delivery and reliability (GS4). Remarkably, although the literature did not focus on project logistics related loading/unloading equipment (OR2) and transport vehicle (OR3), this study found these factors have high priority. The results suggest project logistics selection is slightly different from 3PL selection and other service providers. Because it needs to acquire specialized equipment (e.g., module transporter) and transport vehicles (dedicated vessels, multi-module trailers, barges for heavy cargoes) for the transportation of EPC cargoes, it is an important factor. Thus, this paper might provide valuable insights for strategies, service capability, and sustainable growth as to meet customers' needs in EPC companies through selecting suitable project logistics companies.

Despite the superiority of this study over previous ones, it has some limitations. It has been difficult for decision makers involved in project logistics company selection to obtain reliable and stable data on their decision making and judgments. Therefore, it will be necessary to obtain more accurate results by securing a variety of objective data through more in-depth interviews and surveys.

References

- Baligil, H., Kara, S.S., Alcan, P., Ozkan, B. & Caglar, E.G. (2011), 'A distribution network optimization problem for third party logistics service providers', *Expert Systems with Applications*, Vol. 38, No. 10, pp. 12730-12738.
- Garcia, F.A., Marchetta, M.G., Camargo, M., Morel, L. & Forradellas, R.Q. (2012), 'A framework for measuring logistics performance in the wine industry', *International Journal of Production Economics*, Vol. 135, No. 1, pp. 284-298.
- Gupta, A., Singh, R.K. & Suri, P.K. (2017), 'Prioritising the factors for analysing service quality of 3PL: AHP approach', *Asia-Pacific Journal of Management Research and Innovation*, Vol. 13, No. 1, pp. 1-9.
- Ha, M.-H. & Yang, Z. (2017), 'Comparative analysis of port performance indicators: Independency and interdependency', *Transportation Research Part A*, Vol. 103, pp.264–278.
- Hamdan, A. & Rogers, K.J. (2008), 'Evaluating the efficiency of 3PL logistics operations', *International Journal of Production Economics*, Vol. 113, No. 1, pp. 235–244.
- Hsu, C.-C., Liou, J.J.H. & Chuang, Y.-C. (2013), 'Integrating DANP and modified grey relation theory for the selection of an outsourcing provider', *Expert Systems with Applications*, Vol. 40, No. 6, pp. 2297-2304.
- Huo, B., Selen, W., Yeung, J.H.Y. & Zhao, X. (2008), 'Understanding drivers of performance in the 3PL industry in Hong Kong', *International Journal of Operations & Production Management*, Vol. 28, No. 8, pp. 772-800.
- Jin, H., Shen, L. & Wang, Z. (2018), 'Mapping the Influence of Project Management on Project Cost', *KSCE Journal of Civil Engineering*, (Forthcoming), pp. 1-13.
- Kuo, Y.-F. & Chen, P.-C. (2008), 'Constructing performance appraisal indicators for mobility of the service industries using Fuzzy Delphi Method', *Expert Systems with Applications*, Vol. 35, No. 4, pp. 1930–1939.
- Ma, Z., Shao, C., Ma, S. & Ye, Z. (2011), 'Constructing road safety performance indicators using Fuzzy Delphi Method and Grey Delphi Method', *Expert Systems with Applications*, Vol. 38, No. 3, pp. 1509-1504.
- Mossman, A. (2008) 'More than materials: Managing what's needed to create value in construction', *2nd European Conference on Construction Logistics*, ECCL, Dortmund, May 2008.
- Naim, M., Aryee, G. & Potter, A. (2010), 'Determining a logistics provider's flexibility capability', *International Journal of Production Economics*, Vol. 127, No. 1, pp. 39-45.
- O'Brien, W.J., Formoso, C.T., Ruben, V. & London, K. (2009), *Construction Supply Chain Management Handbook*, CRC press, Boca Raton, US.
- Peng, J. (2012), 'Selection of logistics outsourcing service suppliers based on AHP', *Energy Procedia*, Vol. 17, No. A, pp. 595-601.
- Percin, S. (2009), 'Evaluation of third-party logistics (3PL) providers by using a two-phase AHP and TOPSIS methodology', *Benchmarking: An International Journal*, Vol. 16, No. 5, pp. 588-604.
- Rajesh, R., Pugazhendhi, S., Ganesh, K., Yves, D., Koh, S.C.L. & Muralidharan, C. (2011), 'Perceptions of service providers and customers of key success factors of third-party logistics relationships – An empirical study', *International Journal of Logistics Research and Applications*, Vol. 14, No. 4, pp. 221-250.
- Saaty, T.L. (1980), *The Analytical Hierarchy Process: Planning, Priority Setting, Resource Allocation*, McGraw-Hill, New York, US.
- Shi, Q. & Blomquist, T. (2012), 'A new approach for project scheduling using fuzzy dependency structure matrix', *International Journal of Project Management*, Vol. 30, No. 4, pp. 503-510.
- Sobotka, A., Czarnigowska, A. & Stefaniak, K. (2005), 'Logistics of construction projects', *Foundations of Civil and Environmental Engineering*, Vol. 6, pp. 203-216.
- Zeng, J., An, M. & Smith, N.J. (2007), 'Application of a fuzzy based decision making methodology to construction project risk assessment', *International Journal of Project Management*, Vol. 25, No. 6, pp. 589-600.

STRUCTURE DOES NOT FOLLOW STRATEGY-STRUCTURE IS THE STRATEGY HOW OPERATIONAL EXCELLENCE THROUGH A VIABLE ORGANIZATIONAL STRUCTURE DELIVERS THE FOURTH GENERIC STRATEGY

Qeis Kamran and Rolf Neise
ISM International School of Management GmbH – Nonprofit Organisation, Dortmund, Germany

Introduction

The foundation of management is holistic. Therefore, the scope of embracing and observing the whole in terms of the reality, wherein an organization is embedded is a necessity in the rapidity changing world. The dominant recourse-based-view (RBV) (Barney (1991), Teece et al (1996, 1997 has been essential to developing and enhancing organizational strategic habitus (Bourdieu, …) and eigen-behavior (von Foerster, 2003) in a collective sense. However, the RBV has missed and lacks additional key pillars of managerial foundations. An organization in Bourdieuian sense is required to see the world from understanding and gaining capital resources not only from an economic logic of capital but moreover from a culture capital and relationships capital Weltanschauung (Bourdieu,1984). While Bourdieu's theories have been developed and applied within the sociological interpretations of individuals and groups, and their structured structures of interpreting realities to reproduce further realities in a societal interpretation of theories of class hierarchies (ability to access capital in Boudieuian sense) and ability to capture resources, it is, thus, a good start to translate them into the organizational and managerial realties. These dimensions: 1) whereby an organization makes sense of itself in terms of its structure, processes, information systems and sub-systems, whereof the organization is constructed; 2) the Weltanschauung and habitus, whereby it structures the environmental and market realities, wherein its embedded; and 3) the nature of strong and weak ties from the RBV lens extended by its understanding of attracting and dominating resources as operant and operand resources (Vargo and Lush, 2014), have essential implications for designing global value chains (GVCs). The authors observe GVCs as a necessary evolution of the field under the umbrella of operations research starting from foundations of logistics, supply chain management to global value chains management. Thus, the authors reference to GVCs, henceforth, carries this evolutionary perspective of the field through-out the paper.

Structure and strategy debate

As a solid contribution and point of concentration to the state of current theory and practice of GVC, the role of strategy as a point of entry has been distinguished. Thus, based on the recursive nature of the structure of organizational systems, it is essential in designing GVCs. The authors observe strategy not purely from a top down designed apriori calculus of wahrheit imposed on a system, but moreover from coping with emergent phenomenon constructed and designed by the intertwined interactional intelligence of the organization's internal systems navigating the complex and turbulent global environment in an embodied (structured) sense. (Pfeifer and Bongart 2007) A major foundation, whereupon all of the contemporary strategy models rely has been established by Alfred Chandler (1962). The notion of structure and strategy paradigm through the Chandlerian weltanschauung has delivered the foundation of the contemporary understanding of strategic thought and practice. This top-down and hierarchical understanding of the essence of strategy based on the dimension laid in terms of the Chandler's thesis *"…structure follows strategy"*, has been responsible for the evolution of strategy with vital implications for GVC. Among many scholars, who have dominated the field the role of Michael Porter (1979, 1980, 1985, 1996, 2008, 2015) cannot be overestimated. Porter's understanding of strategy and organizational function in terms of GVCs (Porter, 1985). Porter's 1996 paper "*What is strategy"* as founded within the Chandlerian sense, delivers a solid point of entry to bridge operations research and strategy and is based on the Porterian analogy that: *"operational effectiveness is not a strategy".* This paper contributes to make two vital corrections within the field of GVCs, thus; 1) from a raison d'être point of view of strategy by establishing, that structure is the strategy; and 2) that, operational effectiveness in a holistic sense frames a viable strategy, hence, it

delivers an additional and the fourth generic dimension of strategic logic. These dimension gives organizational structure a special role in designing, constructing and bridging the fields of GVCs and strategic management, and furthermore contributing a new approach to organizational viability. Research in understanding VCs has established Porter's original contributions to strategy and deliver a solid and essential foundation to embed a new and more holistic approach. (cf. Furrer, et al., 2008 & Ramos-Rodriguez and Ruiz-Navarro, 2004) The very understanding of designing GVCs have started and the term *"Value Chain"*, which itself has been coined and institutionalized throughout academe by Porter. Furthermore, no other strategy scholar as Porter has proclaimed that level of justified impact and status in business administration and strategy, its theory and practice since the last four decades. (cf. Ramos-Rodriguez and Ruiz-Navarro, 2004) While the essential role of Chandler can never be underestimated, hence Porter among many is a Chandlerian, the paper inductively will extend Porter's Weltanschauung and therefore extending Chandler's thesis.

The generic strategies

The generic strategies defined by Porter (cf. Porter, 1985,1998) deliver the foundation, where the battle for gaining competitive advantage within an industry is fought. These three pillars of competitive advantage are distinguished in the following manner:

- **Cost Leadership Strategy**

Cost leadership is the strategy whereby a company establishes itself, as *"below the industry price actor"* in the market. This means the company is a low-cost producer and a cost-leader within the industry and among the peers.

- **Differentiation Strategy**

Differentiation enables a company to position itself along the most valued dimensions in the industry for the customers. However, the research work of Kim and Mauborgne, (cf. Kim and Mauborgne, 2005) challenges the common held view of Porter, where a company can be attractive to customers, who are not the general target group, for which the initiated differentiation was incepted, but moreover by a coherent mix of value proposition and breaking the industry boundaries to serve them, additional possibilities of creating a competitive advantage emerges. According to Burke et al. (2009) in their comprehensive study of the Porterian industry-based competition verses the blue ocean strategies they observe: *"Blue ocean strategy seeks to turn competitive strategy on its head by replacing 'competitive advantage' with 'value innovation' as the primary goal where firms must create consumer demand and exploit untapped markets… Our evidence for the Dutch retail industry indicates that blue ocean strategy has prevailed as a dominant long-term viable strategy"* (Burke, et al, 2009, p. 1). Nevertheless, being a high- and above-the-average performer is the key in any differentiation pursuits and a company must decide on what difference it can establish, whereupon it can preserve the uniqueness against the rivals in the market. (cf. Porter, 1985)

- **Focus Strategy**

The focus strategy differs from the above since by this strategy a company optimizes its strategy via excluding other rivals. (Porter, 1985, 1998, p. 15) These optimizations are:

1. **Cost focus**: seeking and establishing a cost focus in the target segment.
2. **Differentiation focus: seeking and establishing a difference for usual needs of the customers that serves better the needs of the target segment.**

Thus, breadth of targeting customers is clearly a matter of the degree of focus, but the essence of focus lies in the exploitation of a narrow target's difference from the forces within the industry. (Porter, 1985, 1998)

Table 1 displays Porter's *"Generic Strategies"* as described above.

1. Cost leadership	2. Differentiation
3A. Costfocus	3B. Differentiationfocus

Source: Author's own illustration based on Porter (1985-1998).

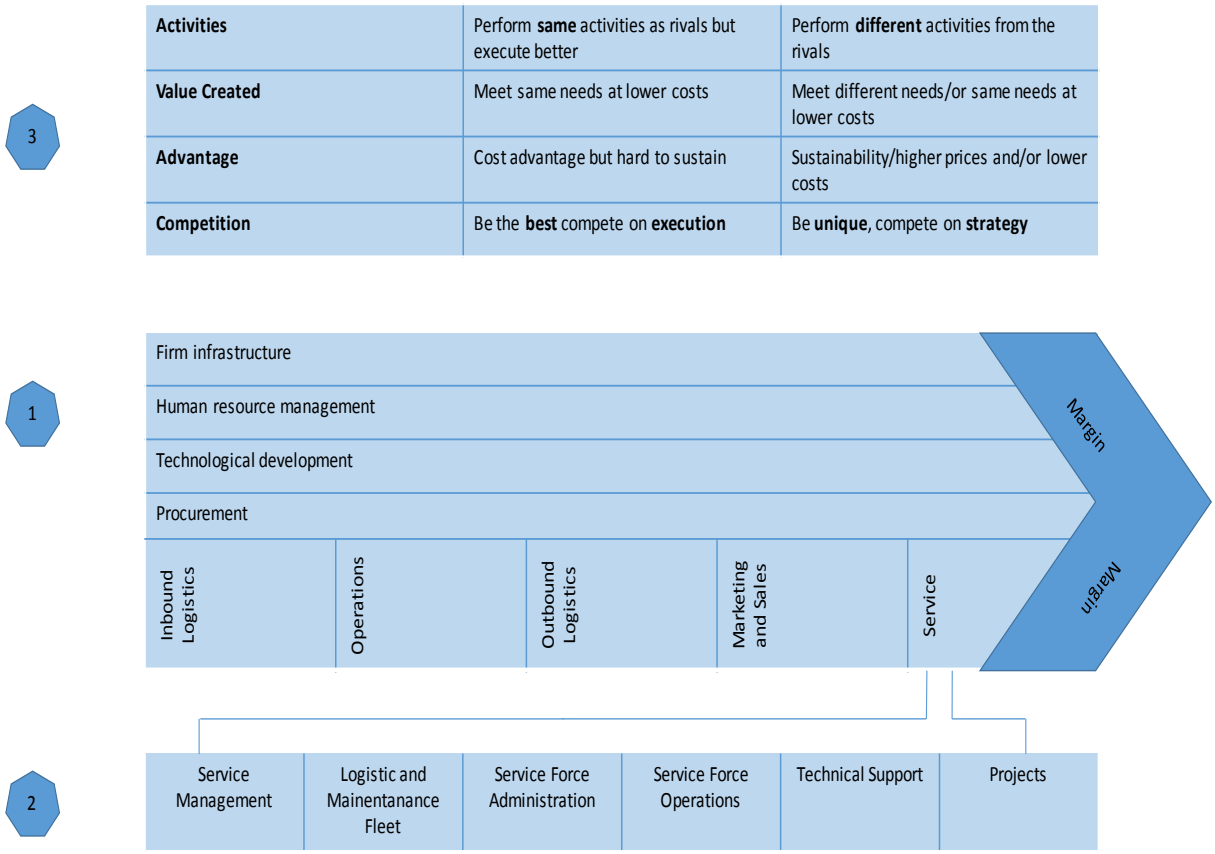
Table 1: Porter's generic strategies

Establishing a difference that a company can preserve and combining the notion with the depth of focus the firm decides to establish by its unique attractiveness to the customer,[1] it requires making trade-offs respectively strategic choices of what not to do. Thus, tradeoffs on the assumption of the focus the organization wants to achieve in its endeavors and the difference it wants to preserve against the rivals are the remedies against mediocrity in the market. (cf. Porter, 1985, 1998)

Porter's Value Chain Model

The basic *"Value Chain Model"* (VCM) (Porter, 1985, 1998, 2008) is illustrated in figure 1, thus, it explains in three sections the spectrum of the model. At the section (I); are the interdependent activities that firms engage in first to build a system of activities and later to divide these activities into further smaller activities and sub-systems. At section (II) 4: an organization creates its holistic structure. It is a system of dynamic activities and not a static departmentalization. The organization must deliver superior performance on the value it has created for the customer or the need it fulfills, which defines its success. According to Drucker (1954), the purpose of a business is to create a customer or a want. The choices a firm makes, strategies it designs, the quality of its execution it applies via receiving feedback (see: figure 4 - Section III, p. 29). How the firm chooses to differentiate itself and as a result, determines its profitability, attractivity, and superiority over the competition is vital to its success and survival. The competitive advantage is a model that is under the direct command of the strategist. One may not be able to shape the industry in a short time, although the first sign of a good strategy embodies that the market plays the industry leader's game, as the Apple Inc.'s rise to become the game changer has revealed. The value chain is a set of superb and uniquely designed activities that firm can perform, which as a result will bring a possible competitive advantage that is not easy to imitate (cf. Porter, 1985 & Hamel and Prahalad, 1990), if a firm chooses to differentiate in terms of business model, execution, and customer satisfaction while maintaining a profit-leadership. (cf. Kim and Maulborgne, 2005-Blue Ocean Strategy Model) The notion can also be substantiated by the works of Teece et al. (1997) and O'Reilly and Tushman (2007) as VCM designed based on dynamic capabilities and ambidexterity of organizations, while they do not speak of VCM which relates directly to Porter's model.

[1] also observed as "Market segments"



Source: Authors' own illustration based on Porter (1985, 1998)

Figure 1: Overview of the Generic Value Chain Model

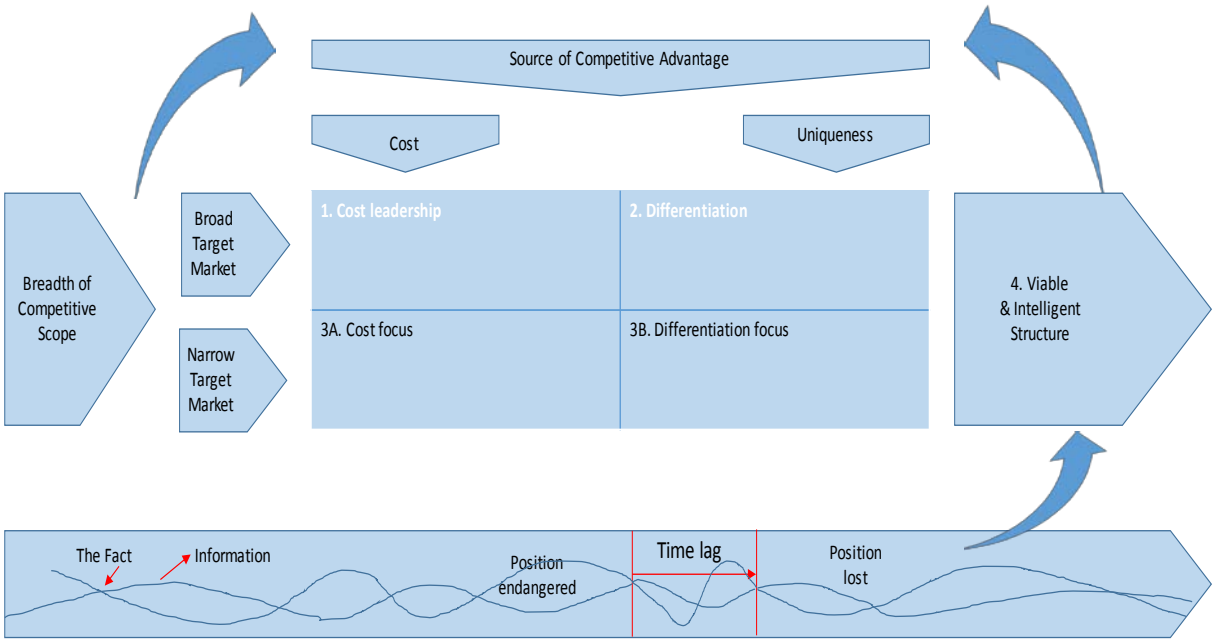
This notion is necessary, hence, it is essential to substantiate the model's strengths, its weaknesses, challenges, and limitations, while understanding the deep impact designing of GVCs will bring to strategy and operations research scholars and practitioners.

Viable and Intelligent Structure as the Fourth Dimension of Generic Strategy

While Porter's claim that generic strategies can only embrace the aforementioned triadic understanding and hybrid interrelationships, however by the evolutionary process of the rise of IT-technology based on the foundations laid within the cybernetics movement (Wiener, 1948; Ashby, 1956; Beer, 1959, 1972, 1981, 1985, 1989, 2002), and not only the Schumpeterian logic of creative destruction applied to product centered innovation, but moreover by the understanding and implementation of process and business model innovation as the locus of competitive advantage, the next frontier of strategic dimension has arisen by the contemplation of the role of organizational design, its structure and the structure of its GVCs as it has been exploited by highly successful companies e.g., Apple Inc. and the Inditex (Zara group).

The enhanced perspective of the fourth generic strategy, as constructed by the authors as a viable and intelligent organizational structure is illustrated in fig. 3. Thus, an organization, which can adapt and sense change ubiquitously by having a structure that can cope with the environmental turbulence in terms of information's fluidity, structure's flexibility and capacity of self-organization, delivers an additional generic strategy. This claim is substantiated by the authors' observations that strategic foresight based on the logic which embraces viability, profits and performance in economic reality and capital, requires an organizational structure that actually can carry out, reshape, refocus and to ubiquitously recreate itself based on organizational autopoieses.

Figure 2 describes the role of operations research since structure is the essence of an organization that can design and embrace, and ultimately execute the strategy holistically. Strategic management so far has ignored the role of execution and organizational eigen-behaviour, and its role in terms of a hierarchical downplay as a separate entity, and thus execution has been left to the organization's operations, while the very embodiment of strategic thought requires executing a conceiving the realized and emergent phenomenon. Pfeifer and Bongard (2007) state that embodiment expresses that intelligence always requires an executing body (operational capability), meaning that intelligence (performance), is attributed to embody real physical systems exhibiting observable behavior during interactions with the environment. They argue that such embodied systems are confronted with various consequences of embodiment as, for example, being subject to laws of physics, implying that their survival is affected by gravity, friction and energy supply. They conclude that the essential significance of embodiment represents the interaction between physical and information processes. (cf. Pfeifer and Bongard, 2007)



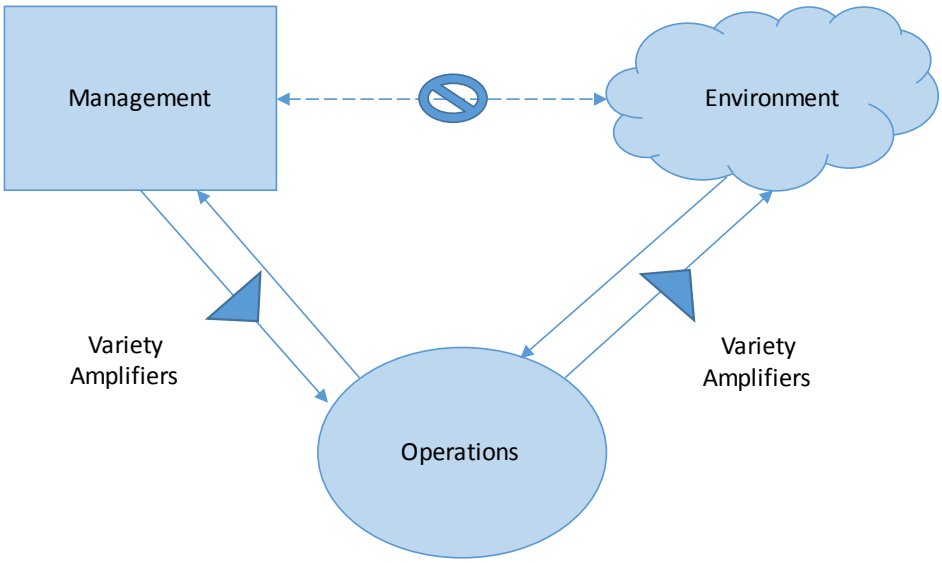
Source: Kamran (2013a)

Figure 2: Extended Generic Strategies

Kamran (2013a) puts the notion of feedback as illustrated above, at the core of organizational viability, thus it's via feedback that course and policy relating corrections, mission accomplishing, goal achieving and problem-solving activities can be corrected within the adequate response-time, without dangerous and costly time-lags, reaction gaps and organizational inabilities in terms of latency.

In order to appreciate the role of the fourth generic strategy a radical and different weltanschauung in strategic thought is introduced in terms of the purpose of a system is what it does. This lens is established by the application of the science of cybernetics. (beer, 1959, 1972, 1981) So far, the notion of capturing the future in terms of long-range-planning and strategic foresight has been conducted by application of forecasting methods, linear thinking in terms of markets and their governing forces e.g. the FFM, industry-based competition and the raison d'être of organizations mainly observed within an economic reality. The authors challenge these dimensions based on observing the reality of organizations function in terms of variety attenuating activity based on an Ashby's Law of *"Requisite Variety"*. According to Ashby's Law— *"the variety in the control system must be equal to or larger than the variety of the perturbations in order to maintain stability"* (cf. Ashby, 1958), and thus, *"variety can destroy variety"* (cf. Ashby, 1956-1957). Beer rephrased it as: *"only variety can absorb variety"* (Beer, 1985, p. 26). This dimension is realized within figure 4, where the role of operations is essential to

strategy and organizational viability. Strategy in essence competes on operations not despite of operations. This notion is illustrated in figure 3 below.



Source: Kamran (2013 based on Ashby (1956) and Beer 1979)

Figure 3: Ashby's Law

Recent developments from empirical and applied research perspective as the case of Inditex (Zara) illustrates that a new pattern contrary to the Porterian logic is arising, thus, delivering operations excellence in terms of absorbing VC perturbations based on an embodied and modeled structure of operations by considering to apply real-time control over operations performance, which is regarded as the essence of strategic control. Furthermore, Ashby and Conant's Theorem, stating: *"Every good regulator of a system must be a model of the system,"* (Conant, Ashby, 1970, p. 1). According to Conant and Ashby: *"The first effect of this theorem is to change the status of model-making from optional to compulsory."* They argue that model-making is yet viewed as a possibility for regulating complex dynamic systems; however, the theorem indicates the necessity of a "*sufficiently similar model*" for successful regulation within a wider class. The construction of such a model may have been realized explicitly or through improvement of the regulator. This notion is also substantiated and applied in model-based-management (MBM). (cf. Schwaninger, 2010, 2015 & Grösser, et al., 2013) According to Schwaninger: *"… the complexities confronting organizations have been subject to drastic amplification. As a consequence, the pressure on leaders has markedly increased. Orientation and steering devices have become all the more important because they enable actors in organizations:*

- *to find their way in complex settings, and*
- *to decide and act more effectively and consciously"* (Schwaninger, 2010, p. 1419-1420).

Schwaninger further claims that *"…high-quality models can make a powerful contribution"* (Schwaninger, 2010, p. 1419-1420), thus, the strategist occupied with the most essential task of this era needs to model viability, immunity, and competence, whereupon steering and control models need to be designed.

Conclusions

From a practical point of view, the fourth generic strategy can be substantiated by the rise of the giant firms within the fast response movement (e.g. fast food, fast fashion Inditex (Zara). For the purpose of engaging in-depth with a solid example the quick response movement as fast fashion has been observed, thus, according to Caro and Martinez-de-Albeniz: *"Fast fashion is a business model that*

others (the perception of) fashionable clothes at affordable prices. From an operations standpoint, fast fashion requires a highly responsive supply chain that can support a product assortment that is periodically changing." (2014, p. 1) Hence, it is the organized structure of Inditex (Zara's) organization, which actually and in contrary to other apparel brands has enabled the firm to obtain a highly defendable source of a sustainable competitive advantage. Based on the sciences of cybernetics, operational effectiveness is a strategy within the paradigm of the authors' enhancement of the generic strategies one can establish the logic of *"embodiment"* (cf. Pfeifer and Bongard, 2007) and the author's analogy of *"structure is strategy"*, (Kamran, 2013a), thus effective strategies require an organizational structure to execute them. This is empirically validated by the example of Inditex (Zara) delivering evidence for the fourth generic strategy. By the authors' enhancement of the generic strategies, one can establish the logic of competing on operations, which is the essence of structural dynamics of viable GVCs.

References

- *Ashby, W. (1956). An Introduction to Cybernetics. London, UK: Chapman & Hall.*
- *Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99–121.*
- *Beer, S. (1959). Cybernetics and Management. London, UK: English Universities Press; New York, NY: John Wiley.*
- *Beer, S. (1966). Decision and Control – The Meaning of Operational Research and Management Cybernetics. New York, NY: John Wiley.*
- *Beer, S. (1970). Cybernetics and Management. Frankfurt, Germany: S. Fischer. Beer, S. (1972 – 1981). Brain of the Firm: A Development in Management Cybernetics. New York,*
- *Beer, S. (1972). Brain of the Firm, 1st ed. London, UK: Penguin Press; New York, NY: Herder and Herder.*
- *Beer, S. (1973). Designing Freedom (CBC Massey Lecture). Toronto, Canada: House of Anansi Press Limited.*
- *Beer, S. (1975 – 1994). Platform for Change. Chichester, UK: John Wiley & Sons Ltd.*
- *Beer, S. (1975). Platform for Change. London, UK and New York, NY: John Wiley.*
- *Beer, S. (1979 – 1995). The Heart of Enterprise. Chichester, UK: John Wiley & Sons Ltd.*
- *Beer, S. (1979). The Heart of Enterprise. London, UK and New York, NY: John Wiley.*
- *Beer, S. (1985a). Diagnosing the System for Organizations. Chichester, UK and New York, NY: John Wiley.*
- *Beer, S. (1985b). Beyond Dispute. The Invention of Team Syntegrity, Diagnosing the System for*
- *Bourdieu, Pierre (1984). Distinction: a social critique of the judgement of taste. London: Routledge.*
- *Chandler, A. (1962). Strategy and Structure: Chapters in the History of the American Industrial Enterprise.*
- *Conant, R., Ashby, R. (1970). EVERY GOOD REGULATOR OF A SYSTEM MUST BE A MODEL OF THAT SYSTEM. Int. J. Systems Sci., 1(2), 89-97.*
- *Foerster, H. (2003). Understanding Understanding: Essays on Cybernetics and Cognition. New*
- *Greene, R. (2006). The 33 Strategies of War (Joost Elffers Books). London, UK: Profile Books Ltd.*
- *Hetzler, S. (2008). Brain Supporting Environments für Entscheide in komplexen Systemen. Schesslitz, Germany: Rosch-Druck.*
- *Intelligence. Cambridge, MA and London, UK: The MIT Press.*
- *Kamran, Q. (2013a). Complexity the Sixth Competitive Force that Shapes Strategy – A Cybernetics Approach to "Porter's FFM" in Turbulent and Complex Environments. Saarbrücken, Germany: Lambert Academic Publishing.*
- *Kim, W., Mauborgne, R. (2005). Blue Ocean Strategy: How to Create Uncontested Market Space and Make Competition Irrelevant. Boston, MA: Harvard Business School Publishing Corporation.*
- *Malik, F. (1984 – 1996). Strategie des Managements komplexer Systeme, überarbeitete und wesentlich erweiterte Habilitationsschrift. Veröffentlicht in der Schriftenreihe „Unternehmung*

und Unternehmensführung“ des Instituts für Betriebswirtschaft an der Hochschule St. Gallen. 5th ed. Bern, Switzerland and Stuttgart, Germany: Verlag Paul Haupt.

- *NY: Herder and Herder.*
- *Organizations. Chichester, UK: John Wiley & Sons.*
- *Pfeifer, R., Bongard, J. (2007). How the Body Shapes the Way We Think: A New View of*
- *Porter, M. (1980 – 1998). Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York, NY: The Free Press.*
- *Porter, M. (1985 – 1998). Competitive Advantage, Creating and Sustaining Superior Performance. New York, NY: Free Press.*
- *Porter, M. (1996). What is Strategy? Cambridge, MA: Harvard Business Review.*
- *Prahalad, C., Hamel, G. (1990). The core competence of the corporation. Harvard Business Review 68(3), 79–91.*
- *Ramos-Rodríguez, A., Ruíz-Navarro, J. (2004). Changes in the Intellectual Structure of Strategic Management Research: A Bibliometric Study of the Strategic Management Journal. Strategic Management Journal, 25(10), 981–1004.*
- *Rumelt, R. (2012). Good Strategy Bad Strategy: The Difference and Why it Matters. London, UK: Profile Books.*
- *Schwaninger, M. (2010a). Model-based Management (MBM): A Vital Prerequisite for Organizational Viability. Kybernetes, 10(9), 1419–1428.*
- *Schwaninger, M., Grösser, S. (2008). System Dynamics as Model-Based Theory Building. Systems Research and Behavioral Science, 25(4), 447–465.*
- *Teece, D. et al. (1996). Firm organization, industrial structure, and technological innovation. Journal of Economic Behavior & Organization, 31(2), 193–224. doi:10.1016/S0167-2681(96)00895-5*
- *Teece, D. et al. (1997). Dynamic Capabilities and Strategic Management. Strategic Management Journal, 18(7), 509–533.*
- *Ulrich, H. (2001). Gesammelte Schriften: Die Unternehmung als produktives soziales System, Band 1. Bern, Switzerland: Verlag Paul Haupt.*
- *Vargo, S. L., Lusch, R. F., & Morgan, F. W. (2014). Historical Perspectives on Service-Dominant Logic. In The Service-dominant Logic of Marketing: Dialog, Debate, and Directions (pp. 29–42). New York: Routledge.*
- *Washington, D.C.: Massachusetts Institute of Technology.*
- *Wiener, N. (1948). Cybernetics: Or Control and Communication in the Animal and the Machine. Paris, France: Hermann & Cie; Cambridge, MA: MIT Press.*
- *York, NY: Springer-Verlag New York Inc.*

SERVICE COMPLEXITY AND AGENCY AND AGENCY THEORY: BEYOND ALIGNMENT

Nigel Caldwell[1], Mickey Howard[2], Jens Roehrich[3], and Christian Köenig[1]
[1]School of Social Sciences, Heriot Watt University, Edinburgh, UK
[2]Department of Management Studies, University of Exeter Business School, Exeter, UK
[3]School of Management, University of Bath, UK

Introduction

Recent work has addressed markets where the seller provides a combination of inter-related products and services, often under the umbrella label of 'integrated solutions' (Mattsson 1973, Wise and Baumgartner 1999, Prencipe et al. 2003, Hobday et al. 2005, Brady et al. 2006, Davies et al. 2007, Cova and Salle 2007, Jacob and Ulaga 2008). Core to the variations on customers wanting integrated solutions is the notion that for the customer the distinction between the product element and the service element is less important than overall performance of the elements in combination (Roehrich and Caldwell 2012). This emphasis on performance rather than product or service elements has led to the emergence of a small but growing literature concentrated on how to buy performance (Caldwell and Howard 2014, Roehrich and Lewis 2014, Spring and Araujo 2014, Roehrich and Caldwell 2012, Caldwell et al. 2009, Lewis and Roehrich 2009). In this emergent procurement led literature, the emphasis has been on examining how the customer as principal influences/designs the service; the role of providers in defining business services has only recently been addressed (Selviaridis et al. 2013). However beyond the much studied pre contract phase, the role of service providers in shaping service provision through the execution and delivery of full service provision contracts remains under researched. For example Kleemann and Essig (2013) raise concern over the extent and implications of supplier or provider involvement in setting the contractual requirements in performance based contracts; and whilst they state that there is no explicit research on how integrators involve their suppliers in setting PBC outcomes, their focus is on contract design not execution. This gap may in part be due to a tendency when differentiating service provision from manufacturing to imply that 'service.

Other studies have focused on the role of the business network, the knowledge gap between customer and provider or the life cycle phase. Some studies seem to imply 'service provision' is a homogeneous activity. Our concern here is to study PBC across differing levels of service provision and therefore how levels of provider service impact provider involvement in setting PBC. Kleemann and Essig (2013) also raise concern over the extent and implications of supplier or provider involvement in setting the contractual requirements in performance based contracts; they state for example that there is no explicit research on how integrators involve their suppliers in setting PBC outcomes.

To focus on specific types of service activity in PBC is supported by recent concern that for example servitization appears to value one type of service growth (Kowalowski et al. 2015). Therefore we need to avoid making arbitrary distinctions between provider activities which in practice are over lapping or ignore that firms consistently operate with a mix of service offerings or are roles that change over time (Windahl and Lakemond, 2010). To find such distinct models for service provision led us to using providers for logistics services as cases, where we believe it is uncontroversial to distinguish between basic logistic providers offering just move and/or store; more advanced outsourcing logistics firms offering to take on a more complex repertoire of customer activities and full scale logistics system integrators who alone run the customers' logistics end-to-end, i.e. to include the end consumer. This distinction between levels of provider services will be made clearer in the later section and case analysis. The heterogeneity of our three cases is intended to facilitate focusing just on the actual post contract service activity in PBC.

For a customer buying a good or service instead of producing the item or service internally creates a relationship which has to be governed. Agency Theory (AT) provides a theoretical framework that

relates to the control of governance in outsourcing relationships, highlighting how the buyer or customer (Principal/P) and the provider (Agent/A) have conflicting interests. Both parties will seek to maximize their self-interest (goal incongruence, moral hazard) based on information asymmetry. In industrial markets performance-based contracting (PBC) appears to offer a solution to the unaligned nature of buyer and provider goals. PBC sets out precisely the performance required of the provider and what they will be paid for. Yet in industrial markets such as the provision of logistics service we see a continuum between outcome-based relationships which are composed of discrete transactions, and performance-based relationships which are an amalgamation of many transactions to produce solutions.

The remainder of this paper is structured as follows. In the next section we review the existing literature on performance-based contracts, and the constructs of Agency Theory. Hence, in section 3 we outline the research design and method. Section 4 presents an overview of the distinct levels of logistics service providers investigated and findings on the case studies. Following a discussion of our findings in section 5, we finally draw together the threads of our argument.

Literature Review

The following section reviews the existing literature on logistics services as the context for this study. In addition, literature on PBC and Agency Theory in the context of service outsourcing is covered.

Growing interest in contracting for an outcome or performance rather than a product both reflects and aligns with recent academic interest in the servitization of industry in the widest sense and research interest in integrated solutions (Prencipe et al. 2003, Hobday et al. 2005, Davies et al. 2007) in a more focused sense. The customer, as the buyer of services aims to reduce costs and risks by using proper contracting and incentive systems (Sampson and Froehle 2006). The view has developed that suppliers or providers are more involved in defining buyer's outputs such as performance as the complexity of the supplier or provider's offering increases aligned with a corresponding fall in buyer knowledge or confidence (Andersson and Norrman 2002, Selviaridis and Spring 2010, Selviaridis et al. 2013). In performance-based contracting, buyers and sellers agree that the core requirement is a level of performance that encompasses various levels of tangibility that are insignificant individually as predictors of the success or failure of the contract. Kim et al. (2007) highlight the gap between the customers' expectation and the providers' implementation as a critical element in PBC. The performance goals clearly need to be specified *ex-ante*, so the supplier knows how to achieve them. However, we focus on the post contractual management of the buyer-supplier relationship of logistics services in order to predict the impact of supplier involvement and the role of providers and customers in ongoing and continuing interactions.

Performance-based contracting in the context of logistics services

PBC can be conceived of as an *operational concept* with short-term performance outcomes, characterized by very control of tight payment schemes and bonus-penalty incentives (Selviaridis and Norrman 2014). However, such short term incentive alignment risks misunderstanding and goal incongruence (Kim et al. 2007). Even though the risk aversion of the buyer might be satisfied to some extent, a full transfer of risk is not guaranteed; as the provider is only offering the services they are confident they are capable of performing in the requested manner. In order to fully transfer the risk and move towards a pure outcome-based contract, the contractual focus must lie on the full understanding of MRO costs and life-cycle requirements, where PBC becomes a more *strategic concept* and the contract or project it relates to must be longitudinal projects, in order to align incentives and willingness to share risk (Kim et al. 2007, Randall et al. 2010, Datta and Roy 2013).

Agency Theory constructs and service provision

Agency Theory originates in discussion regarding the separation of ownership and control (Berle and Means 1932) and property rights (Alchian and Demsetz 1972). Principal Agent research (Mitnick 1973,

Ross 1973) in management focuses on the goal incongruences between different parties in a contractual relationship (Eisenhardt 1989) and therefore in turn on the incentive and contract types that can be used to address these goal incongruences. The main unit of analysis of Agency Theory is the contract between a buyer, i.e. the Principal, and the provider of special services, i.e. the Agent. Jensen and Meckling (1976) point out that any cooperating relationship has different goals due to individual specialization. Agency Theory discusses the use of incentive structures in terms of outcome-based and behavior-based contracts to solve the Principal - Agent dilemma. AT is usually applied in supply chain management or logistics services to understand the inter-organizational dynamic in buyer–supplier relationships, with a focus on therefore managing the ensuing risk and alignment of incentives to overcome the fundamental incongruence of goals (Halldórsson and Skjøtt-Larsen 2006, Shook et al. 2009).

The problem of *adverse selection* is the decision making concerned with selecting the appropriate Agent as a partner. As a pre-contractual issue adverse selection refers to the extent that the skills or abilities of the Agent cannot be completely judged or verified by the Principal, either before or during the contractual relationship. Given our focus on post contract management we do not address adverse selection. *Moral hazard* occurs whenever it is difficult for the Principal to monitor or observe the Agent's performance. Hence, both the *adverse selection* and *moral hazard* constructs are focusing on control over the Agent, i.e. the provider of services in a service supply chain, and therefore can be addressed by either a behavior-based or an outcome-based contract, respectively (Bergen et al. 1992, Datta and Roy, 2013). According to Fama and Jensen (1983), the basis for a behavior-based contract is gaining as much information as possible about the Agent prior to the contractual relationship, and the basis for an outcome-based contract is being able to articulate the outcome(s) In both cases different levels of knowledge and information sharing determine the relationship and contract. Consequently, information sharing is a key element also in performing and maintaining the contract and therefore a key building block in developing a method to address our research question.

Information in industrial marketing relationships is seen as a resource that can be purchased (Eisenhardt 1989). The problems of insufficient communication and poor information systems are also sources of goal incongruence; problems abetted if information is hidden and not accessible to all partners. Misalignment of interests can therefore result in significant hidden costs in the form of monitoring and managing the service outcomes in a relationship. Servitization literature states that particularly increasing complexity complicates the relationship between suppliers and buyers due to the difficulties of translating benefits into performance outcomes (Smith et al. 2014), which in turn results in higher monitoring costs for the Principal. Agency Theory seeks to minimize these costs and therefore reduce the risk of opportunism (Zsidisin and Ellram 2003, Fayezi et al. 2012). Different risk preferences have been argued to derive from information asymmetry between the Principal and the Agent. Selviaridis and Norrman (2014) distinguish between Agent and Principal contract design preferences based on risk aversion. In essence these authors (*ibid*.) argue that the risk aversion of Agents leads Agents to a bias towards behavior-based contracts, whilst the risk aversion of Principals leads Principals to a bias towards outcome-based contracts as more attractive choice of contract design, respectively. Incentives aim to balance the risks and rewards for providers of services that act as agents (Hypko et al. 2010a, Hypko et al. 2010b). Glas et al. (2013) adopt Hypko et al.'s (2010b) perspective and highlight the importance of four distinct perspectives on PBL that concentrate on these relationship factors. (1) *Life-cycle* analysis focuses on the total cost of ownership during the lifetime of a product or service; (2) The level of *cooperation* challenges the application of PBL and the supplier involvement in a contractual relationship; (3) The challenge of properly *implementing* PBL projects due to the individual complexity of long-term contractual relationships; (4) *Pricing* strategy links the payments schemes to the performance or activity outcomes in a contractual relationship.

Key dimension	*LSC (Logistics service carrier)*	*LSP (Logistics service provider)*	*LSI (Logistics service integrator)*
Performance outcomes *(PBC)*	Limited information sharing capabilities prevent higher involvement in defining performance outcomes. LSCs provide standardized and commoditized services and pre-defined performance outputs, based on simple transportation and warehouse utilization and tracking data. Nature of relationships is output-based due to high measurability of activities by downstream service providers.	LSPs flexibility, communication and monitoring capabilities and their ability to translate raw data into valuable information results in the ability to offer high involvement in specifying customers' performance outcomes. LSPs can deliver outcome-based PBC. Increasing supply chain and outcome measurability however results in increasing monitoring costs and higher financial risks in PBC relationships with downstream customers (the more so the nearer LSPs are to being B2C businesses).	LSIs ability to offer flexibility in terms of constantly adapting to ever changing consumer requirements is why Customers in our cases manage LSIs with behavioral not outcome-based contracting. The customers have limited capabilities for evaluating the LSIs dynamic performance and therefore rely on traditional logistics outputs measurements such as on time delivery, transportation lead time and loss ratio.
Agency Theory *(Information asymmetry and PBC)*	LSCs generate high levels of shipment related data but are not capable of translating data into decision useful information. Providing data on simple and discrete processes and activities is of little interest to customers.	LSPs amalgamate basic data from LSCs to create more valuable information relating to supply chain and logistics performance, which increases the level of value adding services and involvement with integrators and customers. Position in the supply chain allows LSPs to gather downstream information from customers and align with data provided by upstream service providers. Reliable communication is crucial nearer to fast moving consumer goods industries (i.e. a B2B delivering to B2C) which increases LSPs monitoring costs; in the slow moving industrial B2B market, communication and information sharing less important.	LSIs generate unique and highly customized end user data and information for their customers, which requires a high level of provider involvement in order to offer supply chain visibility. LSIs are able to adapt to the end consumers' requirements and needs and translate this information into the performance specifications.

Risk transferability (Agency Theory and PBC)	Low level of provider involvement due to short-term relationships (mostly day-to-day) with customers and LSPs transfer the financial and reputational risk to downstream customers and providers. A few relationships might be more integrated, based on trustworthy and reliability of delivery performance. No interaction with end consumer or final customer.	More involved in specifying performance due to the provision of more integrated and complex services. Long-term contractual relationships with integrators and customers results in more appetite for risk. LSPs are exposed and rely on sub-tier providers' performance, which transfers low level payment and financial risk from the customer or integrator to them. Interaction with end consumer is negligible in slow moving industrial markets, but can happen in fast moving consumer goods.	The highest form of integrating and involvement in specifying performance outcomes due to the nature of complex processes. Involves long-term relationships with final retail or commercial customers/consumers. Long-term investments into ICT tools reduce monitoring costs in behavior-based contracting. In one sense the LSIs' risk is limited as ownership of tangible assets remains with the customer; only the mainly intangible assets of organization and management processes belong to the integrator. The LSIs own performance is not measured on a regular basis (as this is difficult) but the LSI's performance with the end consumer is regularly monitored by the Customer on traditional output-based measures like distance and on time delivery.

Table 1: Overview of case data presentation

Summary

AT suggests the Principal drives the adoption of PBC, preferring outcome-based contracting where there is low information asymmetry, e.g. contracting for simple transportation from LSCs. Here the Customer can reduce the costs of monitoring providers – costs are well known and there are many providers in the market. AT suggests the Agent has the reverse interests, i.e. the Agent pushes for and prefers behavior-based contracting, where information such as dynamic or evolving definitions of performance, create information asymmetry. Hence a behavior-based contract results in much higher hidden costs such as monitoring and managing the relationship (Fama and Jensen 1983). In relation to LSIs our findings do not support the view of Principal and actions that Agency Theory suggests. In these established relationships post contract design, we have identified a far more active logistics provider/Agent than the literature suggests. Firstly from our LSI interviews it is not clear that either P or A controls how the contract is managed. Secondly, we find that the Principal does not incur the extra monitoring costs behavioral contracting under PBC suggests. Instead with regard to providers of integrated logistics services, Customers chose to disengage from in-contract measurement but do use simple and cost effective output measures from end consumer sources. Thirdly, none of our interviewees or archetype cases came anywhere close to describing a purely behavioral contractual relationship as AT predicts. This observation does lead us to question whether pure behavioral contracting exists in b2b industrial environments.

Finally, in examining levels of service provision and acknowledging that there can be a dynamic between levels, enabled us not just to explore the LSI role as above but also to note the unexpected prevalence of output-based contracting, as well as its use in combination. The distinction between output and outcome is not new and was well made by Selviaridis and Norrman (2014, p.155), however this research may make a small contribution through re-iterating how strongly output contracting still survives and perhaps a bigger contribution in highlighting that output contracting can be used in combination with other, perhaps apparently more radical, contractual approaches.

Conclusion and implications

The study is able to contribute to defining PBC as a contractual mechanism beyond contract formation, i.e. by contributing a perspective on PBC as an everyday way of working. Our study highlights how logistics services practices, add nuances to accounts that offer polar explanations of contractual forms. That in setting out to study performance-based contracting we encounter not only the continuing use of output-based contracting but also the use of output-based contracting in combination with other apparently more radical forms of contracting contributes a refinement we suggest to existing knowledge on PBC contracting and to our use of Agency Theory in practice.

References

- Alchian, A. A. and Demsetz, H. (1972) 'Production, Information Costs, and Economic Organization', *American Economic Review,* 62(5), 777-795.
- Andersson, D. and Norrman, A. (2002) 'Procurement of logistics services—a minutes work or a multi-year project?', *European Journal of Purchasing & Supply Management*, 8(1), 3-14.
- Bergen, M., Dutta, S. and Walker, O. C. J. (1992) 'Agency Relationships in Marketing: A Review of the Implications and Applications of Agency and Related Theories', *The Journal of Marketing,* 56(3), 1-24.
- Berle, A. A. and Means, G. G. C. (1932) *The modern corporation and private property,* Legal Classics Library.
- Brady, T., Davies, A. and Hobday, M. (2006) 'Charting a path toward integrated solutions', *Mit Sloan Management Review,* 47(3), 39-48.
- Caldwell, N.D., and Howard, M. (2014) 'Contracting for complex performance in markets of few buyers and sellers: The case of military procurement', *International Journal of Operations & Production Management,* 34(2), 270-294.

- Caldwell, N.D., Roehrich, J. K. and Davies, A. C. (2009) 'Procuring complex performance in construction: London Heathrow Terminal 5 and a Private Finance Initiative hospital', *Journal of Purchasing and Supply Management,* 15(3), 178-186.
- Cova, B. and Salle, R. (2007) 'Introduction to the IMM special issue on 'Project marketing and the marketing of solutions' A comprehensive approach to project marketing and the marketing of solutions', *Industrial Marketing Management,* 36(2), 138-146.
- Datta, P. P. and Roy, R. (2013) 'Incentive issues in performance-based outsourcing contracts in the UK defence industry: a simulation study', *Production Planning & Control*, 24(4-5), 359-374.
- Davies, A., Brady, T. and Hobday, M. (2007) 'Organizing for solutions: Systems seller vs. systems integrator', *Industrial Marketing Management,* 36(2), 183-193.
- Eisenhardt, K. M. (1989) 'Agency Theory: An Assessment and Review', *The Academy of Management Review,* 14(1), 57-74.
- Fama, E. F., & Jensen, M. C. (1983) 'Separation of ownership and control', *Journal of law and economics*, 26(2), 301-325.
- Fayezi, S., O'Loughlin, A. and Zutshi, A. (2012) 'Agency Theory and supply chain management: a structured literature review', *Supply Chain Management: An international Journal,* 17(5), 556-570.
- Glas, A., Hofmann, E. and Essig, M. (2013) 'Performance-based logistics: a portfolio for contracting military supply', *International Journal of Physical Distribution & Logistics Management,* 43(2), 97-115.
- Hypko, P., Tilebein, M. and Gleich, R. (2010a) 'Benefits and uncertainties of performance-based contracting in manufacturing industries: An Agency Theory perspective', *Journal of Service Management,* 21(4), 460-489.
- Hypko, P., Tilebein, M., Gleich, R. (2010b) "Clarifying the concept of performance-based contracting in manufacturing industries: A research synthesis", *Journal of Service Management*, Vol. 21 Issue: 5, pp.625-655
- Jacob, F. and Ulaga, W. (2008) 'The transition from product to service in business markets: an agenda for academic inquiry', *Industrial Marketing Management,* 37(3), 247-253.
- Jensen, M. C. and Meckling, W. H. (1976) 'Theory of the firm: Managerial behavior, agency costs and ownership structure', *Journal of Financial Economics,* 3(4), 305-360.
- Kim, S. H., Cohen, M. A. and Netessine, S. (2007) 'Performance contracting in after-sales service supply chains', *Management Science,* 53(12), 1843-1858.
- Kleemann, F. C. and Essig, M. (2013) 'A providers' perspective on supplier relationships in performance-based contracting', *Journal of Purchasing and Supply Management,* 19(3), 185-198.
- Kowalowski, C., Windahl, C., Kindström, D., and Gebauer, H. (2015) 'What service transition? Rethinking established assumptions about manufacturers' service-led growth strategies', *Industrial Marketing Management*, *forthcoming*, 1-35.
- Halldórsson, Á. and Skjøtt-Larsen, T. (2006) 'Dynamics of relationship governance in TPL arrangements – a dyadic perspective', *International Journal of Physical Distribution & Logistics Management,* 36(7), 490-506.
- Hobday, M., Davies, A. and Prencipe, A. (2005) 'Systems integration: a core capability of the modern corporation', *Industrial and Corporate Change,* 14(6), 1109-1143.
- Hypko, P., Tilebein, M. and Gleich, R. (2010a) 'Benefits and uncertainties of performance-based contracting in manufacturing industries: An Agency Theory perspective', *Journal of Service Management,* 21(4), 460-489.
- Hypko, P., Tilebein, M., Gleich, R. (2010b) "Clarifying the concept of performance-based contracting in manufacturing industries: A research synthesis", Journal of Service Management, Vol. 21 Issue: 5, pp.625-655
- Mattsson, L.-G. (1973) 'Systems selling as a strategy on industrial markets', *Industrial Marketing Management,* 3(2), 107-120.

- Mitnick, B. M. (1973) 'Fiduciary Rationality and Public Policy: The Theory of Agency and Some Consequences', in *Annual Meeting of the American Political Science Association*, New Orleans.
- Prencipe, A., Davies, A. and Hobday, M. (2003) *The Business of Systems Integration,* Oxford University Press, New York.
- Randall, W. S., Pohlen, T. L. and Hanna, J. B. (2010) 'Evolving a theory of performance-based logistics using insights from service dominant logic', *Journal of Business Logistics,* 31(2), 35-61.
- Sampson, S. E. and Froehle, C. M. (2006) 'Foundations and implications of a proposed unified services theory', *Production and Operations Management,* 15(2), 329-343.
- theory', *Production and Operations Management,* 15(2), 329-343.
- Selviaridis, K. and Norrman, A. (2014) 'Performance-based contracting in service supply chains: a service provider risk perspective', *Supply Chain Management: An international Journal,* 19(2), 153-172.
- Selviaridis, K., Spring, M., Araujo, L. (2013) 'Provider involvement in business service definition: A typology', *Industrial Marketing Management,* 42(8), 1398-1410.
- Selviaridis, K. and Spring, M. (2007) 'Third party logistics: a literature review and research agenda', *The International Journal of Logistics Management,* 18(1), 125-150.
- Selviaridis, K. and Wynstra, F. (2014) 'Performance-based contracting: a literature review and future research directions', *International Journal of Production Research*, 1-36.
- Shook, C. L., Adams, G. L., Jr, D. J. K. and Craighead, C. W. (2009) 'Towards a "theoretical toolbox" for strategic sourcing', *Supply Chain Management: An international Journal,* 14(1), 3-10.
- Smith, L., Maull, R. and Ng, I. C. L. (2014) 'Servitization and operations management: a service dominant-logic approach', *International Journal of Operations & Production Management*, 34(2), 242-269.
- Spring, M. and Araujo, L. (2009) 'Service, services and products: rethinking operations strategy', *International Journal of Operations & Production Management,* 29(5), 444-467.
- Spring, M. and Araujo, L. (2014) 'Indirect capabilities and complex performance Implications for procurement and operations strategy', *International Journal of Operations & Production Management,* 34(2), 150-173.
- Roehrich, J. and Lewis, M. (2014) 'Procuring complex performance: implications for exchange governance complexity', *International Journal of Operations & Production Management,* 34(2), 221-241.
- Roehrich, J. K. and Caldwell, N. D. (2012) 'Delivering integrated solutions in the public sector: The unbundling paradox', *Industrial Marketing Management,* 41(6), 995-1007.
- Windahl, C., Lakemond, N., (2010) 'Integrated solutions from a service-centerd perspective: applicability and limitations in the capital goods industry', *Industrial Marketing Management,* 39(8), 1278-1290.
- Wise, R. and Baumgartner, P. (1999) 'Go Downstream: The New Profit Imperative in Manufacturing', *Harvard Business Review,* 77(5), 133-141.
- Zsidisin, G. A. and Ellram, L. M. (2003) 'An Agency Theory Investigation of Supply Risk Management', *Journal of Supply Chain Management,* 39(3), 15-27.

PARADIGM SHIFT OF HUMANITARIAN LOGISTICS: FROM DISASTER TO DISASTER RISK

Minchul Sohn
Hanken School of Economics, Helsinki, Finland

1. Introduction

Disaster logistics preparedness studies in humanitarian logistics generally focus quite narrowly on disaster mitigation and risk reduction. The predominant focus of humanitarian logistics tends to be centred on 'preparedness for response'. In other words, the provision of relief often becomes the central issue in studying humanitarian logistics.

In the context of climate-related hazards, it is critical to enhance disaster mitigation and risk reduction measures in disaster logistics preparedness. Such an approach aims for disaster risk management that 1) minimises the negative impact of disasters, 2) ensures the readiness of a society to forecast and take precautionary actions, and 3) responds to an impending disaster (Christoplos et al., 2001). From this perspective, it is argued that current disaster logistics preparedness studies in the humanitarian logistics literature only addresses one aspect – preparedness for response – in a comprehensive way. Thus, the scope of research in this field should be expanded beyond dealing with the consequence of the disaster event itself, instead placing more emphasis on issues related to risk reduction (prevention, mitigation and preparedness).

Disasters cannot be prevented from occurring, but the scale and impacts of a disaster can be addressed more effectively by disaster mitigation and risk reduction efforts than by the ad-hoc post-event emergency response approach (REF). But, planning the required precautionary measures requires a profound understanding of disaster risk itself as well as the possibility of future adverse effects (IPCC, 2012). A wide range of hazardous events must be considered (e.g. climate variability and uncertain changes in climate patterns) as well as the associated vulnerability and exposure of societies (Birkmann, 2007a, 2007b; Thomalla et al., 2006). With recurring small-scale disasters in particular, disaster mitigation and risk reduction is extremely important as a coping capacity to reduce the repetitive damage and cumulative effects (Lavell and Maskrey, 2014; Marulanda et al., 2010). For socially and economically vulnerable communities such as those found in many developing countries, it is essential to maintain sustainable livelihoods against such recurring small-scale disasters because, even if there is no demand for relief and emergency assistance, those communities may suffer harm, experience deteriorations and/or lose livelihood assets due to natural hazards (Birkmann et al., 2013). The issue of sustainable livelihood exemplifies the importance of considering the context of HOSCM and suggests that the definition and evaluation of disaster risk necessarily depends on the setting.

Further attention to disaster mitigation and risk reduction is thus required for disaster logistics preparedness to complement the extant approach in HOSCM literature, but within this, two essential subjects need to be elaborated. The first is the interrelationship between relief and development as disaster mitigation and risk reduction are often overshadowed by these two more broad-ranging areas (Christoplos et al., 2001). The second is that a better understanding of disaster risk should be developed through a focus on the concepts of hazards and vulnerability. Achieving this would broaden the scope to include disaster mitigation and risk reduction, and thereby lead to a more fruitful discussion in HOSCM literature.

2. Disaster mitigation and risk reduction

2.1. Linking relief and development

The subject of integrating relief and development has received significant attention from policy-makers and academics since the early 1990s (Buchanan-Smith and Maxwell, 1994; Collins, 2009). Before this period, the concepts of emergency relief and development were commonly considered independently from one another, with relief and development operations being treated as discrete

efforts. Humanitarian principles and development mandates were developed and applied, whilst each domain was the responsibility of different specialised organisations. However, from the early 1990s, the need to link relief and development emerged from both domains (Smillie, 1998). Humanitarian organisations with a mandate in disaster relief recognised the need for sustainability in order for their work to have long-term implications. At the same time, it was observed that the response to the immediate needs of beneficiaries had sometimes yielded unexpected and unintended negative effects for the long-term development of an affected area. Development funds, for example, were diverted from local institutions to relief operations, making subsequent development programmes more difficult (Buchanan-Smith and Maxwell, 1994). Recurring natural disasters and conflicts required more comprehensive measures than repeated one-off disaster relief operations. Around the same time, the development community began to observe that investment in long-term programmes and projects could be negated almost instantaneously by the impact of disasters (Smillie, 1998).

Consequently, two conditions are required for productive synergy between relief and development. Firstly, relief should not undermine development but its intervention must preserve livelihoods, secure development assets, and be cautious for de-capacitation (Buchanan-Smith and Maxwell, 1994). Secondly, disaster relief operations should contribute to vulnerability reduction through the use of disaster mitigation and risk reduction measures by acting in parallel with a development programme (Buchanan-Smith and Fabbri, 2005) Donor agencies have also highlighted the importance and value in linking relief and development (Lindahl, 1996). As stakeholders in relief and development aid, donors demand more preventive measures and higher efficiency for disaster relief funding. This stimulates the two domains to seek improved linkages (Lindahl, 1996). From the perspective of beneficiaries, the strict division between aid operations is nothing more than artificial categories since the affected populations live constantly with the risk of crisis and plan their lives accordingly (Buchanan-Smith and Maxwell, 1994).

In this context, various policy attempts and approaches have tried to link relief to development. The concept was mainstreamed in humanitarian affairs in 1991 with a UN General Assembly Resolution (United Nations, 1991)[1] although this simply called for coordination mainly between UN agencies working in different phases of intervention (White and Cliffe, 2000). It was anticipated that sequential phases moving from relief to development would emerge and operations were planned accordingly, with distinct organisational responsibilities in each phase. However, this linear approach to treating relief, rehabilitation, and development as separate processes has since been discredited. Instead, an *early recovery*[2] (MSB, 2015; UNDP, 2008), or *contiguum approach*[3] (European Commission, 1996) has been suggested. This paradigm shift was based on the understanding that relief and development do not follow each other in a simple chronological model; rather different needs may exist simultaneously and, in any case, are strongly interlinked (Fan, 2013). This alternative model promotes an integrative relationship between relief and development with a primary objective of reducing disaster risk by simultaneously implementing relief and development principles (Kennedy et al., 2008). It creates an opportunity for sustainability in humanitarian aid that looks beyond survival and poverty alleviation towards "fuller and more equitable wellbeing" (Collins, 2013) while promoting development aid interventions to protect livelihoods and to engage in disaster risk reduction measures.

---

[1] General Assembly Resolution 46/182, Guiding Principles 9 *"There is a clear relationship between emergency, rehabilitation and development. In order to ensure a smooth transition from relief to rehabilitation and development, emergency assistance should be provided in ways that will be supportive of recovery and long-term development. Thus, emergency measures should be seen as a step towards long-term development."*

[2] Early recovery is considered as *"a multidimensional process guided by development principles that begins in a humanitarian setting, and seeks to build on humanitarian programmes and catalyse sustainable development opportunities"* (UNDP, 2008: p. 6).

[3] The document states that the term 'contiguum' would be more appropriate, reflecting the fact that operations in relief, rehabilitation and development may be carried on simultaneously within any given country (European Commission, 1996: Section ii).

The policy conversation continues with the recent discussions in the Sendai Framework for Disaster Risk Reduction 2015 – 2030 and in the Paris Agreement at COP21 on climate change. The discussions underline that humanitarian aid architecture is limited by its delegation of long-term processes to discrete development actors. Priorities for action have, however, emerged from these discussions to reduce disaster losses and to increase resilience to climate-related extreme events(Wilkinson and Peters, 2015).

2.2. Understanding disaster risk through hazards, vulnerability, and coping capacity

The discussion of disaster mitigation and risk reduction also underlines the reality that there are multiple activities that unfold in advance of a disaster. Thus, the challenge is that of anticipating disaster risks through forward-looking and proactive investment; hence, understanding the range and magnitude of such disaster risks is critical to disaster mitigation and risk reduction efforts. With this in mind, it will be appreciated that the focus of this paper is on the potential for (rather than the occurrence of) disasters, and it follows that disaster risk must be understood as an interaction between hazards and the vulnerability of society.

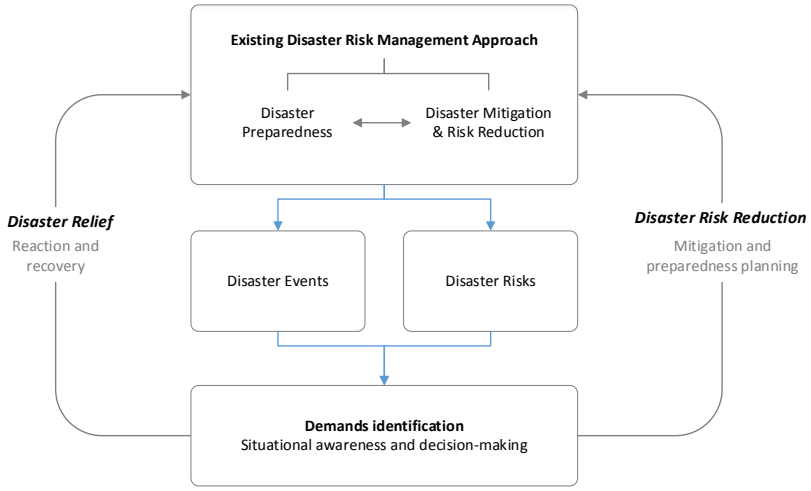
Hazard refers to the possible future occurrence of natural or human-induced physical events that may have adverse effects on vulnerable and exposed elements. Studies from the hazard-oriented perspective reflect the notion that disasters are external to a society; hence, these studies consider disasters to be the agent that may cause harms and losses when they intersect with a social system. Natural hazards, such as extreme weather and climate events have been considered in terms of their physical dimensions as these were thought to determine the potential harm of the natural event.

However, such a relatively simplistic orientation for defining and conceptualising disasters has evolved and now incorporates the concept of vulnerability (Perry, 2007). Vulnerability refers to the propensity of exposed elements such as human beings, their livelihoods and their assets, to suffer adverse effects when impacted by hazardous events. Vulnerability indicates what is at risk, e.g. communities, systems or things of value that are exposed to hazards (Tierney, 2014). A society's capacity to cope under such hazardous conditions contributes to its propensity/susceptibility to harm (Birkmann et al., 2013). Thus, the concept of vulnerability reflects the "chronic and normal condition related to poor development and sustainability practices" (Kelman et al., 2015).

This view echoes the predictive quality of vulnerability which (Cannon et al., 2003) contend is important because vulnerability "is a way of conceptualising what may happen to an identifiable population under conditions of particular risks and hazards" (ibid, p.4). Mileti (1999) suggests three main vulnerabilities relate to the occurrence of disaster: (1) vulnerability to biophysical hazards, (2) vulnerability of the built environment and (3) socially-created vulnerability. In other words, a conceptualisation of disaster that focuses solely on extreme events created by natural forces should be supplemented with the concept of disaster risk which, in turn, incorporates the embedded vulnerability that is deeply rooted in the failure of development practices and other societal characteristics (Manyena, 2012; Tierney, 2014).

The above discussion implies that disaster risk is a function of potentially harmful natural hazards (H). It is also a function of the propensity or predisposition of a community, system or asset to be adversely affected by a hazard – in other words its vulnerability (V). Hence, Disaster Risk = H x V. Wisner et al. (2014) expand this relatively simple model by considering two types of coping capacity—individual and local capacity for protective action (C)—as well as the mitigation and prevention measures carried out by larger organisations/institutions (M). Hence, in their model Disaster Risk = H x [(V/C) – M]. The logic of this equation suggests a clear need for a better understanding of natural hazards that reflect specific spaces and places (geographic locations). At the same time, this representation of disaster risk highlights the importance of building coping capacities to reduce vulnerabilities (Birkmann, 2007) that arise from properties of the society's systems and subsystems (Birkmann et al., 2013; Tierney, 2014).

Such a conceptualisation clearly highlights the significance of disaster logistics preparedness as it is one clear way of building coping capacity that will, in turn, counteract disaster risk - hence, it inherently has dual objectives as presented in Figure 1.



With the above discussion in mind, (Schipper and Pelling, 2006) express concerns about distorted humanitarian relief efforts that try to manage disaster risk without reducing it. Such a concern has important implications for disaster logistics preparedness and suggests a paradigm shift from relief and response to disaster risk management. In other words, disaster logistics preparedness requires a disaster risk management approach that addresses both humanitarian relief and disaster risk reduction. It needs to address the simultaneous demands that arise from the potential effects of hazardous events as well as from vulnerabilities in the logistics and supply chains.

However, it is argued that these different demands can be fulfilled concurrently (Scholten et al., 2014). Similarly, Maon et al. (2009) suggest a dual cycle for disaster relief and risk reduction, including strategic actions for development. The concept of the dual cycle broadens the scope of disaster risk management planning to consider disaster risk reduction in pre- and post-disaster situations (as summarised in Figure 1), meeting both short- and long-term needs (Haavisto et al., 2013) and recognising "steady state demand-driven supply chains" (Day et al., 2012).

3. Disaster logistics preparedness in HOSCM

As Jahre et al. (2016) indicate, there is no agreed understanding on what is meant by the term 'logistics preparedness' in the HOSCM field. Rather, most of the approaches to logistics preparedness are broad and unclear, using a mixed array of vocabulary from 'preparedness' to 'disaster preparedness' and 'emergency preparedness' (see Jahre et al., 2016).

Furthermore, the logistics preparedness studies in humanitarian logistics commonly assign their concerning humanitarian operations into the 'preparedness phase' of disaster operations management (Hong et al., 2015). The rationale behind this practice reflects the typical disaster cycle/phase models that consider a disaster event as an assumed premise. These cycle/phase models are usefully applied in humanitarian logistics, typically presented as, for example, mitigation, preparedness, response, and recovery. Both humanitarian logistics research and practice have recognised the usefulness of this approach for resource mobilisation and as a heuristic model to develop strategies for disaster operations management, with various national disaster management guidelines (manuals) being organised based on such phases. These phases are often also the basis for pre-allocated budgets for disaster operations management and the appeals process for increasing funding. Such phase models typically feature emergency training of staff as well as sourcing and procurement, distribution and delivery, and other logistics preparedness and response activities.

But this approach is potentially flawed if/when humanitarian logistics management focuses mainly on the provision of relief and/or preparedness for response. Although Scholten et al. (2014) acknowledge that mitigation is included in the phase model as a proactive element, the disaster-centred view of cycle/phase models has a potential pitfall in that the disaster itself gains the predominant spotlight. (Kelman, 2011) observes that the disaster cycle "could sometimes be interpreted as implying that disasters must always happen and that the disaster part of the disaster cycle can never be changed" (ibid., p. 2). The disaster-centred view usually indicates that the mitigation and preparedness efforts have failed. In other words, this model gives only implicit attention to mitigation and disaster risk reduction efforts; therefore, ironically, the study of pre-disaster activities continues to focus mainly on the consequence of disaster events rather than on disaster risk management.

3.1. Curative preparedness

For the reasons outlined above, the predominant focus in HOSCM preparedness research is that of prepositioning relief supplies as a curative approach (Jahre, 2017), and this is reflected in the reality of the focus of many humanitarian organisations (Jahre 2016). Prepositioning can be defined as decisions related to number, locations and size of storage facilities; inventory management; and the allocation of relief supplies at each facility (Campbell and Jones, 2011; Rawls and Turnquist, 2012). Under such an approach critical relief supplies can be ready for dispatch in strategic locations to "increase the ability of relief organisations to mobilise relief supplies and delivery aid quickly" (Balcik and Beamon, 2008).

Quantitative model development is a well-established area of research that provides optimal solutions for planning disaster logistics preparedness. The majority of these studies have modelled logistic preparedness decisions regarding location and the replenishment problems for physical goods (Jahre et al., 2016). Most of the studies model effectiveness and responsiveness with metrics such as maximum coverage. Efficiency is another important concern given the financial implications of prepositioning (Balcik and Beamon, 2008) which requires a considerable investment to stock and maintain the desired inventory under the current funding mechanism (Kunz et al., 2014), and is also potentially subject to distribution challenges due to bottlenecks in the field (Charles et al., 2016). A frequently adopted quantitative modelling approach is two-stage stochastic optimisation. This approach clearly focuses on the preparedness stage of the disaster response cycle. In the first stage of such models decisions typically concern pre-disaster preparedness measures such as location and number of facilities, the amount of a commodity that is pre-stocked, and uncertainty about future demand realisation. Decisions in the second stage address re-allocation and/or distribution of supplies in response to the disaster that has occurred, with the assumption that the demand for relief goods is known through an initial needs assessment.

3.2. Preventive preparedness

This paper argues that further research in disaster logistics preparedness is required with a focus on its potential for harm mitigation. Pre-disaster logistics preparedness activities in anticipation of an upcoming catastrophe and/or extreme event are necessary for both adequate preparedness and implementation of appropriate post-disaster activities. However, logistics preparedness to strengthen disaster preparedness aims not only for disaster relief, but also mitigation and disaster risk reduction. This is particularly true in the humanitarian context, especially in communities with high exposure and vulnerability, where even small-scale events can be transformed into a disaster. A vulnerable community may experience severe erosions in development, loss of livelihood and an increase in vulnerability when confronted with recurrent small- or medium-scale events. The human impacts of a specific disaster event are further impacted by its timing (day, month or year) and its sequence relative to other contemporary events. In such contexts, disaster logistics preparedness should strive to reduce the supply chain vulnerability to potential disruptions, for example, through the development/ maintenance of aid supply chains that address food insecurity and public health. Such efforts may not necessarily be associated with a particular acute relief effort; however, they are obviously as important

as preparing for a response to an acute disaster. This paper argues in favour of the dual cycle model, with different objectives for preparedness, as presented in the previous section.

In short, within the dual cycle model, the goal of logistics preparedness can be decomposed into two objectives, both of which require equal investment from humanitarian logistics from the disaster risk management perspective.

4. Conclusions: Logistics preparedness as disaster risk management

Jahre et al. (2016) offer a definition of logistics preparedness that recognises the development of "local community resilience as an essential element of logistics preparedness" (p. 375). In their definition, Jahre et al. (2016) specify processes, structures and systems of logistics preparedness that involve local community and national actors for designing, planning and training for proactive resource mobilisation. However, the definition does not explicitly incorporate the concept of risk management in relation to the mitigative aspects of logistics preparedness. Thus, building upon the definition suggested by Jahre et al. (2016), this paper argues for complementary and mutually constitutive objectives in disaster logistics preparedness.

Several studies have broadened the scope of disaster logistics preparedness. (Apte, 2014) decomposes disaster logistics preparedness into two categories: operational and strategic. Operational preparedness focuses mainly on physical pre-positioning when the disaster is imminent or in the acute response phase, while strategic preparedness develops the capacity for managing logistics activities and functions. The distinction is rooted in the amount of lead-time required for implementation, different levels of implementation (operational preparedness denotes a more activity-based approach while strategic preparedness entails tactical capacity planning), and the types of resources required (operational preparedness uses more tangible resources such as physical supplies, while strategic preparedness uses more intangible resources such as capacity planning and reinforcing infrastructure). Apte (2014) specifies the main objective of capacity planning to be the improvement of relief aid delivery and suggests that supply chain vulnerability can be reduced by acquiring services and supplies.

A number of researchers have considered the components of humanitarian logistics strategy with an emphasis on disaster risk management planning, policies and procedures being offered by Overstreet et al. (2011), whilst Caunhye et al. (2012) emphasise capacity planning in HOSCM for pre- and post-disaster environments. Similarly, Kunz et al. (2014), building on Van Wassenhove (2006), recommend development of disaster management capability, rather than investment in a physical pre-positioned inventory, as an intangible preparedness activity for humanitarian logistics. The suggested capabilities offered by these authors encompass knowledge and process management, human resource development, strategic resource mobilisation and community facilitation. Each capability includes important preparedness activities to contribute to mitigative aspects of logistics preparedness; for example, "developing and disseminating best practices on the basis of past disasters, educating vulnerable communities to recognise disaster risk, pre-negotiating agreements with suppliers and government, harmonising procedures with local government requirements, developing early warning systems, and collaborative planning with local governments and non-governmental organisations" (see Kunz et al., 2014. p.262).

Scholten et al. (2014) analyse different processes associated with each phase of the disaster cycle. These processes are constituted through actions and are integrated with supply chain resilience capabilities. Among the various processes of disaster operations management, they underline the significance of mitigation processes as a fundamental building block for resilient supply chain to prepare for, respond to, and recover from disruption. Among the mitigation processes, this current research suggests that the most critical elements are continuous risk assessment to improve risk mitigation planning, common risk awareness among intra/inter supply chain actors to analyse existing supply chain vulnerability and threats of hazards, and integration and coordination of resources from different functional areas.

Various capabilities and processes that underpin disaster risk management can be applied to disaster logistics preparedness to mitigate the impacts of recurring hazards, for example through forecasting and monitoring of climate risk for logistics management of different humanitarian programmes.

Reference

- Apte, A. (2014), "Strategic and Operational Prepositioning in Case of Seasonal Natural Disasters: A Perspective", *Wiley Encyclopedia of Operations Research and Management Science*, pp. 1–13.
- Balcik, B. and Beamon, B.M. (2008), "Facility location in humanitarian relief", *International Journal of Logistics Research and Applications*, Vol. 11 No. 2, pp. 101–121.
- Birkmann, J. (2007a), "Risk and vulnerability indicators at different scales: Applicability, usefulness and policy implications", *Environmental Hazards*, Vol. 7 No. 1, pp. 20–31.
- Birkmann, J. (Ed.). (2007b), *Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies*, The Energy and Resources Institute (TERI).
- Birkmann, J., Cardona, O.D., Carreño, M.L., Barbat, A.H., Pelling, M., Schneiderbauer, S., Kienberger, S., et al. (2013), "Framing vulnerability, risk and societal responses: the MOVE framework", *Natural Hazards*, Vol. 67 No. 2, pp. 193–211.
- Buchanan-Smith, M. and Fabbri, P. (2005), *Links between Relief, Rehabilitation and Development in the Tsunami Response: A Review of the Debate*, Tsunami Evaluation Coalition, London.
- Buchanan-Smith, M. and Maxwell, S. (1994), "Linking Relief and Development: An Introduction and Overview", *IDS Bulletin*, Vol. 25 No. 4, pp. 2–16.
- Campbell, A.M. and Jones, P.C. (2011), "Prepositioning supplies in preparation for disasters", *European Journal of Operational Research*, Vol. 209 No. 2, pp. 156–165.
- Cannon, T., Twigg, J. and Rowell, J. (2003), *Social Vulnerability, Sustainable Livelihoods and Disasters*, Department for International Development, London.
- Caunhye, A.M., Nie, X. and Pokharel, S. (2012), "Optimization models in emergency logistics: A literature review", *Socio-Economic Planning Sciences*, Vol. 46 No. 1, pp. 4–13.
- Charles, A., Lauras, M., Van Wassenhove, L.N. and Dupont, L. (2016), "Designing an efficient humanitarian supply network", *Journal of Operations Management*, Vol. 47–48, pp. 58–70.
- Christoplos, I., Mitchell, J. and Liljelund, A. (2001), "Re-framing Risk: The Changing Context of Disaster Mitigation and Preparedness", *Disasters*, Vol. 25 No. 3, pp. 185–198.
- Collins, A.E. (2009), *Disaster and Development*, Routledge, London.
- Collins, A.E. (2013), "Linking disaster and development: further challenges and opportunities", *Environmental Hazards*, Vol. 12 No. 1, pp. 1–4.
- Day, J.M., Melnyk, S.A., Larson, P.D., Davis, E.W. and Whybark, D.C. (2012), "Humanitarian and Disaster Relief Supply Chains: A Matter of Life and Death", *Journal of Supply Chain Management*, Vol. 48 No. 2, pp. 21–36.
- European Commission. (1996), "Communication from the Commission of 30 April 1996: Linking Relief, Rehabilitation and Development (LRRD)", European Commission, available at: http://ec.europa.eu/development/body/legislation/recueil/en/en16/en161_0.htm (accessed 18 November 2016).
- Fan, L. (2013), *Disaster as Opportunity? Building Back Better in Aceh, Myanmar and Haiti*, Overseas Development Institute, London.
- Haavisto, I., Kovács, G. and Haavisto, C. (2013), "Performance objectives in relief and development operations", presented at the Joint EUROMA/P&OM World Conference 2013, Dublin, Ireland.
- IPCC. (2012), *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*, edited by Field, C., Barros, V., Stocker, T., Qin, D., Dokken, D., Ebi, K., Mastrandrea, M., et al., Cambridge University Press, Cambridge.

- Jahre, M. (2017), "Humanitarian supply chain strategies – a review of how actors mitigate supply chain risks", *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 7 No. 2, pp. 82–101.
- Jahre, M., Pazirandeh, A. and Van Wassenhove, L. (2016), "Defining logistics preparedness: a framework and research agenda", *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 6 No. 3, pp. 372–398.
- Kelman, I. (2011), *Disaster Diplomacy: How Disasters Affect Peace and Conflict*, Routledge, Oxon.
- Kelman, I., Gaillard, J.C. and Mercer, J. (2015), "Climate Change's Role in Disaster Risk Reduction's Future: Beyond Vulnerability and Resilience", *International Journal of Disaster Risk Science*, Vol. 6 No. 1, pp. 21–27.
- Kennedy, J., Ashmore, J., Babister, E. and Kelman, I. (2008), "The Meaning of 'Build Back Better': Evidence From Post-Tsunami Aceh and Sri Lanka", *Journal of Contingencies and Crisis Management*, Vol. 16 No. 1, pp. 24–36.
- Kunz, N., Reiner, G. and Gold, S. (2014), "Investing in disaster management capabilities versus pre-positioning inventory: A new approach to disaster preparedness", *The International Society for Inventory Research, 2012*, Vol. 157, pp. 261–272.
- Lavell, A. and Maskrey, A. (2014), "The future of disaster risk management", *Environmental Hazards*, Vol. 13 No. 4, pp. 267–280.
- Lindahl, C. (1996), *Developmental Relief?: An Issues Paper and an Annotated Bibliography on Linking Relief and Development*, Swedish International Development Cooperation Agency (SIDA), Stockholm.
- Manyena, S.B. (2012), "Disaster and Development Paradigms: Too Close for Comfort?", *Development Policy Review*, Vol. 30 No. 3, pp. 327–345.
- Maon, F., Lindgreen, A. and Vanhamme, J. (2009), "Developing supply chains in disaster relief operations through cross-sector socially oriented collaborations: a theoretical model", *Supply Chain Management: An International Journal*, Vol. 14 No. 2, pp. 149–164.
- Marulanda, M.C., Cardona, O.D. and Barbat, A.H. (2010), "Revealing the socioeconomic impact of small disasters in Colombia using the DesInventar database", *Disasters*, Vol. 34 No. 2, pp. 552–570.
- MSB. (2015), *Early Recovery Road Map Linking Relief to Recovery and Development*, Myndigheten för Samhällsskydd och Beredskap (Swedish Civil Contingencies Agency), Karlstad.
- Perry, M. (2007), "Natural disaster management planning", *International Journal of Physical Distribution & Logistics Management*, Vol. 37 No. 5, pp. 409–433.
- Rawls, C.G. and Turnquist, M.A. (2012), "Pre-positioning and dynamic delivery planning for short-term response following a natural disaster", *Socio-Economic Planning Sciences*, Vol. 46 No. 1, pp. 46–54.
- Schipper, L. and Pelling, M. (2006), "Disaster risk, climate change and international development: scope for, and challenges to, integration", *Disasters*, Vol. 30 No. 1, pp. 19–38.
- Scholten, K., Scott, P.S. and Fynes, B. (2014), "Mitigation processes – antecedents for building supply chain resilience", *Supply Chain Management: An International Journal*, Vol. 19 No. 2, pp. 211–228.
- Smillie, I. (1998), *Relief and Development: The Struggle for Synergy*, Thomas J. Watson Jr. Institute for International Studies, Providence, RI.
- Thomalla, F., Downing, T., Spanger-Siegfried, E., Han, G. and Rockström, J. (2006), "Reducing hazard vulnerability: towards a common approach between disaster risk reduction and climate adaptation", *Disasters*, Vol. 30 No. 1, pp. 39–48.
- Tierney, K.J. (2014), *The Social Roots of Risk: Producing Disasters, Promoting Resilience*, Stanford Business Books, an imprint of Stanford University Press, Stanford, California.
- UNDP. (2008), *Guidance Note on Early Recovery*, UNDP, Geneva.
- Wilkinson, E. and Peters, K. (Eds.). (2015), *Climate Extremes and Resilient Poverty Reduction: Development Designed with Uncertainty in Mind*, Overseas Development Institute, London.

UNIVERSITIES AS A SUSTAINABLE LIVING LABS. EXPLORING COMMERCIAL TRAFFIC AT THE UNIVERSITY OF LEEDS CAMPUS.

Anthony Ezenwa[1, 2] and Eleonora Morganti[1]

[1]University of Leeds, United Kingdom and [2]Federal University of Technology Owerri, Nigeria

Introduction

Urban freight sustainability has become a global problem as the urbanization continues to rise across regions of the world. In Europe for example, 60% of the population currently lives in the urban areas representing 85% of the EU's GDP (European Commission, 2007). The adverse effects of this development have been recognized especially related to congestion and environmental pollutions such as noise and CO_2 emissions (Zunder et al., 2014). In the urban freight field, research embraced not only issues related to the safety of high goods vehicle (HGV) but also ways to optimise supply chains and to improve urban freight sustainability (Browne et al., 2012, Gonzalez-Feliu et al., 2014). However, issues regarding urban freight challenges are yet to be captured by city authorities and administrators strategically (Ballantyne and Lindholm, 2014), hence it continues to be a subject of discussion in academic and policy circles (Dablanc, 2007, Lindholm and Behrends, 2012).

Some established measures to mitigate urban freight problems include: road pricing system; goods vehicles access and off-peak deliveries; low emission zones (LEZ) and urban consolidation centred (UCC); active transportation and low emission vehicles; delivery service plan (DSP) and private-public partnership (PPP) (Stathopoulos et al., 2012); delivery service plan (DSP) and private-public partnership (PPP) (Stathopoulos et al., 2012). PPPs and DSPs are widely acknowledged as more proactive approaches, grounded in policymaking (Lindholm and Browne, 2013, Stathopoulos et al., 2012). Moreover, Zunder et al. (2014) suggest the need to address urban freight management challenges in the compact environment as the University campuses. This paper focuses on the compact environment of the University of Leeds (UoL), exploring the main issues related to the freight operations. The objective of this study is to gain a preliminary understanding of the flow of vans and other commercial vehicles across the campus. The study addressed the following research question: what are the main patterns of freight deliveries at the entrances of the campus and how these vary throughout the year? We adopted several methods including traffic counts, interviews of the relevant stakeholders (van operators and relevant University managers), and review of the relevant documents to achieve the objective of the study. The rest of the paper is structured as follows: literature review; research methodology; data analysis and results; and the discussion and conclusion of the study.

Literature Review

Urban freight management in compact environments

Delivery and service plans (DSPs) are recognized as one of the effective urban freight management schemes in the United Kingdom (Cherrett et al., 2012), classified as soft urban freight policy (Wagdahl, 2010). The concept of DSPs integrates the optimisation of a single operation within the last leg of supply chain management and management of the multiple operations of last mile deliveries through efficient freight planning (Zunder et al., 2014). The goal of DSPs is to combine actions such as consolidation of deliveries, out-of-hours deliveries, ad hoc contracts with shippers and engaging vehicles from notable fleet operators (Zunder et al., 2014). The concept has been applied to a pilot case in London to design the London Freight Plan (LFP) for retail business operators (Transport for London, 2009). The results suggest that the implementation of the pilot contributed to the reduction of the overall deliveries by 20%. Individually, catering, archives, and stationary deliveries were

lessened by 40% respectively. Notwithstanding, there is the need for further investigation of DSP to ensure efficient management of freight movements in the compact environments (Zunder et al., 2014). Few empirical studies on urban freight movements in compact environments reveal that about 50% operations of the whole urban freight traffic are linked with providing services to public institutions (Aditjandra et al., 2016). The results suggest the importance of incorporating the urban freight management at the compact levels combined with central and regional policies. It aligns with the notion of achieving sustainable urban logistics via receiver and purchase link initiatives.

Zunder et al. (2014) carried out detailed analysis of the University of Newcastle, around 22,242 purchase orders (PO) were made through electronic finance system between September and December 2011, Tuesdays appearing the busiest days (1,200 POs) in October and November while the daily average involve 255 POs over the five working days of the week. Individually, Institute of Cellular Medicine constitutes the highest faction of POs, 800 monthly, followed by the medical research establishments, 450 POs per month. Other establishments covered in the study include: agriculture, catering, chemistry, civil engineering departments and estate support services (ESS) constitute about 200 POs monthly respectively. Vendor data reveal that catering department cover up to 10 suppliers – the highest on campus, while the suppliers for the medical institutions represents singular vendors. Concerning freight flow, freight comprises about 20% of the campus traffic, LGVs covering 16% of the share. Tom et al. (2017) findings indicate that in cities with multiple higher education institutions (HEIs), where over 8000 students live in halls, over 13,000 courier trips could be generated annually, delivering over $4000m^3$ of packages. The authors assess that the whole delivery that the whole delivery operations could be consolidated onto fewer than 300 vehicles with the associated costs, approximately £18 per a student. Similar initiatives contribute to improving air quality and to reducing congestion, and parking infringements. Operational challenges include enforcement, performance risk, finance and delivery speed. The literature review supports the need of advancing the urban freight management in the compact environments especially mitigating operational challenges, formulating and implementing feasible policies.

Methodology

Our investigation combined field observations, survey, interviews and desktop research, and analysis of publicly available information about traffic flow on UoL main campus. Individual face-to-face interviews were conducted with 5 van and truck drivers and 7 stakeholders related to freight traffic on campus as reported in Table 1.

Category	Interviews
Truck and van drivers	5
Stakeholders on campus	7
Total	12

Table 1: Interview by respondents' category

Interviews topics were defined with the aim of detecting the operators' attitudes regarding sustainable freight operations on campus. The main questions covered the following: (i) patterns of deliveries on campus (frequency, volumes, and type of goods); (ii) vehicle access and parking procedure and (iii) supply chain arrangements with their customers. The stakeholders interviewed included officers working in the University services for mail, parking, and retail operations.

Study context and site

Leeds University lies very close to a city with a population of a circa 700, 000 within a conurbation of circa 1,700,000 which lies on the West of the Yorkshire region. The University is the third largest employer in Leeds with approximately 8,000 staff and over 32,000 students. The University has over 150 schools, centres and institutes and over 90 buildings (https://www.leeds.ac.uk/news/article/3917/university_of_the_year, Retrievd, 31 August, 2018). The scope of the study is the main campus only since it can be clearly isolated, without including the National Health Service (NHS) hospital (Figure 1)

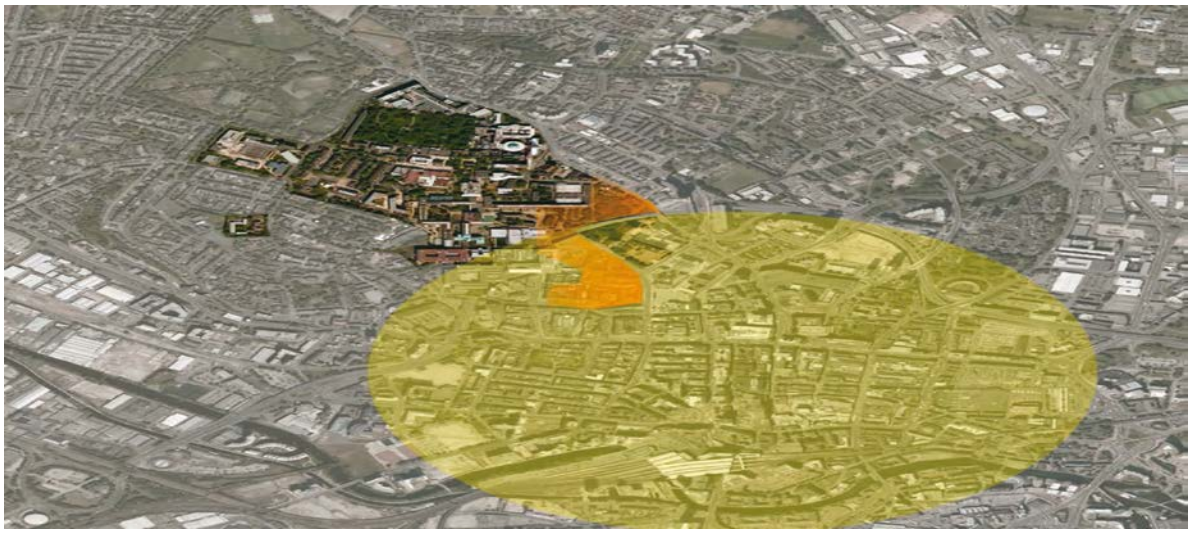


Figure 1: Aerial map of University of Leeds (Source: Master plan 2015-2025)

Description of the traffic regulations on campus

As a general rule, contractors and other commercial vehicles are allowed for a maximum of 40 minutes parking periods at the orange zone car park to drop off essential personnel, tools, and material.

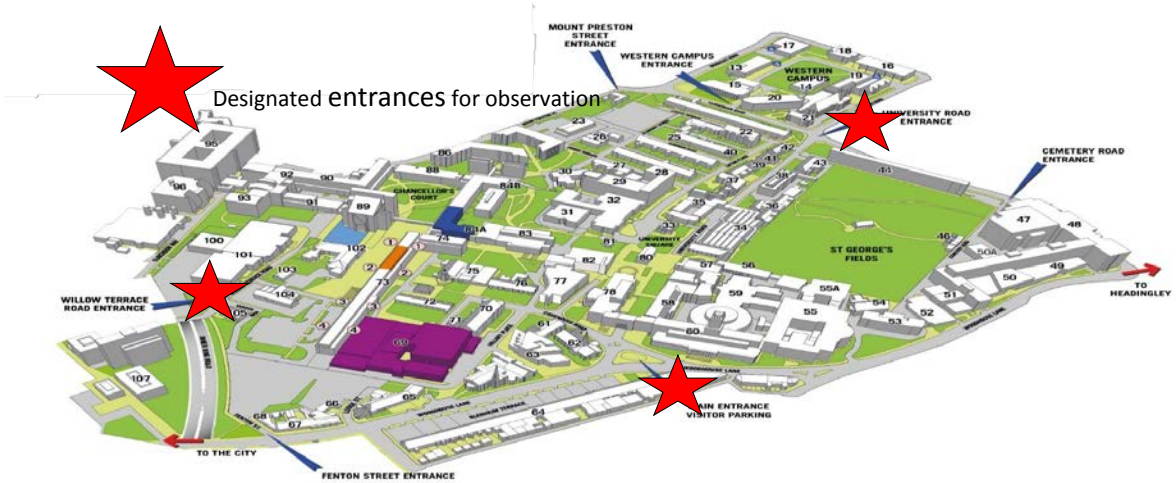


Figure 2: University of Leeds map showing the designated entrances for observation (https://www.google.co.uk/search?q=map+of+university+of+leeds&rlz, Retreived, 31 August, 2018)

For longer parking, they must either park off campus or be booked in to park as authorized persons. The contractors and other vehicle owners get a parking permit from the University's Estate Service. The UoL campus is accessed from the main entrances to the University: the University main gate, University Road, and Willow Terrace entrances (see Figure 2). It was based on this we selected the

designated entrances for the traffic counts and observations. Emergency responses to the University are allowed via the main entrances. The University security department is allowed to direct traffic, regulate entry to the car parks, exercise control over parking and maintain order/compliance. No regulations are guiding consolidated deliveries on the campus currently but parking policy is subject to review as the need arises.

Data collection and analysis

The two traffic surveys were conducted in Winter 2017 and Spring 2018 respectively. The winter traffic survey comprised four days term time, Monday (Cyber Monday) and Wednesday in the week of November 27 and December 04, 2017. Cyber Monday is the first working day following the Black Friday online sale offers. That Monday was purposely selected to ascertain the effects of the popular e-commerce event and verify the impact on commercial vehicle traffic on campus. The second stage of the study involved three day term time, Tuesday and Friday in the week of May 12 and Tuesday in the week of May 21, 2018. The longitudinal data collection technique was adopted to ascertain if there were differences in the two important seasons of the University calendar: the Winter and Spring respectively. In both surveys, 4.5 hours were covered: 07:00 -11:30. Timescales and periods of observation were suggested by the stakeholders at the security and mail services. Random interviews were conducted with drivers of vans and trucks operating on campus and with retail operators. The interviews with the University officers in the mail and parking services were arranged and scheduled in their respective offices, December 15 and 19, 2017.

For the data analysis, descriptive data analysis (bar charts) with Excel 2013 was used to analyse the sorted traffic survey data accordingly. On the other hand, the qualitative audio data was transcribed and read severally by the research team until consensus reached. Participants were contacted where necessary to clarify ambiguity statements. The documented observation during the survey was also reviewed by the research team to establish their actual meaning for proper reporting.



Figure 3: Sample of vehicle categories

Vehicle categories

The vehicles categories observed in the survey included:

- Hired cars (HC) up to 1.8 tonnes;
- Small and medium-sized light commercial vehicles (LCV1) with a weight range of 1.8t - 2.6 tonnes
- Large-sized light commercial vehicles (LCV2) with a weight range of 2.6 – 3.5 tonnes (Aderson, 2006);

- Medium-sized commercial vehicles (HCV1), up to 12 tonnes;
- Large heavy commercial vehicles (HCV2), over 12 tonnes;
- (Other goods vehicles (OGVs), Hiab vehicles/cargo bikes (see Figure 3).

Limitations of the study

The study is not presented as a comprehensive picture of the UoL campus traffic but rather as the first step in identifying the main traffic flows especially relating to the limited duration of the traffic counts. An additional limitation deals with the lack of information about the scope of the trips as the majority of the white vans did not provide details on the type of delivery or service provided.

Results

The result of the Winter traffic survey (Figure 3) reveals as follows:

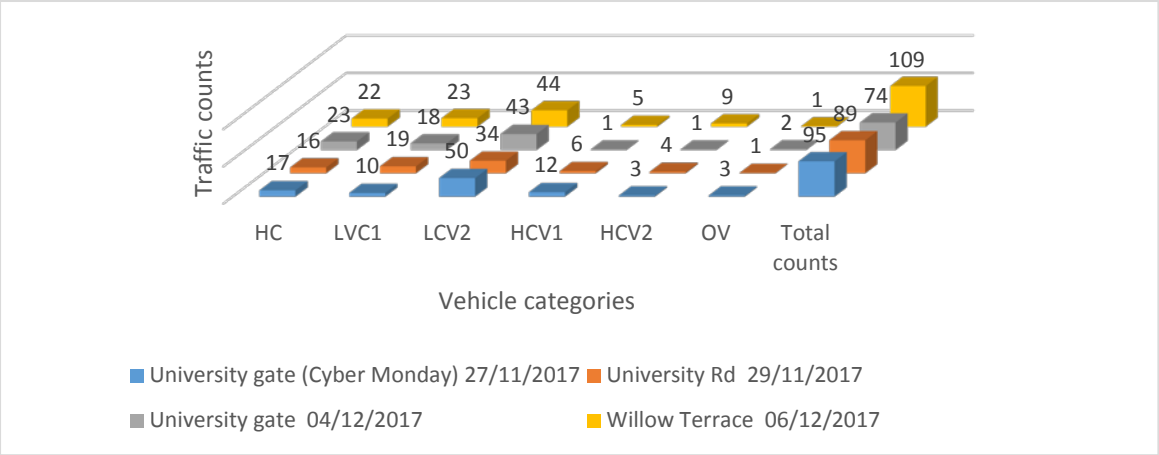


Figure 3: Traffic survey counts in the Winter 2017

Day 1, Cyber Monday, November 27, 2017, at the University main gate, included: LCV2 (50); HC (17); HCV1 (12); LCV1 (10); HCV2 (3) and OGV (3). Day 2, November 29, 2017 at the University Road comprised: LCV2 (34); LCV1 (19); HC (16); HCV2 (4) and OGV (1).

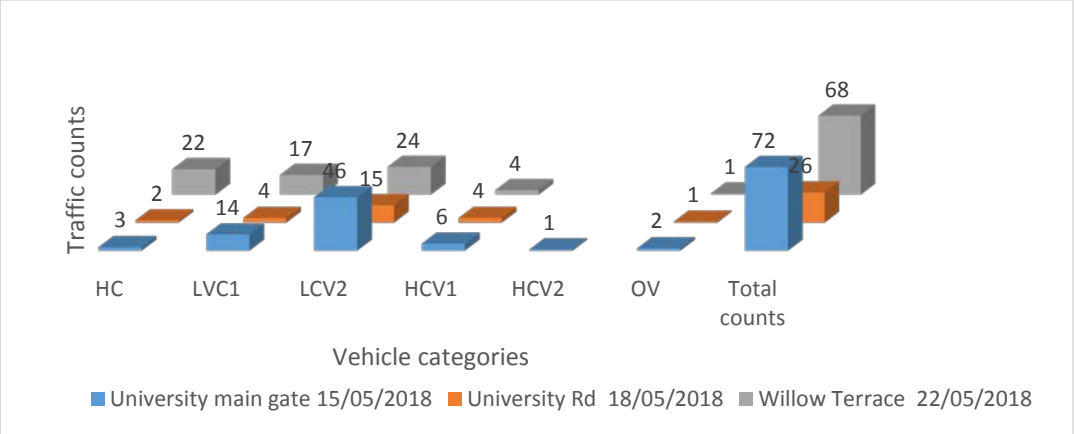


Figure 4: Traffic survey counts in the spring 2018

Day 3, December 4, Standard Monday at the University gate involved: LCV2 (43); HC (23); LCV1 (18); OV (2); HCV1 (1) and HCV2 (1) respectively. Last, December 06, at Willow Terrace included: LCV2 (44); LCV1 (23); HC (22); HCV2 (9) and HCV1 (5) respectively. Overall: University main gate, Cyber Monday (95); University Road (89); University main gate on the standard Monday (74) and Willow Terrace entrance (109). As observed, LCV2 recorded the highest commercial vehicle traffic on UoL during the

Winter traffic counts while the Willow Terrace entrance attracted the highest traffic on the campus premises, followed by the University main gate on the Cyber Monday, the University Road and the University gate on the Standard Monday.

The spring traffic survey result as demonstrated in Figure 4 revealed: First day, May 15, 2018, at the University main gate: LCV2 (46); LCV1 (14); HCV1 (6); HC (3); OV (2) and HCV2 (1). On the second day, May 18, 2018, at the University Road: LCV2 (15); LCV1 (4); HCV1 (4); HC (2) and OV (1), while HCV2 did not record any count. Last, May 22, 2018 at the Willow Terrace: LCV2 (24); HC (22); HCV1 (4), and OV (1). Again, there was no record of HVCV2 here. Overall: the University main gate (72); Willow Terrace entrance (68) and University road entrance (26) respectively. Again, the LCV2 recorded the highest traffic counts on the campus during the Spring Survey, but the University main gate attracted the highest traffic this time, trailed by the Willow Terrace entrance and the University Road respectively.

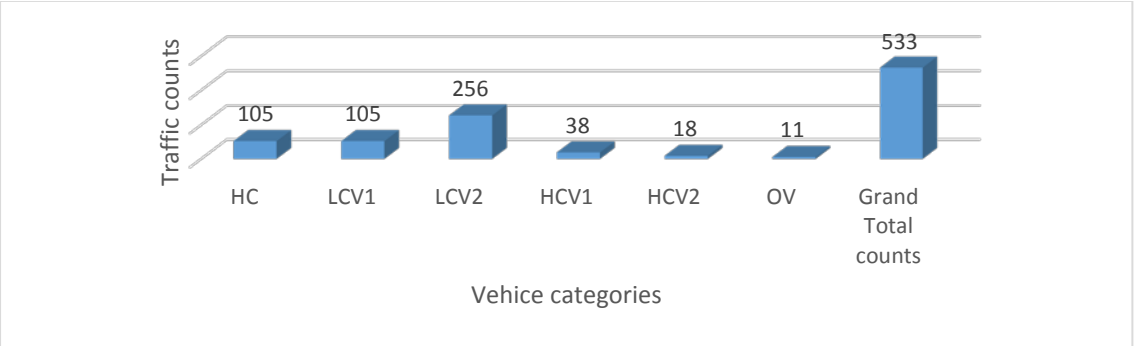


Figure 5: Cumulative result of the traffic survey in both summer 2017 and spring 2018

Cumulatively, the overall survey revealed: LCVs constituted 67.7% of the traffic survey, followed by the HCs (19.7%), HCVs (10.5%) and OVs (2.1%) respectively. There was a 20% reduction in commercial vehicle traffic between the Cyber Monday and a Standard Monday; 61% reduction between Winter 2017 and Spring 2018 using the three standard days as a criterion. Peak hours were between 09:00 – 10:00. Most of the delivery vans were white vans, resulting in limited information about the scope of the trip like maintenance, parcel deliveries or construction. About 10% of the total traffic made multiple trips into the campus, and the majority were the University of Leeds food vans. The majority of the HCs disembarked their passengers at the University main gate. Finally, safety issues were observed on campus in the presence of the articulated vehicles and other categories of heavy commercial vehicles.

Qualitative results

Two set of interviews were conducted to complement the traffic count and the field observation. The interviews with vans and trucks drivers provided additional information about patterns of deliveries. Most of the respondents stated that they perceive very low or no restriction for entry and parking on campus, in some cases they are not aware of the 40-minutes maximum window. Their mode of operations varies, depending on their line of business and supplies. Some drivers indicate that they visit the campus regularly but on request while others claimed that they are under contract to drop specific type of products on a particular interval of periods. Finally, we deduced from their statements that there is no coordinated supply chain arrangement amongst members of the retail outlets across the University.

The main outcome of interviews with stakeholders deal with the trends on deliveries throughout the year and on the recent years. Different stakeholders from the University services observed an increased flow of vans and number of parcels delivered by Royal Mail and other couriers over the last

few years. The flow does not appear homogenous in an academic year and it has peaks in different moment, e.g. early December. Although it is not possible to define whereas the items in the parcel are for professional or personal use, the common perception is that the parcel growth derives from online shopping activities. To explain the increased vans traffic, respondents also mentioned higher number of subcontractors and maintenance works. Moreover it appears from the interviews that there is a lack of information on the type of freight movements occurring on campus and a growing interest on better understanding suitable measures to monitor the traffic of commercial vehicles.

Discussion and Conclusion

The preliminary study on the main patterns of freight deliveries at UoL's campus identifies vans as the large majority of commercial vehicles circulating on campus. Although only limited data were available from the observation activities, results from interviews support traffic account on describing a non-homogenous traffic flow throughout the year. A peak period is for example Cyber Monday, the Monday following the online sale offers of Black Friday. In this article, we argue that assessing freight challenges in higher education (HE) environment, such as campuses can offer an important lens for addressing the complex interactions between environmental challenges relating to increasing urban freight traffic, new consumer's trends (e.g. online shopping) and freight management practices. Drawing upon evidence in the UoL campus, we demonstrate solutions for urban freight problems lie not only with the broader urban freight management at city level, but also by incorporating freight challenges in compact environments like the University campuses. The notion of managing urban freight challenges at the University environments used in this study addresses more searchingly the issues of managing patterns of freight deliveries around the UoL campus, considering changing traffic flow patterns around the University throughout the year. These are critical issues as there are no clear data defined policies guiding freight movements on campus.

Future adoption of Delivery and Service Plans (DSPs) is recommended to improve the freight traffic sustainability. DSP are expected to be more effective when drafted on the basis that higher portion of online purchases/ orders are attributed to the young adults (university students) and public institutions like University community (Wells et al., 2009, ShopperVista, 2016, Tom et al., 2017). Other aspects to take into account are: identifying the main subcontractors, planning maintenance work and coordination purchasing orders. Our study suggests that engaging more with compact environments, such as campuses can contribute to improve urban freight operations at city level. It is important to raise awareness among policy makers on the different seasons of the year, including the University calendar and special sales event periods (e.g., Black Friday) and how these events influence freight delivery patterns on campus and therefore the broader urban freight movements. Managing freight patterns from the UoL perspective can represent a useful point of entry into managing freight challenges in compact environments. However, it would be entirely misguided to focus on managing freight patterns in the compact environment alone to either improve air quality or resolve other freight challenges in urban public centres. Focusing on all components and linkages from compact environment conditions to the management of freight movements and online purchases is critical. It reflects where incorporating enhanced urban freight management models like DSP (Cherrett et al., 2012) can be useful regarding identifying ways to streamline the direct connections between suppliers and customers. Further research, therefore, needs to focus more on why and how the various connecting variables emerged in this study in order to create potential avenues for addressing urban freight challenges in the compact environments. On these bases, scholars can better construct useful models/frameworks to advance the strategic management of urban freight challenges.

References

ADERSON, R. 2006. LCV scoping study 1: Review of published literature. *In:* VALLINT, J. (ed.) *Report to DfT Logistics Policy Division ED06135 Issue 1.*

ADITJANDRA, P. T., GALATIOTO, F., BELL, M. C. & ZUNDER, T. H. 2016. Evaluating the impacts of urban freight traffic: application of micro-simulation at a large establishment. *European Journal of Transport and Infrastructure Research,* 16**,** 4-22.

BALLANTYNE, E. E. F. & LINDHOLM, M. 2014. *Identifying the need for freight to be included in local authority transport planning.*

BROWNE, M., ALLEN, J., NEMOTO, T., PATIER, D. & VISSER, J. 2012. Reducing Social and Environmental Impacts of Urban Freight Transport: A Review of Some Major Cities. *7th International Conference on City Logistics, June 2011.,* Mallorca, Spain: Procedia - Social and Behavioral Sciences.

CHERRETT, T., ALLEN, J., MCLEOD, F., MAYNARD, S., HICKFORD, A. & BROWNE, M. 2012. Understanding urban freight activity – key issues for freight planning. *Journal of Transport Geography.,* 24**,** 22-32.

DABLANC, L. 2007. Goods transport in large European cities: Difficult to organize, difficult to modernize. *Transportation Research Part A: Policy and Practice.,* 41**,** 280-285.

EUROPEAN COMMISSION 2007. GREEN PAPER Towards a new culture for urban mobility, COM(2007) 551 final, Brussels. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52007DC0551&from=EN.

GONZALEZ-FELIU, J., SEMET, F. & ROUTHIER, J. 2014. Sustainable urban logistics: Concepts, methods and information systems. *Heidelberg: Springer.***,** v-ix.

HTTPS://WWW.GOOGLE.CO.UK/SEARCH?Q=MAP+OF+UNIVERSITY+OF+LEEDS&RLZ. Retreived, 31 August, 2018. *University of Leeds map* [Online].

HTTPS://WWW.LEEDS.AC.UK/NEWS/ARTICLE/3917/UNIVERSITY_OF_THE_YEAR Retrievd, 31 August, 2018. University of Leeds.

LINDHOLM, M. & BEHRENDS, S. 2012. Challenges in urban freight transport planning – a review in the Baltic Sea Region. *Journal of Transport Geography.,* 22**,** 129-136.

LINDHOLM, M. & BROWNE, M. 2013. Local authority cooperation with urban freight stakeholders: A comparison of partnership approaches. *European Journal of Transport and Infrastructure Research,* 13**,** 20-38.

MASTER PLAN 2015-2025 Online.

SHOPPERVISTA 2016. Online Shopping Trends 2016.The Institute of Grocery Distribution, Watford, UK. *<http://shoppervista.igd.com/Hub.aspx?id=35&tid= 4&rptid=368> (accessed May 2018).*

STATHOPOULOS, A., VALERI, E. & MARCUCCI, E. 2012. Stakeholder reactions to urban freight policy innovation. *Journal of Transport Geography.,* 22**,** 34-45.

TOM , C., JANET, D., FRASER, M., JASON, S., GAVIN, B. & GARY W. 2017. Logistics impacts of student online shopping – Evaluating delivery consolidation to halls of residence. *Transportation Research Part C,* 78.

TRANSPORT FOR LONDON 2009. *pilot delivery servicing plan for TfL's Palestra Offices in Southwark: A case study.,* London, ZUNDER, T., H., ADITJANDRA, P., T., CARNABY, B.

WAGDAHL, K. 2010. TRAILBLAZER (Transport And Innovation Logistics by Local Authorities with a Zest for Efficiency and Realization) deliverable D2.1 report on the state of the art. Eskilstuna Sweden. Climate Protection Agency, Sweden for Intelligent Energy Europe (IEE).

WELLS, P., BRISTOW, G., NIEUWENHUIS, P. & CHRISTENSEN, T. B. 2009. The role of academia in regional sustainability initiatives: *Wales. J. Clean. Prod.,* 17**,** 1116-1122.

ZUNDER, T., H., ADITJANDRA, P., T., & CARNABY, B. 2014. Developing a local research strategy for city logistics on an academic campus. *International Journal of Urban Sciences,* 18**,** 262-277.