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Benchmarking and efficiency

The design guidelines for improved best practices implementation at South African wine-packaging facilities

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Abstract

Purpose – The purpose of this study is to develop design requirements that will align supply chain management best practices and the current need existing at South African wine-packaging facilities to react in a more responsive manner towards increased customized demand requirements. The guideline will assist small- medium-sized wine-packaging facilities with the knowledge of how the identified best practices can be helpful towards improving responsiveness, while also indicating how digital technologies can assist with the realization of best practice implementation.

Research approach – The design requirements are constructed by means of a thorough literature review dealing with the topic of supply chain management best practices and also specifically how these are applicable to the wine industry. Furthermore, the needs and challenges existing at the wine-packaging facilities are explored by conducting semi-structured interviews with experts in this industry. These are merged into design guidelines that encompass best practice design requirements with existing industry needs.

Findings and originality – Six prominent SCM best practices are identified that can possibly improve the responsiveness of wine-packaging facilities in order to be able to manage increased customized demand. These include procurement and planning, process integration, collaboration, visibility and the level as well as quality of information sharing. These can be implemented using appropriate digital technologies outlined in this paper. The aim of this paper is to construct guidelines that will align already explored and developed supply chain best practices with challenges experienced by wine-packaging facilities. It also contributes towards the identification of possible digital technologies that can enhance supply chain operations. It is specifically aimed at the transformation of wine-packaging facilities, which is an industry that is in growing need of both supply chain best practice and technological development as there is an increasing demand for customized packaged products.

Research impact – This research provides guidelines for the implementation of best practices at wine-packaging facilities and identifies digital technologies that can be used to enhance the implementation thereof. However, the integration of these practices and technologies have not yet been tested within the industry.

Practical impact – Wine industry researchers have called for the implementation of supply chain best practices and the integration of digital technologies into the wine supply chain. This paper aims to provide guidelines to fill this gap, specifically assisting wine-packaging facilities with the integration of these components. Furthermore, it was aligned with suggested industry best practices found in wine supply chain studies, to help the wine supply chain to not only survive in difficult economic times and an ever-changing supply chain environment, but also to thrive in these conditions.

Keywords – Supply chain management, Best practices, Wine supply chain, Digitalization, Technology

1. Introduction

The South African wine industry reported wine exports of 448 million liters (SAWIS, 2017). Packaged wine exports increased by 3.4 percent and contributed 170 million liters towards total wine exports (WOSA, 2018). Focused research over the last decade aimed to improve supply chain awareness along all channels of the wine supply chain. This research includes topics such as supply chain performance measurement and the implementation of industry-related best practices (Van Eeden et al., 2014).

The South African wine industry aims to transform into a market oriented industry. The Wine Industry Strategic Exercise (WISE) initiative launched in 2015 aims at improving coherence and international competitiveness for the industry. According to VinPro managing director, Rico Basson, this involves the development of a strategic framework that will provide stakeholders with the necessary tools and methodologies to improve business performance and create a more unified local wine industry by 2025 (Melck, 2017). One aspect it specifically focuses on is increasing the ratio of packaged versus bulk exports from 40:60 to 60:40 by 2025 (PWC, 2015). The WISE initiative also aim to improve technology usage and the industry's innovative ability (PWC, 2015; Vinpro et al., 2016). As the complexity of the industry is increasing due to this drive towards increased customer focused and customized exports, there is a growing need for more mature, responsive supply chains (Du Toit, 2018; Swanepoel, 2018).

Several studies identified industry best practices that could enhance the international wine industry performance, while other studies emphasize the benefits technological innovations can provide to various supply chain environments (Spens, Tatham and Kovács, 2014; Kovács et al., 2015; PWC, 2015; Knoblauch, van Eeden and Edwards, 2016; Apprise Software, 2017; Melck, 2017; Palm and Van Eeden, 2018). As the South African vision is to increase packaged wine exports, it could increase the degree of customization required for finished products, increasing the complexity for this industry. This could increase the need for responsiveness (delivery time and flexibility of product delivery) and pressurize wine-packaging facilities to improve utilization of their bottling capacity. The absence of supply chain best practices in the international wine industry is very apparent (Spens, Tatham and Kovács, 2014; Kovács et al., 2015). This, with the absence of technological innovation in the South African wine industry, makes it difficult to increase global competitiveness (Donati, 2013; PWC, 2015; Melck, 2017).

The problem for the local wine-packaging industry addressed in this paper, is the lack of guidance towards best practices that will enhance responsiveness requirements associated with increased customized orders. Furthermore, limited knowledge regarding the identification of appropriate digital technologies specifically aimed at improving the challenges addressed by best practice, prevents the local wine industry from increasing its international competitiveness.

2. Research Objectives and Methodology

The main objective of this research is to identify design guidelines towards the desired future state of best practice implementation along with the use of digital technologies, within wine-packaging facilities. This paper focuses on the following sub-objectives:

1. Investigate supply chain management literature for best practices found in supply chain industries beneficial for supply chain planning involving customized products.

2. Identify digital technologies and digital concepts from literature found to be enhancing best practice implementation to handle increased demand for customized packaged wine.

3. Use expert interviews to understand planning within wine-packaging facilities, their strategy, current configuration and need for suggested best practices due to challenges faced.

4. Develop design guidelines that merge the implementation of industry best practices and the utilization of appropriate digital technologies that will improve responsiveness toward increased customized demand characteristics.

The authors reviewed existing research to understand the applicability of best practices and the application of digital technologies. Several studies have focused on the absence of best practices in the wine supply chain (Spens et al., 2014; Kovács et al., 2015; Knoblauch et al., 2016; Kruger and van Eeden, 2016), but few have focused on the wine industry and the application of evolving digital technologies.

Using this literature, it is possible to identify and clarify the problem and also find possible ways of guiding the implementation of identified industry best practices, as well as provide options of possible digital technologies that can be integrated. The resources accessed included journal papers, reports, journal articles and books found on online databases. Keywords used in online searches included “supply chain management”, “best practices”, “wine supply chain”, “responsiveness”, “technology”, “digitalization”, “collaboration” and “South Africa”, amongst others. Informal understanding and knowledge related to this specific topic was acquired by reading online articles, wine supply chain exhibition visits and other shared documentation having valuable knowledge of this industry.

This paper investigates the concept of supply chain management (SCM) along with the application of digitalization technologies by means of a literature study and supplementary semi-structured interviews with experts at a number of South African wine-packaging facilities providing a service to cellars. The semi-structured interviews provided clarity on the current wine-packing process, the challenges this industry faces and opportunities that exist for the integration of industry best practices along with digital technologies. This information is used to develop the guidelines that aim to introduce a list of several best practices that can be integrated at wine-packaging facilities, focusing on managing the increased customized demand.

3. Literature review

The vision of the South African wine industry is driving export of more customized packaged products. Wine-packaging facilities thus requires the ability to react in a more responsive manner. To enhance this ability, it is worth knowing which best practices found in literature and other industries can be applied to wine-packaging facilities to improve responsiveness. It is also worth exploring the contribution that technology can make towards successful implementation of identified best practices.

3.1. Supply chain management best practices

Supply chain planning, sourcing and making are three of the six major categories of SCM identified by Done (2011) considered to be integral for improved responsiveness in a supply chain environment. Planning involves upstream (suppliers) and downstream (customers) supply chain partners. Sourcing involves the procurement of dry goods needed for wine packaging. The advancement of maturity in this aspect involves establishing collaborative relationships between wine-packaging facilities and their direct supply chain partners, both upstream and downstream, enabling the sharing of information related to inventory availability and delivery. In turn, these two dimensions are crucial for delivering a product to the market and a big concern for many manufacturers and retailers globally (Enslow, 2007).

As the WISE initiative aims to increase the volume of packaged-wine export, it will lead to the production of more customized products, as packaged wine requires customized packaging components such as labels, bottles, corks or screw caps and shipment boxes (Du Toit, 2018; Swanepoel, 2018). This calls for shifting the current efficient bulk wine export supply chain strategy, toward a responsive strategy that will allow reliable delivery of products to customers.

Having a more responsive approach will allow wine-packaging facilities to react purposefully and within an appropriate time

frame to meet customer demand to maintain a competitive advantage, which is the definition of responsiveness as defined by Holweg (2005). This is confirmed by the study of Adebambo and Adebayo (2013) which found that a higher level of SCM practice implementation improves supply chain responsiveness. This study also stresses that technology is an important enabler of this advance and that the applicability of technology types may differ from company to company.

Several best practices that support responsive supply chains wider than the wine industry that address reliability issues can be applied to specific problems experienced by the South African wine industry. The maturity level of several SCM aspects is lacking on many of the channels of the South African wine supply chain (Spens et al., 2014), degrading the competitive edge of the industry as organizations in the supply chain tend to compete against one another instead of against other supply chains. The responsiveness of wine-packaging facilities is often affected by the reliability of their supply chain partners, directly influencing their ability to meet increased customized demand (Du Toit, 2018; Swanepoel, 2018). The implementation of SCM best practices can be of value as it has proven to improve the performance of the implementing party as well as their suppliers (Hamister, 2012).

Five core SCM best practices have been identified from literature that allow organizations to be integrated with their trading partners (Li et al., 2006). These include strategic supplier partnerships, customer relationships, information sharing, the quality of information sharing, and postponement. A study by Koh et al. (2007) concludes that these practices and several other overlapping best practices by other authors indeed have a positive influence on supply chain responsiveness. Flexibility is another word used interchangeably in literature.

Spens et al. (2014), provide a framework that summarizes the “baseline practices” and “best practices” that are useful, specifically to the wine industry. This framework was constructed from the completion of a study that investigated practices found in literature as well as practices commonly observed in supply chain environments that are considered to have excellent performance. The baseline practices and best practices described (refer to Table 1) are highlighted to be of specific importance to wine- packaging facilities, in fulfilment of Objective 1 of this study.

Best Practice	Description
Planning and procurement	Includes sales and operations, range forecasting, collaborative forecasting, planning, information sharing, strategic sourcing and sourcing information, supplier development and supplier relationship management. This is a key aspect for agricultural procurement in order to realize improved reaction to changed demand characteristics (Du et al., 2009).
Process integration	Aligning the supply chain and operational strategies of the supply chain partners to ensure that the entire supply chain competes as an industry unit.
Visibility	Ensure responsiveness to changing demand, with the key enabler being information sharing - a prerequisite for responsiveness as it allows for improved exception management (Ibrahim, 2007).
Strategic Supplier Relationship	Improves supply chain performance as responsiveness of a supply chain is influenced to a certain degree by the ability and performance of their suppliers (Hamister, 2012).
Level of information sharing	Refers to the extent that non-public information is shared and communicated amongst the different supply chain partners and channels - an aspect of successful implementation of SCM practices that contribute toward improved supply chain responsiveness (Li et al., 2006; Koh et al., 2007; Lee, Kwon and Severance, 2007).
Quality of information sharing	Enhances the level of information sharing and the quality of a strategic supplier partnership. Accuracy, timeliness and credibility of shared information are important factors to improve supply chain performance (Li et al., 2006; Hamister, 2012).
Collaboration	Internal and external collaboration or linkages, both needed to drive innovation. It increases predictability and creates solid partnerships between wine-packaging facilities, dry goods suppliers and wine farms (Palm and Van Eeden, 2010). Supply chain collaboration or linkage is considered important for supply chain reliability (Lee, Kwon and Severance, 2007), which in return influences supply chain responsiveness.

Table 1: Best practice guide for wine-packaging facilities

Even though these best practices are commonly found in other supply chain industries that excel in performance, Spens et al. (2014) found no evidence of these practices being listed in literature as common practices in the wine supply chain, which is in line with the findings of The South African wine industry Insights survey 2013 (PWC, 2013). In a further study by Spens, Tatham and Vaillancourt (2015),

the lack of the presence of these best practices was investigated. Not only did they find the absence of best practices in the international wine industry to be very evident, but also the absence of some baseline practices, although literature suggests that baseline practices are used or known about.

The improvement of information tracking related to sourcing, procurement, labeling and bottling will have significant value in wine supply chains as tracking information will help to eliminate uncertainty along all the channels of agriculture supply chains (Du et al., 2009). Furthermore, Spens et al. (2015) mention that collaboration efforts revolving around the mentioned best practices are a possible lever of responsiveness that can assist the wine industry to conquer logistical obstacles in order to keep up with the changing demand and customization required by customers.

3.2. Digital technologies

The increasing reliance on collaborative partnerships as a key enabler of responsive SCM calls for more supply chain integration and greater visibility along the different channels of a supply chain. This results in the significant importance of information sharing, the continuous growth of information systems and better utilization of developing digital technology (Xu, 2011). As stated in an article by Apprise Software (2017), 5 Ways Technology Can Improve Wine & Spirits Supply Chains, wine and spirits supply chains often do not use the correct technology to improve overall supply chain management and performance. This can be attributed to players in this industry not being aware of the appropriate solutions available to address specific problems that exist in the current supply chain configuration or players have too many options to choose from.

The implementation of digital technologies requires investment in infrastructure, either totally replacing existing infrastructure or adjusting the capabilities of current infrastructure. It is important that a specific supply chain industry knows the applicability of available digital technology to their supply chain configuration as well as the benefits that the implementation thereof can yield, in order to avoid costly inefficiencies (PwC, 2014). Having a digitized and digitalized supply chain provides companies the opportunity to have a more efficient, agile and customer-focused supply chain orientation (PwC, 2016), but it is worth noting that it does not always guarantee success.

According to the article “How digitization makes the supply chain more efficient, agile, and customer- focused” (PwC, 2016), future digital supply chains will consist of eight elements: integrated planning and execution, logistics visibility, Procurement 4.0, smart warehousing, efficient spare parts management, autonomous and B2C logistics, prescriptive supply chain analytics and digital supply chain enablers. These elements form part of a digital supply chain ecosystem consisting of a wide range of digital technologies

including Internet of Things (IoT), big data analytics, the cloud, etc. Having a digitally enabled supply chain will allow traditional linear supply chains to be transformed into a digitally enabled supply ecosystem. This ecosystem will have complete transparency, allowing for improved communication, collaboration, flexibility and responsiveness (PwC, 2016).

Enabling technologies include cloud platforms, smart sensors, mobile tracking solutions, connected cyber-physical systems, computer processing power as well as the IoT and related services. As most supply chains operate along the well-known SCOR processes, these technologies can assist supply chain partners such as suppliers, warehouse sites, production companies and distribution partners to have supply chain visibility enabled by the use of an integrated planning and execution platform. This allows thorough awareness and collaboration regarding the strategic, tactical and operational goals of all the parties involved (PwC, 2016).

From a supply perspective, having such a platform will allow integrated material requirements planning, vertical integrated real-time planning in production and end-to-end logistics visibility. Integrated IT systems are a key enabler of supply chain digitalization and will realize beneficial effects for inventory levels, delivery times and SCM flexibility (Schmidt et al., 2015; Israelit et al., 2018). From a logistical point of view, transport data can be collected and distributed using centralized systems, supplier hubs and events platforms. These can be enhanced by real-time status information notifications related to carrier feeds as well as tracking devices. (Schmidt et al., 2015; PwC, 2016).

Procurement of raw materials is integral for the development of digital supply chains as digital tools and interfaces allow closer collaboration, which helps with supplier co-creation, supplier integration in planning and development, risk management and KPIs (PwC, 2016). Thus, wine supply chains should focus on improving this specific node, the wine bottling facility, to reap the benefits of digitalization.

4. Wine-packaging process analysis

Wine supply chains, classified as an agri-food supply chain, have proven to be one of the more complex supply chains of this type (Ahumada and Villalobos, 2009). Factors contributing to the complexity of this supply chain include food safety and quality, limited shelf life, weather variability and seasonal changes which cause demand and price variability.

4.1. Wine-packaging process

The wine-packaging process consists of several operations including filling, corking or capping, capsuling, labeling, packaging of finished products and palletization for shipping. Actors involved at this node of the wine supply chain include the filler/packer, the wine producers (or wine cellars) and dry goods suppliers. The wine producer is responsible for the manufacturing and/or blending of wine products and is reliant on the quality of raw material supplies (dry goods) such as packaging materials, corks, labels, etc. The raw material suppliers are responsible for delivering the necessary dry goods required for the actual filling and packing of wine and separate raw material suppliers are mostly responsible for a single dry good item that is required during the filling/packaging stage.

The filler/packer is responsible for wine packaging, which essentially is an assembly operation. This entails receiving bulk wines and dry goods which are used as inputs for the filling and packing operations. The bulk wines are packaged according to the customers' (in this case the wine producer/wine cellar) specifications and can vary widely between different container types, branded corks or screwcaps, labels and boxes for distribution with unique specifications according to the destination country's specific import regulations. Filler/packer operations are subjected to a high degree of customization as there is a big variety of customization options related to all the input components required for packaging. Furthermore, this node in the overall wine supply chain merges several separate supply chain entities and a delay at one of the upstream entities causes production problems for the filler/packer. Also any changes in the product requirements downstream, filter upstream and escalate the impact through this merge point.

Interviewees mentioned various possible information sharing options between partners. Currently no shared information database is visible to all, thus duplication of information sharing efforts and communication often occurs (Du Toit, 2018; Swanepoel, 2018). The nature of the current information sharing patterns and the lack of visibility between partners often results in communication delays, transferred to bottling plant scheduling constraints and dry goods sourcing delays. These have previously been identified as root causes for responsiveness issues in the South African wine industry (Knoblauch et al., 2016). Interviewees mentioned that improved information sharing capabilities, visibility and supplier collaboration are some of the main needs identified by stakeholders (Du Toit, 2018; Swanepoel, 2018).

Dry good sourcing in particular proves to be a challenge and requires a large coordination effort. Most facilities functions on just-in-time (JIT) delivery of dry goods supply. It is mainly the responsibility of clients to order dry goods and have them delivered to the packaging facility three days before production, especially when customized materials are required. As there is currently no means of visible information sharing amongst the supply chain partners, dry goods sourcing delays are one of the top three causes of bottling plant production delays identified during interviews (Du Toit, 2018; Swanepoel, 2018). It was established that wine-packaging facilities have a well-defined working relationship with their suppliers and clients, but coordination and integration can be improved by having visibility of aspects such as order placing, dry goods availability, order delivery tracking, changing requirements and performance measurement.

As concluded from expert interviews it will require a combined effort from wine producers, dry goods suppliers and wine-packaging facilities to improve their daily planning operations in order to cope with increased amounts of customization possibilities.

4.2. Use of digital technologies at wine-packaging facilities

Interviewees confirmed that the level of technology use and advanced technological concepts is relatively low in the South African wine industry. The current functioning of wine-packaging facilities relies largely on a paper-based system (Expósito, Gay-Fernández and Cuiñas, 2013; Du

Toit, 2018; Swanepoel, 2018). Data is manually entered into spreadsheets, resulting in duplicated efforts to gather information available electronically. Revising spreadsheets is a very inefficient method of updating data, with interviewees recognizing the absence of a common communications platform providing the opportunity for supply chain visibility, creates challenges in managing deviations and exceptions in this environment. This calls for a more innovative system that can be used for data collection, storage and recovery, without duplicating data in the process.

Having limited visibility and information sharing restricts the ability of supply chain partners to collaborate. The restriction of visibility and appropriate information sharing can partly be attributed to the lack of technological use. According to Palm and Van Eeden (2018), the occurrence of these root causes has been verified and these are linked to Supply Chain Operations Reference (SCOR) processes and relevant best practices as defined by SCOR. Best practices relevant to the root causes mentioned in Section 4.1 includes vendor collaboration and Electronic Data Interchange (EDI).

Implementing vendor collaboration along with an integrated EDI system between wine producers, wine-packaging facilities and dry goods suppliers will allow the alignment of dry goods supply leading to production being on time at the wine-packaging facility. Utilizing digital technologies will equip partners with capabilities such as real-time order and inventory tracking, visible information along the supply chain and improved decision-making to manage increase customized demand.

4.3. Design guidelines for best practice implementation at wine-packaging facilities

The need to improve information sharing, information tracking and the daily operational requirements for planning and execution of operations at wine-packaging facilities is rising. Fixing operational processes without making complementary technological improvements will not allow full effectiveness of changed practices. The integration of specific digital technologies will allow the wine supply chain to enhance specific best practices.

Marrying these best practices, industry needs and digital technologies, will equip wine-packaging facilities with the ability to reach the desired transformation capabilities. This will not only benefit wine-packaging facilities, but the wine industry as a whole. Figure 2 provides a guideline for aligning SCM practices at wine-packaging facilities to industry related best practices with the assistance of enabling digital technologies. The implementation of such an initiative will rely on having strategic supplier (and customer) relationships in place as a best practice to ensure success, as it is crucial that all the parties involved commit to the initiative.

5. Conclusions

Literature related to SCM best practice implementation specifically applicable to the wine industry is very limited. Furthermore, integration of technology in the wine supply chain leaves room for significant improvement. As the focus of the South African wine supply is shifting towards increasing the quantity of packaged exports, the implementation of best practices can assist supply chain members to manage the increased customization requirement.

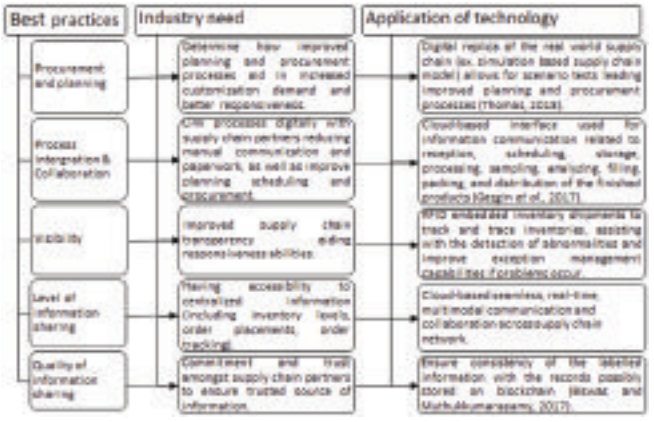


Figure 1: Best practice design requirements

The best practice design guideline developed aims to make stakeholders at wine-packaging facilities aware of the exciting best practices implemented by other industries, while all of the best practices identified typically aid improved responsiveness. The technologies identified serve as guidance towards the identification of possible digital technologies that can make a contribution towards the implementation of best practices. However, implementation has not yet been tested and verified and a suggested field for further research. Aligning best practice with digital technologies as suggested will assist the wine-packaging industry to address challenges currently experienced in the daily operating environment and also give other wine stakeholders a stepping stone towards improved SCM. This will help the wine industry to better align the supply chain of wine production from farm to table in order to satisfy increased customized demand.

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A study on improving transport efficiency in multi-tier retail supply chains

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Abstract

Purpose – To explore ways to improve transport efficiency in retail multi-tier supply chains by integrating raw material sourcing of suppliers into the transport network.

Research approach – The case study includes the collection of qualitative and quantitative data from Retailer Alpha historical records, interviews and questionnaires sent to Retailer Alpha suppliers. The performance of the proposed new scenario is assessed using a discrete event simulation model that includes the new pickup and drop off points of the transport network.

Findings and originality – The results show an improvement in the transport network efficiency of Retailer Alpha evidenced in the reduction of empty running levels and costs. This is the first study that provides empirical evidence which support the idea that the integration of raw material sourcing of suppliers into retailer's transport network brings significant improvements.

Research impact – This paper focuses on the collaboration between Tier 2 suppliers, Tier 1 suppliers and retailers, which is an area where literature is scant.

Practical impact – This research demonstrates the benefits of transport collaboration in multi-tier supply chains by providing quantifiable evidence of the transport operational improvements.

Keywords – Collaboration, Multi-tier supply chains, Transport efficiency, Retail sector, Empty running, Simulation

1. Introduction

The retail sector has seen unprecedented changes during the last decades which has created many operational challenges. Retailers have evolved from being a passive recipient of goods from manufacturers and suppliers to lead and manage their supply chains from production to consumption (Fernie and Sparks, 2014). After extending the channel control and focusing on efficiency and effectiveness of their own operations, retailers have started to adopt more collaborative practices to get even greater benefits (Sheu et al., 2006; Sparks, 2010; Panahifar et al., 2018). This trend has been also reflected in the literature, with prior research looking at the benefits of supply chain collaboration. Some of these authors have highlighted, in particular, that there are still opportunities to improve supply chain performance by focusing on collaborative transport practices (Chan and Zhang, 2011; Wang and Kopfer, 2014). Many leading retailers have been adopting these practices successfully, increasing the annual volume of goods transported by lorry, reducing the kilometres travelled per vehicle and as a consequence cutting down fuel transportation costs (Hingley et al., 2011; Fernie and Sparks, 2014).

Even though previous research on supply chain collaboration has been promoting the integration across the whole supply chain, in reality the focus has been primarily the dyad between pairs of manufacturers and retailers ignoring other supply chain members (Bourlakis and Weightman, 2004). Therefore, this research looks to expand the focus of analysis to include lower tier suppliers. This is important since the inefficiencies in one link of the supply chain can have a cascading effect on the entire supply chain by transferring the additional cost to the other supply chain members. The question guiding this research is: How can the integration of raw material sourcing to suppliers in the existing distribution network of Retailer Alpha increase the transport efficiency of the distribution network?

2. Literature Review

2.1. Transport Collaboration in the retail industry

Collaboration is a type of inter-firm partnership that may be undertaken by parties that aim to go beyond the regular commercial relationship (Matopoulos et al., 2007). In the past, retailers used to believe that the competition was only among retailers alone at a horizontal level. However, according to the literature, retailers have realized that supply chain collaboration can deliver more powerful advantages (Mentzer et al., 2000; Sheu et al., 2006; Panahifar et al., 2018). Transport collaboration in the retail industry, has been widely researched by many authors. As Fernie and McKinnon (2003) suggest, even though individual companies can become more efficient by focusing on the reduction of distance travelled and

fuel consumption, better results may be achieved when supply chain members decide to work together. In order to maximize the transport efficiency, in particular, many retail companies have been adopting vertical collaboration techniques such as Supplier collection / Onwards delivery, Factory Gate Pricing (FGP)(Mason and Lalwani, 2006; Fernie and Sparks, 2014).

A. Suppliers collection / Onward delivery: In the case of "supplier collection" practice, the shop delivery vehicles instead of returning to a Distribution Centre (DC) empty, can be routed to the suppliers sites to collect orders and deliver them to the retailer's DC (Fernie and McKinnon, 2003; Mason and Lalwani, 2006; Fernie and Sparks, 2014). Whereas, in an "onward delivery" practice the supplier's vehicle offload products at the retailer's distribution centre and backload with goods to the retailer's shops (Fernie and Sparks, 2014). Commonly the suppliers deliver the goods to shop premises that are on the way back to the factory to minimize the time and kilometre deviation (Waters and Rinsler, 2014). The resulting trips of the application of suppliers collection and onward delivery eliminate empty journeys and reduce the total kilometres travelled per lorry (Fernie and Sparks, 2014). The British retailer Tesco was one of the first companies that applied these practices having successful results (Fernie and McKinnon, 2003).

B. Factory Gate Pricing (FGP): The use of Factory Gate Pricing (FGP) within the UK grocery sector is one of the first largest applications of the concept in the world (Potter et al., 2007). Under a FGP, the retailer separates the transport costs that the suppliers impose in the products, assume the cost of the inbound transport and take over control of the transport organization. (Davies, 2004; le Blanc et al., 2006; McKinnon and Ge, 2006). However, in the logistics sector, the term has a wider meaning and does not just refer to the actual product pricing (Potter et al. , 2007). As Kyle (2003) suggests, the main purpose of this practice is to get transparency in costs, and based on this information find improvement opportunities and make the correspondent changes in the distribution network to increase the efficiency of operations. According to the literature (McAllister, 2003; Potter et al., 2007), the replication of FGP practices has improved the backhauling and provided retailers with a major control of the inbound distribution. Many British leading retailers such as Tesco, Asda, Sainsbury have adopted this practice successfully during the last years (McAllister, 2003; Potter et al., 2007). Over the first 5 years, Tesco backhauling initiatives (supplier collection, onward delivery, FGP) allowed them to increase the annual volume of goods transported per lorry by 26.5% and save 4.8 million vehicle-km (Energy Efficiency Best Practice Programme, 1997). Moreover, during the same period, Tesco was able to reduce the fuel expenditure by £750,000 (Energy Efficiency Best Practice Programme, 1997).

Even though previous supply chain collaboration pieces of research and case studies have been promoting the integration across the whole supply chain due to the benefits for its members, some authors such as Bourlakis and Weightman (2004) have questioned this assertion specifically the fact that these collaborative practices normally focus on the integration along the chain between pairs of manufacturers and retailers ignoring other supply chain members. Moreover, this type of collaboration only leads to retailers gaining more power and benefits at the expense of manufacturers (Bourlakis and Weightman, 2004). Therefore, this research aims at bridging this gap by expanding the focus of analysis to include lower tier suppliers to improve supply chain efficiency through the transport collaboration. Hence, this research contributes to the literature by exploring the transport collaboration among Tier 2 suppliers, Tier 1 suppliers and retailers to achieve greater efficiency in the retail supply chain.

3. Research methodology

3.1. Research context and approach

Due to the exploratory nature of this research a case study approach was selected, since it provides an exemplar practice of real life situation in depth and within in its original context to get richer insights (Yin, 2009; Denzin and Lincoln, 2011). Moreover, single case studies have been used in the past in the logistics and SCM field because of their greater applicability in comparison to other traditional methods (Halldorsson and Aastrup, 2003; Da Mota Pedrosa et al. , 2016). Regarding the data collection methods, a mixed method approach was chosen to be followed using qualitative and quantitative methods. For this research, primary data was collected through interviews and questionnaires and secondary data was collected from company records. This paper presents a case study of an international multi- channel retailer that sells branded food, clothing and home products in its stores and online. Retailer Alpha has presence in many countries, being its most important market in the UK. For this research, one of the eight Regional Distribution Centres (RDC), RDC X, was chosen to be analysed and in particular the category of fresh goods and processed food transport which currently has the highest levels of empty running and underutilisation of lorries.

3.2 Data collection

Firstly, primary data was collected through interviews with the Food Supply Chain Manager of Retailer Alpha who is responsible of the primary distribution, secondary distribution and E-commerce of Long Life Ambient, Beer, Wines, Spirits, Chill, Short life and Frozen food. The first part of the questionnaire contained questions about the general configuration of the distribution network and its participants. The second part of questions dealt specifically with the distribution of chilled, ambient and short life food, in order to identify the main problems and concerns of this network to posteriorly decide in what area in particular to focus. To ensure the consistency of the data collected, responses were further explored and cross checked by reviewing the files and documents provided by the company which were also used in the next stage of the research. In this next stage, secondary data from company records was collected. This data corresponded to 176 journeys of 78 lorries from RDC X to the different 66 Retailer Alpha stores that are located in the surrounding areas to the RDC X. The historical records requested to the company were the journey summary reports that include vehicles routes, arrival/departure time and distance from/to RDC X and stores, time, type of journey, loading information. Such records were used to analyse the current situation of the retailer's distribution network in terms of performance and efficiency levels. After that, primary data was collected through online questionnaires to identify the potential suppliers of raw material deliveries that may



be added to the retailer's distribution network. From the 24 suppliers of Short life, chilled and ambient food that supply food to RDC X, it was identified that some of them had their own supplier in the areas covered by the store delivery trucks that depart and return to RDC X. Therefore, twelve questionnaires were sent through email to these retailer's suppliers to conduct this research. These questionnaires included both multiple choice and close questions mainly related to potential suppliers and the correspondent geographical locations of the potential new pick up and drop off points, weekly volumes, frequency of deliveries, etc. This latter information was used as input for the potential improved simulation model that included the new deliveries between Tier 2 suppliers and Tier 1 suppliers in order to assess its correspondent efficiency improvements.

4. Empirical evidence

4.1. Retailer Alpha Distribution network

In the first part, the qualitative data collection through the interviews with the supply chain manager was analysed to understand the research context and how the overall food supply chain network works. Both Primary distribution and secondary distribution processes are illustrated in Figure 1. In the case of primary distribution, as it can be seen in Figure 1, the chill (CC), short life, frozen food were collected from 150 suppliers' sites, sent to a consolidation centre and posteriorly delivered to the 8 RDC. The second part of the Food supply chain network involves the secondary distribution (See Figure 1). The products stored in the 8 RDC are delivered to the nearly 1000 Retailer Alpha stores 7 days a week.



Figure 1. A schematic overview of the Food Supply Chain

During the call meetings, it was mentioned by the Food Supply Chain manager that their main concern was the high empty running levels of the store delivery trucks. According to the Food Supply Chain team, in order to manage the distribution Retailer Alpha has contracts with two different hauliers that operate independently. Supplying costs are agreed directly with and paid to Retailer Alpha. The cost of the haulage contracts is managed and paid by Retailer Alpha allowing them to enjoy better haulage rates than they would be able to negotiate independently. A key aspect that was mentioned by the managers was that a great number of Retailer Alpha suppliers of primary product such as meat, fish, poultry, bread etc. also supply raw materials to other Retailer Alpha T1 suppliers for use in processed chilled foods. However, Retailer Alpha Tier 1 suppliers of processes food manage their supply independently with suppliers' vehicles and/or other haulier companies. Moreover, it was identified that Retailer Alpha's distribution network has hundreds of vehicles already moving close to the Tier 1 and Tier 2 sites. Hence, it was decided to identify and assess the existing opportunity to expand the transportation network to integrate raw material sourcing to suppliers.

4.2. Empty journeys store delivery vehicles

A detailed analysis of the performance of store delivery trucks was developed to assess the initial performance and compare it posteriorly with the new proposed scenario. The empty journeys were assessed in terms of distance travelled and man-hour. According to the statistics of journeys in Table 1, 40.5% of the Km travelled by the store delivery lorries were run empty, while 20% of the hours were dedicated to empty journeys (Table 1).

Type of Journey	Kilometres	Percentage	Man-Hours	Percentage
Empty Journeys	18,526	40.5%	240	20%
Loaded Journeys	27,217	59.5%	962	80%
Total	45,743	100%	1,202	100%

Table 1. Descriptive statistics of journeys

In terms of the economic impact of empty journeys, the cost was estimated based on two components: fuel cost and driver cost. According to the results, the total fuel cost of the empty running of one week of operation is £5,919 (See Table 2). In the case of the driver cost, as it may be seen in Table 2, the total drivers' cost of one week of operation was £5,711. Therefore, the total cost of the empty journeys of one week was £11,630 (Sum of fuel and driver cost) and £604,760 if calculated annually.

Fuel cost	
Consumption (litres/km)	0.326
Fuel price (£/litre)	0.98
Empty journeys (Km/week)	18,526
Total Fuel cost (Weekly)	£ 5,919

Driver cost	
Average driver cost (£/hour)	23.75
Empty journeys (Hour/week)	240
Total Driver cost (Weekly)	£ 5,711

Table 2. Fuel and driver cost

4.3. Simulation Study of current situation

According to the literature, the use of simulation as a decision support system in the supply chain context is receiving significant attention by many authors (Acar et al., 2010; Petering, 2011; Hilletofth et al., 2016). As Thierry et al. suggest (2008), mathematical models are sometimes impractical to reflect realistic cases and experimentations may have technical or cost limitations. In contrast, simulation systems can be easily used to represent the model of a more realistic operation system and evaluate what-if scenarios to compare them and arise with the best decision. Hence, a simulation analysis was decided to be performed and the simulation software chosen for the analysis was Arena Software 15.1.

In order to build the simulation model, the Input Analyser tool of Arena Software was used to analyse a sample of the data collected and fit it to the most suitable distribution and add variability to the simulation model. The distribution that needs to be determined is the unloading time. According to the results obtained in the input analyser the distribution that best fit is 179 * BETA (1.9, 3.86). Having finished with the initial data collection, analysis and mapping the process the simulation model that represents the current situation of the secondary distribution network was built using the ARENA discrete-event simulation software. The software allowed the building up of a complex transportation and the use of Microsoft Excel spreadsheets as input data. The entities of the model are the lorries and to represent the stores and

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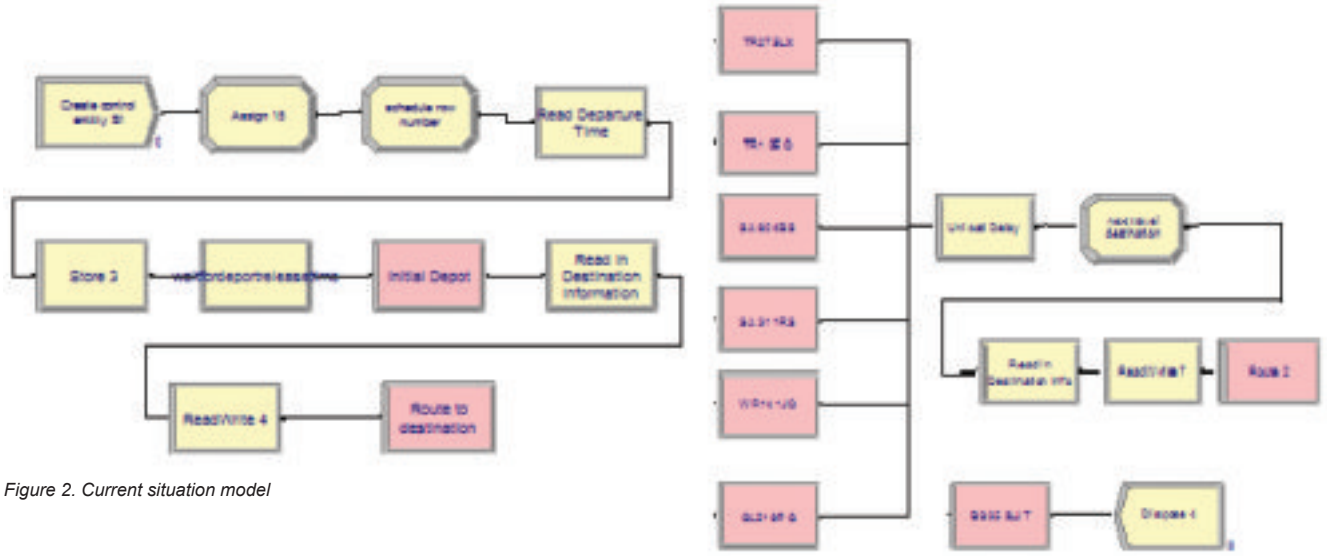


Figure 2. Current situation model

sequences the modules STATION and ROUTE were used. The schedule information, including routing sequences and timings, were uploaded to the simulation model as Attributes and Array Variables. The entities follow the schedule information uploaded on spreadsheet files. The resulting mode of the current situation that includes only a part of the stations can be seen in Figure 2. After finishing with the modelling, the simulation was run 50 times and for twenty-four hours and a summary of the replication results was created to continue with the verification and validation process of the model and proceed with the experiments.

4.4. Verification and validation

Before analysing the results of the simulation model it is necessary to ensure that the model built provides a valid representation of the system under study. In order to do so, the verification and validation was performed. The aim of the verification process is to ensure that the model build using the software is a correct representation of the process map of the system (Greasley, 2004). While the validation process is used to assure that the model behaves close enough to the real system under examination (Greasley, 2004).

To perform the verification of the model, the animation inspection was selected. The animation inspection was conducted by reducing the speed of the simulation to verify that the entities were moving following the correct sequences. The outcome of the verification was that the entities in the model were following the route sequences correctly. A validation process was also performed to check the precision of the model by comparing it with the real system. As it can be seen in Table 3, four indicators were chosen to validate if the model results were similar to the ones in the real system. After comparing the results, it is possible to affirm that the deviation is low and the results are quite close with a maximum of 5% deviation and minimum of approximately 0.5%.

	Real data results	Current model results	Deviation
Average journey (min)	484	508	5%
Unloading time (min)	173	178	3%
Empty running (% km)	40.5%	40.0%	0.5 pp
Empty running (% man-hour)	20.0%	18.1%	1.9 pp

Table 3. Comparison between Real System and Simulation results for validation

4.5. Simulation Study of proposed scenario

With the information collected through the online questionnaires and the previous data analysis, the new model of the extended secondary distribution network was built (See Figure 6). This model besides the deliveries from RDC to Retailer Alpha stores includes the deliveries from Tier 2 suppliers to Tier 1 suppliers. As it can be seen in Figure 6, the new model includes a new decision point that decides if the lorry should go straight back to the depot or if it should go to a new station to pick up goods from a Tier 2 supplier, then to drop them off in a Tier 1 supplier premises and finally go back to the depot.



Figure 3. Potential Improved Scenario simulation model

In order to decide which lorries should do the additional pickups and drop-offs an Array variable was created in the Arena model that includes the number of the route, the time to route from the last location to pick up point, the time from pickup to drop-off, the time from drop-off to base, pickup load time and drop-off unload time. The information used to build the array variable was obtained through the questionnaires sent to suppliers and complemented with a location mapping. The mapping analysis was crucial to identify the locations of Retailer alpha Tier 1 and Tier 2 suppliers and verify if their locations were close to the way back to the RDC X. Google Maps tools were also used to measure the distance between pick up and drop off points and their correspondent trip

durations. The pick-up and drop off points that did not demand a major deviation were added to the simulation model as part of the lorries' journeys.

Table 4 summarises the results of the complete analysis of the secondary distribution networks and its potential expansion that includes the sourcing from Retailer Alpha Tier 2 suppliers to Tier 1 suppliers. This table compares the Real data results and the potential improved scenario. The results suggest that the new scenario provides significant improvements. Firstly, the empty running expressed measured as a percentage of kilometres reduces by 14 percentage points. Secondly, the empty journeys measured as a proportion of the man-hour reduces by 3 percentage point. Finally, the cost of the weekly empty running (Fuel cost + Driver cost) reduces by £1,377 which represents a reduction of 12%.

	Current situation before expansion	Potential scenario simulation results
Empty running (% km)	40.5%	26.1%
Empty running (% man-hour)	20.0%	17.1%
Empty running Fuel cost	£ 5,919	£ 4,135
Empty running Driver cost	£ 5,711	£ 6,118
Empty running Total Cost	£ 11,630	£ 10,253

Table 4. Results from the overall analysis

5. Discussion

An overall review of the Retailer Alpha distribution network operations was performed in order to identify the main improvement opportunities. It was identified that the secondary distribution network had high empty running levels, therefore there was an opportunity to use the existing spare capacity. In this particular case by promoting the transport collaboration between Tier 2 supplier, Tier 1 suppliers and retailer to increase the distribution network efficiency and as a consequence reduce the associated costs. This decision was made in consonance with the literature findings that suggested that there were still opportunities to improve supply chain performance by focusing on collaborative transport practices (Chan and Zhang, 2011; Wang and Kopfer, 2014).

The secondary distribution network of Retailer Alpha was investigated by analysing company records in the form of journey summary reports. The first indicator chosen to be analysed was the empty running since, as McKinnon (2000) suggests, is the most common and visible indicator of vehicle underutilization. The results of the first part of the analysis suggested that the empty running levels of the RDC X reached the 40.5% which is in line with the UK food chain empty running levels that reached 38% according to a previous research of the Department of Transport features (Department for transport, 2017). Then, the time consumption of the empty journey was also decided to be measured as a percentage of man-hour which, according to the analysis, was 20% for this particular case. Moreover, to do an economic analysis similar to the one performed by (Davies, I., Mason, R. and Lalwani, 2004) the empty journey features were used to estimate the annual fuel and driver costs associated to the empty running which resulted on £604,755 (Sum of fuel and driver cost) only in the RDC X.

To expand the current research on transport collaboration that only has studied the collaboration along the chain between pairs of manufacturers and retailers ignoring other supply chain members (Mason and Lalwani, 2006; Potter et al., 2007; Fernie and Sparks, 2014) , the sourcing between Retailer Alpha Tier 2 and Tier 1 suppliers was also investigated. Questionnaires were used to identify the expansion opportunity in terms of general characteristics of the new deliveries, the location of the new pick up and drop off points in order to measure the integration effect.

In line with the findings from the literature (Acar et al., 2010; Petering, 2011; Hilletofth et al., 2016) that highlighted the benefits of simulation as a decision support system in the supply chain context, a simulation model was decided to be built. This simulation model was used to represent the current secondary distribution network operations and assess the efficiency impact of the network's expansion (including the sourcing between Retailer Alpha Tier 2 and Tier 1 suppliers) having the following results:

- Empty running measured as a percentage of kilometres travelled reduced from 40.5% to 26.1%.
- Empty journeys measured as a proportion of the man-hour reduced by 3 percentage point.
- The cost of the empty running (Fuel cost + Driver cost) in RDC X reduced by 12% which represents
- £71,604 savings per year.

The results suggest that the integration of the raw material sourcing to suppliers into the secondary distribution network of Retailer Alpha decreases significantly the empty running levels and costs. As a consequence, the proposed scenario increases the efficiency of the distribution network. This is in line with what Chan and Zhang (2011) and Wang and Kopfer (2014) claimed that there were still more opportunities to improve the supply chain performance through transport collaboration. In this particular case, as Bourlakis and Weightman (2004) recommended, with other supply chain members besides the commonly chosen manufacturer - retailer pair.

6. Conclusions

The present paper set out to answer the following research question: How can the integration of raw material sourcing to suppliers in the existing distribution network of Retailer Alpha increase the transport efficiency of the distribution network?. This research investigates the integration of the secondary distribution network of a retailer and the retailer's suppliers sourcing. By doing a predictive analysis and building a simulation model to compare the current situation and proposed scenario of the distribution network, the case study was analysed. In relation to the research question, the study confirmed that the proposed distribution integration increases the transport efficiency of the network by reducing its empty running levels and costs. Moreover, the proposed methodology that includes a discrete event simulation has proved to be a useful tool to make this evaluation.

6.1. Research implications

This study contributes to the knowledge by complementing the transport collaboration research that mainly focuses on the collaboration between Tier 1 suppliers and retailers. Hence, this research explores opportunities to improve supply chain efficiency with lower tier suppliers. Moreover, this

research uses a simulation model that can be easily adapted in terms of routes, stations (e.g. stores, supplier sites), entities (e.g. lorries) to represent a retailer's distribution network. This initial model was posteriorly adapted to represent a new improved scenario that besides the store deliveries includes the deliveries from Retailer alpha Tier 2 suppliers to Tier 1 suppliers to compare the results that can be achieved through transport collaboration.

6.2. Limitations

An important limitation is the use of a single case study and the number of questionnaire used to collect the suppliers data for the analysis of the expansion of a retailer's distribution network to include suppliers' sourcing. The use of this single case study and sample used may be considered as a limitation since other retailers' distribution network and suppliers may operate under different conditions and may have different network configurations. Another limitations of this piece of work is related to the data collected for the simulation model. Specifically the lorry journey data used as input for the model. The data used as input corresponded to one day of operations which does not allow to represent a weekly or monthly pattern which may be necessary for a development phase. Additionally, the human factor that affects journeys length and transport efficiency has not been explored in the present research.

6.3. Future research

For future research, the human factor effect in transport efficiency could be explored. The driving habits of lorry drivers could be widely explored to identify how the driving style, including excessive speed and harsh affect fuel efficiency. Future work should also include the evaluation of other transport efficiency indicators such as Vehicle load factor and Space utilization to complement the efficiency analysis. By using other indicators it would be possible to have a more accurate estimation of the variation of the efficiency levels and savings achieved through a distribution network expansion. Finally, further research is recommended to explore not only the integration of suppliers' sourcing to the secondary distribution network but also include the primary distribution network to such integration since, it may be argued that there are still missed efficiency opportunities that can be achieved by using the spare capacity of the primary distribution network.

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Big data

The application of big data and AI in the upstream supply chain

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1. Introduction

The use of Big Data has grown in popularity in organisations to exploit the purpose of their primary data to enhance their competitiveness (Saban et al., 2017). In conjunction with the increased use of Big Data, there has also been a growth in the use of Artificial Intelligence (AI) (Hokey, 2008) to analyse the vast amounts of data generated and provide a mechanism for locating and constructing useable patterns that organisations can incorporate in their supply chain strategy programme. As these organisations embrace the use of technology and embed this in their supply chain strategy, there are questions as to how this may affect their upstream supply chains especially with regards to how SME's may be able to cope with the potential changes. There exists the opportunity to conduct further research into this area, mainly focusing on three key industry sectors of aerospace, rail and automotive supply chains.

2. Big Data and AI in the Supply Chain

The term 'Big Data' was first used by NASA in 1997 by researchers to refer to the visualisation challenge for the computer systems with large amounts of data (Benabdellah et al., 2016). One of the sectors that have benefited from the technological and methodological advancements in the use of Big Data has been the logistics sector. Organisations such as DHL (Germany), UPS (United States) and Maersk (Denmark) have successfully used the Big Data field to enhance their competitiveness (Benabdellah et al., 2016).

As the supply chain becomes more global, there is an increase in the amount of valuable information generated. This information requires analysing to be useful in the establishment of an effective supply chain management strategy, and this introduces the notion of Big Data. This is where organisations are getting smarter and learning to collect and turn the large-scale quantities of data into a competitive advantage. They will use this data to forecast market demand, identification of radical customisation of services and, develop new business models to exploit their previously untapped data (Benabdellah et al., 2016). By applying the use of analytics to extract this valuable information, it can be used to enhanced decision making, and support informed decision making.

Richey et al. (2016) introduced the concept that as the Global Supply Chain Management (GSCM) includes many geographically dispersed companies that the Big Data generated is unstructured, of a wide variety and requires very speedy processing. This, therefore, becomes a critical issue in how to maximise the benefit of the data. As the data is very complex, decentralised and dynamic, the system of systems theory would fit well in the management of GSC's and the use of the Big Data. A system of systems (SoS) refers to a large-scale distributed system in which its components are complex and independent systems themselves (Choi, 2016).

Choi (2016) further explores the implementation of SoS in GSCM by indicating that this requires the use of information technology as Big Data related technologies such as Radio Frequency Identification (RFID) devices, sensors, data storage processing and interconnected networks play a critical role in modern Global Supply Chain Management. Choi (2016) also suggests that several technological advances and applications have contributed to SoS and GSCM strategy.

These include;

- Information Technology for the integration of communication networks and unified communications
- Enterprise Resource Planning (ERP) to support the major business processes within the organisation and cases where the organisations ERP system formed part of an interconnected system and has been linked with the ERP systems of individual supply chain partners
- Cloud Computing application tools such as cloud storage for large amounts of data and the sharing of common platforms such as Cloud-ERP
- Internet of Things (IoT) which can help establish a virtual linkage between businesses so that the critical parts are all connected by devices. Modern technologies in this area relating to Big Data include Industry 4.0.

As previous stated, Supply Chain Management (SCM) is becoming more information intensive and, in some cases, has substituted of other assets such as inventory, warehouses and transportation equipment (Min, 2010). Supply Chain professionals must explore ways to manage better and leverage the information to make better business decisions. This is where the use of Artificial Intelligence (AI), which has existed for decades, is growing in SCM.

Merriam-Webster online dictionary defines AI as "A branch of computer science dealing with the simulation of intelligent behaviour…." and "the capability of a machine to imitate intelligent human behaviour." So, put differently, AI is the imitation and simulation of human intelligence by machines, particularly computer systems (Nakamki, 2018). The problem with present AI systems is that they can handle large amounts of data but are limited in their ability to use analytical and independent self- awareness which will be the key to building future intelligence. They are either reactive or have limited memory. Nakamki (2018) theories that "Future Event Artificial Intelligence" will not only understand consciousness but have

it based on Theory of Mind which refers to the understanding that others have beliefs, desires and intentions that impact the decisions they make and, Self- Awareness where the AI system has a sense of self and consciousness. This type of AI does not yet exist (The Conversation, November 14, 2016)

3. Use of Big Data

However, the use of AI is starting to increase in several global organisations. In a recent project, Llamasoft's AI platform was used to review and improve the efficiency of Schneider Electric's global supply chain. (Bharadwaj, 2019).

Schneider's existing supply chain flows across 240 manufacturing facilities and 110 distribution centres around the world. They wanted to reduce the costs and analyse potential opportunities as they acquire new business units and how they can assimilate them into their supply chain. Schneider contacted Llamasoft and charged them with creating a supply chain predictive model which would automatically devise the best routing options for their large number of raw materials which includes circuit breakers that could fit on a warehouse shelf to transformers that are the size of a room. In conjunction with this, the supply chain data (such as transportation rates, data regarding shipping routes, etc.) resided on some 27 legacy ERP system from several new acquisitions and the company's existing supply chain data.

Data engineers at Schneider first built a data extraction tool that could collect the enterprise data from all the ERP systems, verify and 'clean' the data to be input to the Llamasoft platform. Llamasoft has made claims that their model needs around 2-4 hours to analyze some 200,000 transportation policy data points, 130,000 flow and routing constraints, and more than 150 initial scenarios (Data provided by Schneider) and could identify $9.32 million (8 million Euros) in annual savings for Schneider which could potentially be obtained by altering product flow in the supply chain. This could potentially be achieved by, re-routing certain shipments directly from the manufacturing plants rather than through one of their distribution centres to save on material handling and inventory storage costs.

This case study indicates how the supply chain of just one global organisation creates vast amounts of data (Big Data) and that by using the power of IT and AI that improvements can be made that can lead to a good level of cost savings.

The University of Melbourne carried out global research in collaboration with the Chartered Institute of Procurement and Supply (CIPS) to gather intelligence on the level of understanding of the supply chain digitalisation (including the use of Big Data and AI) and what this means for procurement and the wider business community (Fig 1). This collaboration primarily aimed at understanding the nature of digitalisation technologies managers have applied or intend to apply across their firm's supply chain practice, motivations and benefits behind pursuing a digitalisation strategy and challenges facing managers towards implementing supply chain digitalisation. This global survey was conducted in mid-2018 with over 700 managers in more than 20 different industries from 55 different countries taking part in the study. Findings have revealed significant insights on how digitalisation is shaping the future of procurement and supply chain management (Fig 2) with several organisations either having or planning to have the use of Big Data and AI in place in the next 2-3 years.

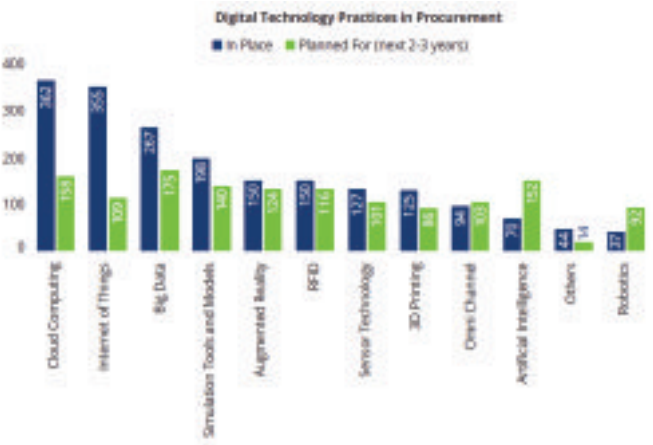


Fig 1. Digital Enablers in Procurement (University of Melbourne)

4. Supply Chain Development

Organisations are increasingly replacing their traditional supply chains with extended supply chains (Saban et al., 2017) which requires the suppliers of the organisation to collaborate, both upstream and downstream (Fig 2) to create value-laden products to the customer (Davis & Spekman, 2004). For organisations to achieve this, they require a high degree of supply chain collaboration (SCC) between the partners in the supply chain. According to Saban et al. (2017), to achieve SCC, organisations are turning towards using the latest decision support systems and technologies to

improve the organisation's agility, reduce cycle times, achieve higher efficiencies and, achieve the delivery of the value-laden products to their customers.

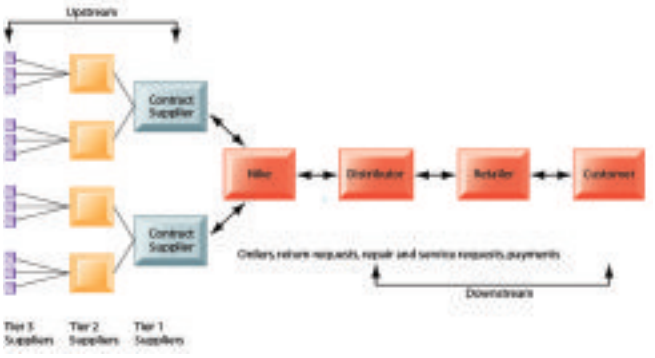


Fig 2. Nike Supply Chain

Benabdellah et al. (2016) state that competition is shifting from the "firm v firm" perspective to a "supply chain v supply chain" perspective. This changing perspective is making many organisations rethink the strategies that they will need to adopt in the future to remain competitive in the global marketplace. Procurement and supply chain are at the centre of how much of this data is processed and applied to the development of a competitive supply chain. There has been a growth in the term digitalisation (University of Melbourne, 2019) which could lead to increased transparency, flexibility,

agility and a customer-centric value-adding supply chains. With this change in mind, the ability to strive for excellence in the supply chain has driven the expansion in the use of structured and unstructured data which, can be classified as, Big Data (Ramen et al., 2018).

McCormack & Kasper (2002) define the extended supply chain as:

"Extending outward beyond company boundaries to your customers and suppliers and connecting with them through the use of digital technologies and integrating practices".

This definition is relevant as the competition amongst organisations shifts from the "firm v firm" perspective to a "supply chain v supply chain" perspective (Benabdellah et al., 2016). According to Hult et al. (2004) to achieve and maintain this competitive edge, the sharing of information within a supply chain is vital due to the long-term benefits that can be delivered such as coordinated processes and enhanced planning.

The differing viewpoints bring into question how an organisation can develop a supply chain network that includes multi-directional links and interdependent activities amongst multiple tiers of the supply chain (Manuj and Shain, 2011). An extended supply chain network requires the collaboration of companies, both downstream and upstream, to cooperate to achieve supply chain collaboration (SCC) between them and deliver value-added products to customers (Saban et al. 2017).

Fawcett et al. (2012) argue that part of the reason why organisations cannot achieve high levels of SCC is that they will be constrained by inter-firm conflict, nonaligned goals and, the non-sharing of sensitive information. These constraints will inhibit the use of collaborative communication technologies such as Management Information Systems as argued by Saban et al. (2017) who also

coined the term 'Technocentric thinking.' They believe that SCC can be achieved by having the right technology in place which aids the development of a competitive and productive supply chain. This position is further supported by the research of Chopra and Meindl (2013) whose posit is that SCC is best achieved when separate autonomous organisations integrate, not only their resources such as people, processes and technology but, also their expertise and sensitive information at the right time to drive business success.

This approach is important as supply chains have increasingly become global in nature and the requirements of organisations to be able to rapidly respond to customer requirements is fundamental to business success. Coupling this with the macro-economic factors that require lean and agile supply chains drives the emerging trends in SCC. The emergence of SCC into a blueprint for the development of a well-integrated sales and operation planning (S&OP) system, supported by synchronised Management Information Systems, has made it possible for organisations to create and maintain strong customer relationships (Rokonuzzaman, 2018).

5. Information Flows

As mentioned previously, SCM is a series of members interconnected not only by the flow of physical items but also by information flows. The flow of physical items is, traditionally, sequential and linear as products flow from supplier to customer while information is simultaneous, especially through the use of electronic exchanges by all the supply chain partners (Bouhaddou and Benablehafid, 2015).

It is the flow of this information upstream through the supply chain and how this is influenced by the downstream organisations using Big Data and AI to develop their supply chain strategy that creates the question for this research. The changes in requirement patterns such a batch sizes, frequency of orders, changes in requirements, delivery locations, economic order sizes and late customer customisations (to name a few) can all affect the ability of SME's to be able to cope with the changing demands of the downstream organisation's requirements which are influenced by the results obtained by the use of Big Data and AI. Fig 3 shows an illustration of a supply chain for the provision of laptops. As the information flows through the supply chain. Changes in the information pattern by the laptop manufacturer which can be influenced by customer requirements, the external environment and the competitive nature of the marketplace



Fig 3. illustration of a supply chain for the provision of laptops

6. Research Originality

Early research has indicated that the use of Big Data and AI is limited in the sectors mentioned earlier of aerospace, rail and automotive. This is due to the fact to how many organisations are still competing on a "firm v firm" basis and that the dynamic complexity of a supply chain network (Fahhama et al., 2017) has restricted the ability of the supply chain to adapt to the "supply chain v supply chain" approach.

The research suggests that although organisations are aware of the existence of AI and Big Data, there are few that are activity investigating the potential use and benefits that could be realised by using adopting the use of these data and knowledge assets.

The emergence of new terms, such as Supply Chain Analytics (SCA), reflects a broad interest in leveraging the business value of supply chain data and harnessing the power of various analytical technologies and methods. Top performing companies are better at utilising their data for business planning, and execution and this has led to the increase in

supply chain integration and visibility. In general, academic research expects the benefits of analytics in supporting supply chain operations (Bongsug et al., 2013).

Thus, after reviewing studies and research papers on supply chain management, we have identified the research gap in supply chain management which requires technological changes along with better implementation to tackle the upcoming and the current issues subsequently.

7. Research Objective

As can be seen from figure 4 below the supply chain had a linear relationship between the suppliers, manufacturers, distributors and the consumers but now with the advent of e-commerce and rising customer demands the supply chain has become complex and hence the managers are finding it difficult to optimise the operations.

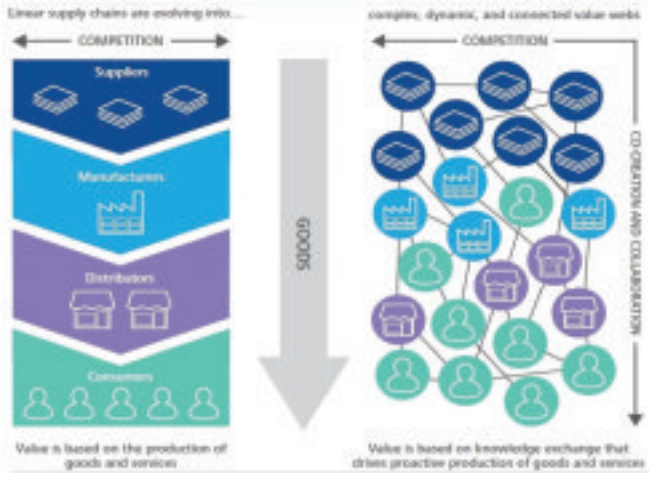


Fig.4. Supply Chain Evolve into value web

So the main objective of the research is to find a way to reduce the complexity of the supply chain by using Big Data Analytics and to identify the data sources that may be considered for decision-making purposes in each of the SCM levers: procurement, marketing, transportation, and warehouse operations.

8. Practical Impact

To achieve and retain customer confidence and trust, organisations that use AI and Big Data need to be able to present the provenance and authenticity of the data and knowledge they use to make decisions.

Making effective use of collective intelligence and crowd-sourced data presents opportunities for organisations from all market sectors to better understand the facts and experiences to use AI to improve decision making, produce new options and ideas, and give better oversight and monitoring of the environment that they operate in.

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Exploring the effect of big data analytics capability on port performance

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Abstract

A central question for the scholars and port managers is whether and how Big Data analytics capability (BDAC) can improve port performance. To address this question, this paper focuses on investigating how to develop BDAC and exploring the impact of BDAC on port performance. Drawing on the literature review of resource-based theory, BDAC and ports, this paper identifies various resources that in combination develop BDAC and build a model to show the relationship between BDAC and port performance. The model details that the impact of BDAC on port performance is mediated by port supply chain integration and port sustainability. This paper makes a contribution to filling the research gap of BDAC and port performance, providing useful insights for port managers to develop BDAC and improve port performance.

Keywords – Big data, Port supply chain, Sustainability, Port performance

1. Introduction

Seaborne trade constitutes almost 90% of world trade in term of volume and about 80% in term of value. Thus, as a significant part of seaborne trade, ports are facing many challenges from the global supply chain and customers. In order to overcome these challenges and improve port performance, ports need to integrate into supply chain to create a stronger supply chain to deliver more value for the customers (Nebot et la., 2017). Meanwhile, ports need to develop sustainability to reduce environmental impact and social conflict to improve competitiveness (Schipper et al., 2017). Enhancing the operation efficiency and speed of decision making is argued to offer ports the opportunity to improve performance. Past research has asserted that Big Data analytics capability (BDAC) has great potential in improving organisational performance (Akter et al., 2016, Wamba et al., 2017). Ports are rich with amounts of data available to be analysed. Thus, ports' managers and authorities need to reach valuable insights to improve port performance from high volume, velocity, variety and value of data by developing BDAC. However, although many advancements were achieved in literature in the last few years, there is a dearth of studies about the BDAC in the port area. This paper develops and proposes a framework in relation to BDAC, port supply chain integration (PSCI), port sustainability and port performance based on the literature review, making contributions to have a deepening understanding of BDAC in port performance.

2. Literature review

2.1. Big Data analytics capability

In recent years, some scholars consider that Big data analytics (BDA) is an important drive of firm's development (Akter et al., 2016; Mikalef et al., 2017). Through analysing the data with Big Data features, managers are able to detect and capitalise on market shifts and make better decisions to improve competitiveness (Wang et al., 2016). The capability closely related to BDA is called BDAC. From the capability perspective, BDAC is defined as the capability to manage and analyse a huge volume of disparate data to enable companies to implement data analysis (Hurwitz et al., 2013). This paper is to explore the impact of BDAC on port area, thus, this paper defines BDAC in context of port supply chain as the ability of port organisations to collected and harness relevant data from the port operation, heterogeneous systems and business activities participants, then managing, processing and analysing these data and visualising them intuitively to offer valuable business insights and support decision-making. Understanding and developing BDAC could help managers of organisations in deploying their Big Data strategies and support to become a data-driven organisation. Mikalef et al. (2017) stated that different theoretical lenses such as resource-based theory (RBT), dynamic theory, agency theory and institutional theory could offer various frameworks to describe and develop BDAC. In this study, RBT theory will be employed to employed to constitute BDAC, since compared with other theories, RBT offering a strong framework to demonstrate the relationship between organisation performance and organisational resources.

Barney (1991) argued that firms could exploit a bundle of valuable, rare, inimitable and non-substitutable resources to achieve profitability in a highly competitive market. After years of research and development, RBT has become one of the most powerful and prominent theories for explaining, describing and predicting competitive advantages and organisational relationship across the business disciplines. Many researchers consider BDAC could be regarded as a significant source of organisation competitiveness (Akter et al., 2016; McAfee and Brynjolfsson, 2012). Mikalef et al. (2017) emphasised that building BDAC needs to integrate different resources rather than merely relying on investments

or technology. Thus, Gupta and George (2016) presented seven resources as the enables of BDAC. The following Fig. 1 shows the resources of BDAC. Tangible resources consist of data, technology and basic resources. Intangible resources include data-driven and organisational learning. Human resources involve managerial skills and technical

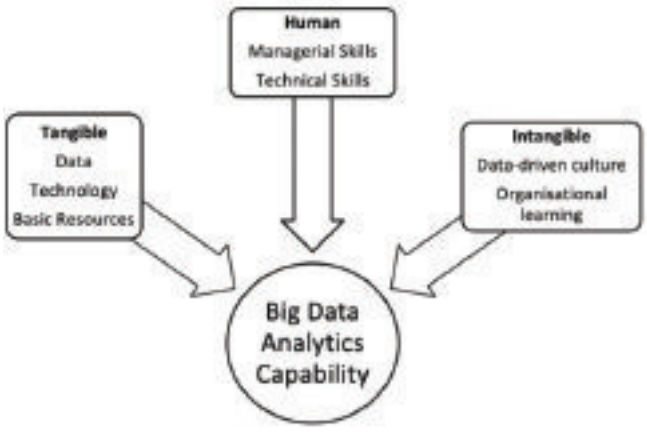


Figure 1: Resources of Big Data analytical capability

2.2. Port supply chain integration

Port supply chain integration starts with the development of the role of ports. The role of ports has improved from the level of providing basic ship-shore operation to a level of an integral part of supply chain (Panayides and Song, 2008). As a significant part of supply chain, ports need to integrate various functions to offer more activities and value-adding services to supply chain participants (Stevens and Vis, 2016). Thus, in this paper, the PSCI is defined as the integrations of various port activities and functions into supply chain. Moreover, Woo et al. (2013) presented five constructs to constitute PSCI including information and communication systems, long-term relationships, value-added logistics services, inter-modal transport services and supply chain integration practices. Port managers could evaluate the degree of supply chain integration of their ports via these five components.

2.3. Port sustainability

Sustainable development has become a primordial focus in the research field. Ports as a significant part of supply chain and economic need to develop their sustainability to face environmental and social challenges (Sislian et al., 2016). One of the major environmental impacts generated by ports is air pollution and greenhouse gas (Burel et al., 2013). Air pollution not only impacts on the environment but also affects human health of people who leave near the port-city area. Moreover, the development of ports causes road congestion and noise which impact local residents who live near the ports (Tobollik et al., 2016). Thus, ports need to develop sustainability to gain support from city residents and managers to improve their competitiveness. The American Association of Port Authorities (AAPA) has developed a framework of port sustainability which involve the dimension of environment, society and economy, implying that ports not only need to contribute to the economy of nations and regions but also need to recognize their responsibilities of the environment and build a harmonious port community (Cheon and Deakin, 2010). However, the management and operation of port involve many stakeholders such as terminal operators, stevedoring companies, truck companies and supply chain participants (Denktas-Sakar and Karatas-Cetin, 2012). The bias between stakeholders will restrict the integrated consideration among economic, social and environmental factors. Hence, developing port sustainability require port managers not only could find an appropriate balance of economic, social and environmental impacts but also could develop collaborations with stakeholders.

2.4 Port performance

As a significant part of supply chain, the port performance should reflect the comprehensive competitiveness of ports rather than the operation of ports (Woo et al., 2013). Improving competitiveness could help port to create more value and offer more efficient services to attract customer, user and stakeholders (Seo et al., 2016). Thus, port performance should reflect the effectiveness aspects of ports concerning customers' perspectives and expectations. Adopting the measurement items developed previous studies (Kim et al., 2016; Yeo et al., 2011; Woo et al., 2013), this paper uses service quality, cost and operational efficiency to measure the port performance. Service quality could measure the extent to which ports are able to offer safe and reliable services. The cost could measure the extent to which ports are able to provide cost-effective service price. Operational efficiency could measure the extent to which ports are able to act quickly when faced customers' requirements.

3. Research problem

In the ports supply chain, ports managers are facing several challenges when developing BDAC and when extracting value and knowledge from the information of port operation to improve port performance. Considering the importance of BDAC to port survival and growth. Hence, this study utilises existing literature to develop a research model in relation to BDAC, PSCI, port sustainability and port performance, in this study, previous literature is reviewed to propose the hypothesised relationship between BDAC and port performance.

4. Research result

4.1 Research model development

Based on the review of existing literature covering both port, supply chain, sustainability and Big Data research a basic conceptual research model was developed. Fig. 2 displays a detailed model of the hypothesized relationships as presented in this Section. The proposed research model presented below illustrates our hypotheses and assumes that the impact of BDAC on port performance is mediated by the PSCI and port sustainability performance. Therefore, a strong BDAC is hypothesized to promote PSCI and port sustainability, enabling competitive advantage for port supply chain which is viewed as a fundamental condition of port performance. The following Sections will discuss in more detail about the model and the hypotheses development.

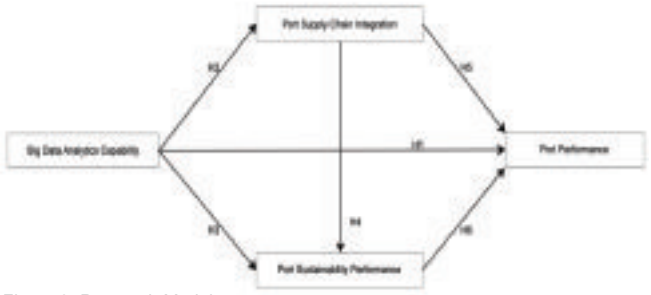


Figure 2: Research Model

4.2 Research hypotheses development

4.2.1 Big Data analytics capability and port performance

There is an increasing discussion about the importance of BDAC in improving the organizations performance (Chen et al., 2015; Akter et al., 2016; Jeble et al., 2018) Chen et al. (2015) stated that BDA is a significant organizational information processing capability and BDAC could improve supply chain value creation. Akter et al. (2016) argued that BDAC had a positive impact on organisational performance and presented a hierarchical model of BDAC which included three dimensions: management, technology and talent capability. Moreover, Kache and Seuring (2017) pointed out that although the application of BDA is still in its infancy stage, BDAC appears to possess huge potential in information usage and decision-making at supply chain level. Furthermore, Jeble et al. (2018) emphasised that organisations could derive valuable business insights and patterns from Big Data and extended previous studies by presenting the positive impact of BDCA on supply chain sustainability. Therefore, BDAC is one of the key organisational capabilities that affect competitive advantage in the Big Data environment. Based on the literature reviewed and general logic, the following hypothesis is proposed:

H1. Big Data analytics capability positively influences port performance.

4.2.2 Big Data analytics capability, port supply chain integration and port sustainability

Previous studies have suggested a positive relationship between BDAC and PSCI. A few researchers have discussed how the information system is improved by using Big Data and indicated that integrating Big Data into information systems could increase information visibility and transparency across the supply chain (Kache and Seuring, 2017). Heilig and Voß (2016) stated that Big Data is used by information systems of ports to improve decision analytics. Wang et al. (2016) indicated that advancing IT capability to develop port community systems could improve the coordination of port operators and affect the performance of port supply chain. Neagoe et al. (2017) focused on the relationship between multiple transports and terminal operators and argued that deploying information systems could help ports to integrate into the supply chain. Moreover, many intermodal transportation service providers apply Big Data to improve operational efficiency and build integrated information exchange platforms which could share information and increase relationship with partners (Harris et al., 2015). Sanders (2016) suggested that the implementation of BDA could improve the integration and collaboration of supply chain.

The need for sustainable development has been articulated widely. Achieving the sustainable development of ports requires an appropriate balance between economic, social and environmental impacts. Authorities and relevant organisations have recently turned their attention towards BDAC to improve port sustainability. Ferretti and Schiavone (2016) showed that the Port of Hamburg tries to build an intelligent port by utilising Big Data to improve both the economic and ecological performance. Moreover, some port authorities monitor the pollutant emission and gather relevant data, then using BDA to analyse these data to improve environmental performance (Shahrokni et al., 2015). Furthermore, Jeble et al. (2018) focused on the perspective of firms and stated that Big Data and predictive analytics capability could improve the sustainable performance of the supply chain. Besides, innovation can provide a solution to the main environmental issues (Acciaro et al., 2014). Burškytė et al. (2016) indicated that port could improve environmental performance and remedy conflicts among ports and local communities by implementing eco-innovations. Big Data as a significant driver of innovation could assist ports in eco-innovation. Therefore, based on the literature reviewed and general logic, the following hypotheses are proposed:

H2. Big Data analytics capability positively influences port supply chain integration.

H3. Big Data analytics capability positively influences port sustainability performance.

4.2.3 Port supply chain integration, port sustainability and port performance

Port sustainability performance not only is influenced by the application of Big Data but also is influenced by integrating ports into the supply chain. Hazen et al. (2016) indicated that when organization integrated into the supply chain, they will share information, values, goals and experiences with members of the supply chain to improve overall performance. When ports could work together with members of the supply chain and understand other points of view, they could make an effort to achieve the collective sustainable goal (Lu et al., 2016). Furthermore, achieving port sustainability requires coordination between port authorities and other stakeholders such as local communities and supply chain participants rather than a narrow focus on themselves (Cheon and Deakin, 2010). Denktas-Sakar and Karatas-Cetin (2012) argued that building a good relationship with supply chain stakeholders is one of the most significant prerequisites for the port sustainability. Ports integration into the supply chain could increase collaboration between ports and supply chain participant (Stevens and Vis, 2016).

Ports which have high competitiveness could offer more efficient services to attract customers and gain more market shares from competitors. Thus, port competitiveness is a significant dimension of port performance. Stevens and Vis (2016) indicated that the relationship between PSCI and port competitiveness has significant improvements. Moreover, some researchers have shown that another relevant dimension affecting port competitiveness relates to the port sustainability performance (Yang et al., 2013; Beleya et al., 2015). Cheon and Deakin (2010) also stated that port authorities try to improve port performance and competitiveness by increasing sustainability. Therefore, based on the literature reviewed and general logic, the following hypotheses are proposed:

H4. Port supply chain integration positively influences port sustainability performance.

H5. Port supply chain integration positively influences port performance.

H6. Port sustainability performance positively influences port performance.

5. Conclusion

In recent years, Big Data is not a single technology, technique rather it is a trend across many areas of business. BDAC show great potential in improving organisational performance. Many managers develop BDAC to improve the competitiveness of companies. In a port supply chain, there is no doubt that study on BDAC is still in the initial stage of development. Hence, developing a ports BDAC was the main purpose of this paper. The developed model aims to identify resources of development BDAC and investigate the impact of BDAC on port performance, port sustainability and port supply chain integration. This model could help port managers to understand how to develop BDAC and the relationship between BDAC and port performance. Moreover, the finding proposes some hypotheses. In further research, the hypotheses will be tested by structural equation modelling to further help port managers to improve BDAC and port performance.



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Circular economy

Sufficient economy practices for green supply chain management: Sila village, Khon Kaen, Thailand

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Abstract

Purpose – For several decades, Thailand has used chemical substances for growing crops and vegetables and overused non-local products. Therefore, unsustainable lifestyles and high environmental impacts from, e.g., long delivery routes are common (Elhedhli and Merrick, 2012). This trend contrasts with the National Theory - Sufficiency Economy Philosophy (SEP), which focuses on organic agriculture and self-sufficiency (Malikhao, 2018). The principal aim of this research project was to design a production plan and generate organic products to promote green supply chain management (GSCM) and sustainability.

Research approach – The Sila Sub-District, Khon Kaen was used as a case study in this research (Yin, 2009). Community resources were examined in order to create organic products in alignment with the outcomes of a marketing survey. The developed products were tested for their 'safety,' 'quality,' 'taste' and 'market' (Berdegué et al., 2005). The research tools employed included interviews, documentation reviews, in situ observations, a survey questionnaire, and experimentation.

Findings and originality – Two products were newly created, i.e., crispy crickets and cricket-pumpkin crisps, while another was developed further from a previous product, which was vegetable seasoning. Sila Village is the key cricket producer in Thailand and mostly sells this product as a cheap raw material. To increase the value added, the crickets were fried to produce several tastes and mixed with locally-grown pumpkin to produce chips. Some herbal ingredients that can cause abortion were removed from the seasoning. Most of the herbs used in the new vegetable seasoning are now locally-grown or purchased from neighbors. Therefore, the local economy and social relationships were improved and a green supply chain became evident, one that followed Thailand's Sufficiency Economy Philosophy (SEP) concept.

Research impact – Even though, the SEP network is growing constantly, innovation/creative thinking and research have rarely been integrated for generating new products. This issue was addressed by this study, which also combined GSCM with SEP.

Practical impact – Communities should focus on the effective use of local resources to produce new products to market and contribute to sustainable sufficiency. Doing so allows Thailand to build a strong community and a healthy economy in the long run. This study presents the guidance and support necessary for such a transformation.

Keywords – Sufficiency Economy Philosophy (SEP), Green Supply Chain Management (GSCM), Closed-Loop Supply Chain (CLSP), Local community, Practice

Introduction to Closed-Loop Green Supply Chain

The paradigm shift from firm-level to supply-chain-level competition made it necessary for supply chains (SCs) to act as quasi meta-organizations coordinating the flow of information, materials and financial flows from raw-material extraction to the final customer (Gold, Seuring and Beske, 2010). Regardless of whether SCs operate regionally or globally, they encompass multiple tiers, including vendors, manufacturers, distributors and retailers. In addition industries are usually involved in multiple SCs simultaneously. Thus, complex networks engaged in a variety of activities are involved in delivering a finished product to the end-user or customer (Hervani, Helms and Sarkis, 2005). Firms add value to an article through processes such as production, marketing and after-sale services (Porter and Millar, 1985). Consequently, the management of its value chain can be a central aspect of a company's competitive advantage (Preuss, 2005).

Bloemhof-Ruward et al. (1995) have argued that waste and emissions caused by SCs have become the main sources of serious environmental problems (Fleischmann et al., 1997). The introduction of Our Common Future in 1992 changed the environmental requirements and enabled developing and addressing environmental management (EM) strategies across all tiers of SCs, ushering in green supply chain management (GSCM) (Schmidt, Foerstl and Schaltenbrand, 2017). GSCM aims to lower environmental damage from operations and to meet sustainable goals (Beamon, 1999; Van Hoek, 1999). This emergent field has been growing over the past three decades (Fahimnia, Sarkis and Davarzani, 2015). Empirical evaluations of the greening of the different phases of the SC have revealed that doing so leads to an integrated green supply chain (Rao and Holt, 2005).

Firms must respond promptly to competitive conditions and regulatory pressures, thus improving their industrial and environmental performances simultaneously (Porter and Van

der Linde, 1995). However, various industries do not believe in environmental benefits (Mathiyazhagan et al., 2013). Top management in these industries resists change since it could lead to monetary losses as well as a lack of funding for environmental projects. Accordingly, they have been slow to accept GSCM and progress. Regulations, customers, competitors, society and suppliers are common external drivers, and the main internal barriers include cost and lack of legitimacy (Walker, Di Sisto and McBain, 2008). Govindan et al.'s (2014) survey-questionnaire research indicated that the expense involved in technological change is the first priority for firms followed by selecting green suppliers. Small and medium-sized enterprises (SMEs) are usually slow to respond to the challenge of improving environmental performance, as they lack technical resources (Massoud et al., 2010; Zhu and Geng, 2013). Smaller firms have difficulty in getting their suppliers involved in green initiatives (Wooi and Zailani, 2010). Various studies have confirmed the positive economic performances resulting from greening SCs, which come about not only from substantial cost savings, but also enhanced sales, market shares, and being able to exploit new market opportunities (Wooi and Zailani, 2010; Malviya and Kant, 2015; Schmidt, Foerstl and Schaltenbrand, 2017). The implementation of green supply chain management (GSCM) works through the Rs (Reduce, Re-use, Rework, Refurbish, Reclaim, Recycle, Remanufacture, Reverse logistics, and so forth) (Srivastava, 2007). Motivated by an environmentally-conscious mindset, it closes the loop of a typical forward SC (Hervani, Helms and Sarkis, 2005). A closed-loop SC (CLSC) refers to taking responsibility for end-of-life (EOL) products, and some researchers believe that this concept falls into the reverse logistics (RL) paradigm (Govindan and Soleimani, 2017). CLSC, according to Daniel et al. (2009), is: "the design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time." Practices involved in CLSC include remanufacturing used products into new ones (recovering product environments) and the designing of these products and material (Savaskan, Bhattacharya and Van Wassenhove, 2004; Zhu, Sarkis and Lai, 2008). Minimizing the use of resources, generating smaller volumes of pollution, and the on-going developments/ modifications of operations and products are measures and metrics used in green initiatives (Hervani, Helms and Sarkis, 2005).

Identification of Research Opportunities

This section reviews articles in order to identify themes and patterns of research for the purpose of making future contributions to the field. An online database was searched with the terms "green supply chain" and "sustainable supply chain" to find articles in international journals such as the International Journal of Management Review and the Journal of Cleaner Production. The outcomes of reviewing extant literature are provided below.

More than a thousand of papers discussed GSCM in different ways and via different angles, i.e., through literature reviews (Fahimnia, Sarkis and Davarzani, 2015; Touboulic and Walker, 2015; Rajeev et al., 2017); development of measurements (Hervani, Helms and Sarkis, 2005; Shaw, Grant and Mangan, 2010; Bai et al., 2012); network design (Ramudhin et al., 2008; Elhedhli and Merrick, 2012); life cycle assessment (Kainuma and Tawara, 2006; Chung and Wee, 2011); practice implementations in large firms/industries (Zhu and Cote, 2004; Zhu et al., 2010; Hu and Hsu, 2010); strategy development (Yol Lee and Rhee, 2007); drivers, barriers and pressure (Zhu, Sarkis and Geng, 2005; Hu and Hsu, 2010; Diabat and Govindan, 2011); benefits/paradoxes of addressing GSCM (Rao, 2002; Rao and Holt, 2005; Bowen, 2002); theory building (Touboulic and Walker, 2015); and SMEs (Cote et al., 2008; Wooi and Zailani, 2010). Key industries studied include the electrical and electronics, chip manufacturing, power generation, chemical/petroleum, paper, and automobile industries. Further, these industries were studied primarily in the UK, China, India, Taiwan, the Philippines, Portugal and Japan.

The results of this literature review align with the perspectives of Touboulic and Walker (2015), Sachan and Datta (2005) and Rajeev et al. (2017). Touboulic and Walker (2015) claimed that the vast majority of papers published prior to 2015 could be categorized as empirical research (79%) since the key methods that these papers employed were surveys and case studies. Others reviews noticed that survey research has been moving away from exploratory work and towards model building and testing (Sachan and Datta, 2005). GSCM should consider testing and extending other potentially relevant theories from various disciplines, as well as build a more holistic and multilevel understanding of GSCM on the micro level of humans and society (Touboulic and Walker, 2015). However, the consensus is that the methods used to overcome adoption barriers are still insufficient, particularly given the low level of awareness concerning environmental issues and protection as well as implementation strategies for small-sized firms, local communities, the public sector and emerging economies. Furthermore, very few studies have extended other relevant theories when observing specific areas or measured the outcomes of implementing the recommended solutions. For that reason, this case study research contributes to a more detailed understanding of how GSCM is addressed in a local community of a developing nation when creating valued products.

Sufficiency Economy Philosophy – The Key Concept of Thailand

For several decades, Thailand has used chemical substances for growing crops and vegetables and overused non-local products (Chaipattana, 2012). Consequently, unsustainable lifestyles and high environmental impacts from, e.g., long delivery routes are common (Elhedhli and Merrick, 2012). This trend contrasts with the National Theory - Sufficiency Economy Philosophy (SEP) developed by the previous King of Thailand, which centers on organic agriculture and self-sufficiency (Malikhao, 2018). Within the ethos of pursuing and embedding sustainability, the Thai government advocates compliance with the country's Sufficiency Economy Philosophy (SEP).

"At the heart of the 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." (Ministry of Foreign Affairs Thailand, 2016, p. 40):

The SEP concept has been applied across Thailand since 1997 (NESDB, 2017). The practices it champions include living sufficiently, exchanging local products within communities, lifelong learning, consuming local foods, green areas, increasing the use of renewable energy and so forth (Pruetipibultham, 2010; Walker, 2010). This study is based on the King's own words:

"A self-sufficient economy doesn't mean that each family must produce its own food, weave and sew its own clothes. This is going too far, but I mean that each village or district must have relative self-sufficiency. Things that are produced in surplus can be sold, but should be sold in the same region, not too far so that the transportation cost is minimized" (as cited in Walker, 2010, p. 243).

Methodology

GSCM literature asserts that several areas have received little or scant attention, such as local communities and adoption strategies. Relevant disciplines should be integrated for a better understanding of GSCM in specific study areas (Touboulic and Walker, 2015, pp. 28-29). The Sila Sub-District, Khon Kaen, the Northeast region of Thailand was the case study used in this research (Yin, 2009). Sila was selected due to its strong community and willingness to participate in the research. The villagers needed to enhance the quality of their products and revenues in the long term. Therefore, fieldwork was carried out from January to June 2017.

The principal aim of this research project was to design a production plan and generate an organic product to promote green supply chain management (GSCM) and sustainability. The CLSC begins with product design and continues through to waste management (Zhu, Sarkis and Lai, 2008; Daniel, Guide and Van Wassenhove, 2009), while a sufficiency economy focuses on using local resources wisely to minimize environmental impacts (Pruetipibultham, 2010; Walker, 2010). Consequently, the local raw materials were investigated and some were selected to create a product that meets market demands. Production was designed to use clean energy, reduce transportation and better manage waste. Three developed products were tested for 'safety,' 'quality,' 'taste' and 'market' (Berdegué et al., 2005). In a complex system such as an SC, Bisson et al. (1993) recommends using various tools for a better understanding of the phenomenon. As a result, the research tools employed included interviews, documentation reviews, in situ observations, a survey questionnaire, and experimentation.

Findings

Fieldwork research was completed, and the empirical outcomes are presented as follows. The first product, vegetable seasoning, was of improved quality compared to the previous one, and another two products were newly created to increase the value of the raw materials, following Porter and Millar (1985). These two products were crispy crickets and cricket-pumpkin crisps.

The seasoning contained sixteen herbal ingredients with three major tastes: sweet, sour and greasy. This product is very convenient for users because it can replace using various fresh herbs and spices used in Thai local cuisine. Before the development/adjustment took place, their beneficial medicinal properties and side effects were assessed by a Thai herbal expert (Faculty of Pharmacy, Khon Kaen University). Ethical and business concerns resulted in the removal of three of the sixteen herbal ingredients which could cause abortions. The three ingredients included Plu Kaow, Nead and Chinese violet, and all four were replaced by similar-tasting herbs. Most ingredients are produced organically and locally, and some were provided free of charge. Three high-priced herbs had to be purchased: garlic chives, parsley, and spinach. However, the participants started growing them based on our recommendations. The planting schedule was designed based on a year of demand and the seasons. This strategy enhanced the incorporation of organic materials in the seasonings and cost savings (15-50%). The mixing of herbs was dried in a 'Solar Drying Plant,' which uses clean energy. In terms of the new products, the crickets were fried to produce several tastes. One was the herbal seasoning taste. The crickets were also mixed with locally-grown pumpkin to produce chips. After conducting a survey-questionnaire and interviewing 200 people, the developed products were test-marketed for two weeks during May 2017. The empirical outcomes involved total sales of 3,120 Baht (78GBP), which were broken down as follows: vegetable seasoning (12 boxes or 12*60= 720 Baht), fried cricket (17 boxes or 17*20 = 340 Baht) and chips (103 packs or 103*20 = 2,060 Baht). Waste from the production as well as local manure were used to produce organic fertilizer for planting. The economic improvements and increase in the exchange of locally-grown products were apparent.

Discussion and Conclusions

This case study research was based principally upon GSCM and SEP concepts since the Sila community wished to use its local resources more efficiently to create valued products (Walker, 2010; Kumar and Kumar, 2013; Drechsler, 2016). They also required to make the lowest environmental impact possible. In consequence, three products were launched, i.e., crispy crickets, cricket-pumpkin crisps and an improved-quality vegetable seasoning. The lesson learned from this study was that the successful SEP-GSCM implementation in a Thailand community necessitates integrated knowledge from various fields such as management, pharmacy and agriculture, in agreement with Touboulic and Walker (2015). Success in this project also hinged on the support the community, researchers and government authorities. On-going developments/modifications of operations and products are key to green initiatives (Hervani, Helms and Sarkis, 2005). Further, ethical considerations should not be ignored when designing products delivering value to society. By taking the above into consideration, a strong community and a healthy economy and environment can be expected in the long term.

Limitations

This study involved a small community as well as a limited time period for market testing. These constraints could possibly have affected the reliability and validity of the research. However, further observations undertaken from January to May 2018 found that the idea has been adopted by another cricket farm in the same area. This farm aims to produce the protein powder from crickets to meet the high demand with a high price. The farm is facing limited knowledge and technology in production. This is because they were prohibited by patent rights for using invention which owned by the Agricultural Faculty, Khon Kaen University.

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1 GBP = 40 Baht

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Diffusion of circular economic practices in the UK wheat food supply chain

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Introduction

The sustainability of food supply chains is a concern for consumers, governments, academy and business alike. Among the many different approaches to the topic of sustainability, Circular Economy (CE) has gained prominence in the last few years (Ghisellini, Cialani and Ulgiati, 2016; Murray, Skene and Haynes, 2017), with both a theoretical and a practical framework for research and practice. Circular Economy is the economic system that by intention and design, goes from the make-use- dispose model to a restorative and regenerative triple bottom line (TBL). It maximises utility and value of products, components and materials, and has open and closed loops in their flow through the supply chains, also encompassing operational practices, business models and governmental policies Different authors have addressed the diffusion – adoption by different actors - of CE practices (Govindan and Hasanagic, 2018) by companies, industries and supply chains. Supply chains that adopt CE precepts are known as circular supply chains. One of the elements of influence in the adoption process is the relationship between clients and suppliers in circular supply chains, and by understanding it better, the diffusion of these sustainable operations will be facilitated.

Various theoretical frameworks address relationships between actors in supply chains, such as network theory, resource dependence theory and transaction cost economics (TCE) (Meixell and Luoma, 2015). This is also true in the agri-food industry, where different products have different types of supply chains varying, for instance, in the number of actors between farmers (where food is produced) and retail (where consumers purchase food) (Célio et al., 2018; Vasconcelos, Viana and Batista, 2018; Vlajic, Mijailovic and Bogdanova, 2018). The wheat food supply chain is an example of a long supply chain, with many possible forms of relationships between the different organisations (e.g. farmers, coops, traders, mills, bakeries, supermarket). The present research focuses on the relationship between buyers and suppliers throughout the supply chain and uses TCE (also known as transaction cost theory) as part of its framework (further developed in the next section).

The paper presents the preliminary findings of an ongoing PhD research using transaction cost economics (TCE) to clarify the role of transactions in the diffusion of CE practices in the wheat food supply chain in the UK. It is A multiple case study approach considering two different British supply chains was chosen, given the need to adapt the existing theories (CE + TCE) to the setting (wheat food circular supply chain), since no previous research with these characteristics was identified.

The next section expands upon the theory used in the research as well as in the framework used for the analysis, followed by the methodology, results, analysis and final considerations.

Literature Review

Sustainability - environmental, social and economic - of the wheat agri-food supply chain in the UK is a significant issue given the importance of wheat in the food security of the country since the UK is a major consumer of wheat (nabim, 2018). CE is one of the leading theoretical frameworks to study and implement sustainable practices and is the main theory used in this research. A considerable number of works have looked into the adoption of CE practices but fewer researches so far focused on agri- food supply chain (Balboa and Domingues Somoente, 2014; Ghisellini, Cialani and Ulgiati, 2016; Jesus and Mendonça, 2017; De Angelis, Howard and Miemczyk, 2018; Govindan and Hasanagic, 2018; Masi et al., 2018). The agri-food setting has particularities that should be investigated to improve CE as a viable pro-sustainability option for organisations and supply chains.

Despite the relevance of sustainability in the British wheat food supply chains in the UK (this research's field of application) and the relevance of CE as a triple bottom line (TBL) school of thought, no research was identified that links this type of food chain and CE practices (and diffusion) in both countries. There is, therefore, a lack of benchmarking references for similar practices between both countries, as well as consideration of contextual factors determining different or CE practices in each country.

The diffusion of CE practices in a supply chain involves a series of organisations adopting new practices and operations CE-related. Adopting new operations and practices is a process that involves drivers, barriers and enablers (to reduce the barriers problems) (Dossa, Batista and Gough, 2018). These are some of the operational concepts used in this current paper. Many works have investigated drivers and barriers, and the present research used the work of Govindan and Hasanagic (2018) as the bases for the identification of the drivers involved in the diffusion of CE practices in the wheat supply chain. These drivers are clustered in five categories: policy and economy, health, environmental protection, society and product development. In the same sense, barriers to adopting a new practice are also relevant. The work of Kirchherr et al. (2018) regarding barriers is used in this paper as the guiding work relating to obstacles and bottlenecks

of CE adoption by the wheat supply chain. It groups these difficulties in four clusters: cultural, regulatory, market and technological. For enablers, Mishra et al. (2018) is the guiding work, and consider examples such as partnerships and collaboration across the value chain, digital tools, existing systems of support, among others.

The interaction of clients-suppliers in this can also influence the diffusion process. One of the more prominent theoretical frameworks to evaluate interactions in this dyads is TCE (Davies and Lam, 2001; Kolmar, 2017). TCE is the supporting theory in this present work. While some research has been conducted to join TCE and CE, no research was identified that unites both CE practices adoption and TCE. There are three benefits to this approach: it brings Economic Science closer to CE research; second, TCE has structured models of analysis to understand actor's behaviour relating to transactions and decision-making regarding suppliers or buyers; and third, it is an innovation in the research related to CE, CE practices adoption and circular supply chains.

TCE is not used in this research in its entirety (Williamson, 1998, 2008). Given the exploratory nature of this research, it was deemed necessary to first understand the characteristics and possible roles of transactions in the diffusion process, before identifying using other elements of TCE. This means that four elements are used as the final operational concepts for the research: the three main characteristics of transactions – asset specificity, risk/uncertainty and frequency (Wever et al., 2012; Klein, 2013) and types of contracts.

To summarise, given the importance of wheat food supply chains, it is relevant to improve on the sustainability of said supply chain. CE is a prominent pro-sustainability school of thought, but further research on CE adoption in complex agri-food supply chains is still needed. This is particularly true for the role that the transactions between organisations in the supply chain (namely suppliers and buyers) have in influencing the diffusion of these practices. Therefore, to investigate these aspects can improve on the sustainability of wheat food supply chain; thus, the present research investigates how transactions between organisations in wheat food supply chains influence the adoption of CE practices.

Methodology

The two major theoretical frameworks used in the research (CE + TCE) although employed in previous research in conjunction (Maaß and Grundmann, 2018), have not been investigated within this particular setting (wheat food supply chains). Considering that the theory still needs to be adapted to the context, a qualitative research (Cooper and Schindler, 2014; Neuman, 2014) approach was chosen to that end, since it is better suited for theory development and adaptation (Bryman and Bell, 2015).

Among the many different types of qualitative research, a multiple case approach (Bryman and Bell, 2015) was selected. Case studies research allows in-depth exploration of a subject, and by adopting a multiple case methodology, the theoretical generalisation and trustworthiness of the research (at its end) were made more robust (Lincoln and Guba, 1985; Welch and Piekkari, 2017), since it better represents the possible variations of the supply chain actors of the wheat industry. The research used a semi-structured interview approach (Braun and Clarke, 2013), that although having the same framework of questions, allowed adaptations on the spot if the interview required. Such decision, aligned with the interpretivist paradigm of the research, was necessary considering that different participants gave different perspectives of the phenomenon, often not previously identified by the existing theories

Participant selection followed a two steps strategy: first, two British mills were contacted and asked to participate, which they agreed. Each one represents a different wheat food supply chain: one longer, with more organisations part of it, and the other more vertical, with fewer links between farm and retail. This method of case selection follows an accessibility criterion, which is essential in case studies (Stake, 1995; Bryman and Bell, 2015). The second step was a snowball method, where the participant recommended organisations in the supply chain that could contribute to the research, both upstream and downstream. These secondary participants were approached and asked through various forms, such as wheat industry events, LinkedIn and email, then agreeing to participate in the research.

Eight interviews were conducted so far in the research: Supply Chain A (Farm A, Grain Cooperative, Mill A), Supply Chain B (Farm B and mill B), Supporting organisations (farmer assurance organisation, extensionist agent and mills association).

The main method for primary data collection was semi-structured interviews (Braun and Clarke, 2013). Considering the exploratory characteristic (Cooper and Schindler, 2014) of the research, semi- structured interviews allowed on the spot adaptations if the interview required it, thus gaining valuable insights not previously expected based on the interview script, constructed using literature as cited in the previous section. The interviews took place between February and May – 2019 and were audio recorded, except for one that the participant was not comfortable with having it recorded. Secondary data include website information, reports and other materials from the sector and interviewed companies.

Results/analysis

Supply Chain A: arguably a traditional regional wheat food supply chain design in terms of organisations and roles executed (Smith and Barling, 2014). The organisations interviewed have some variations of CE practices, but all have the following CE-related operations: reduction of waste and inputs, redesign of processes, reclassification, repurpose, certification that include environmental concerns, recycling efforts (e.g. packages, plastic containers, papers, etc.), among others. They report that the most significant driver to implement these operations are linked to cost reduction and financial gains. All the organisations are looking into renewable energy use or have implemented it.

Long term contracts tend not to be as prevalent as long term non-formal relationships. This is both connected to the organisations interviewed, as well as supporting organisations such as traders (grain

merchants), neighbouring farms and suppliers. Some examples of practices that are not commonly discussed in the CE-literature regarding food supply chains include: crop

rotation and soil management - two elements that reduce waste (of water, agrochemicals, operations and biomatter), pests (weed, insects, diseases) and risk; storage practices to reduce waste; filters to reduce air particles for the flour that is reused in the production system.

Grain can be stored in the farm or in the grain cooperative for a fee (dependent on the amount stored) and is a sod to the mill normally through a trader (grain merchant). These transactions have few contractual demands: wheat quality, price, date and location of delivery, quantity and assurance scheme requirements. The forms of wheat commercialisation can vary from the spot market, hedged future contracts or pool of farmers. If by any reason the wheat does not meet quality requirements, it will be classified as lower grade and can be moved to animal feed instead of remaining in the food (milling supply chain).

Supply Chain B: arguably a shorter supply chain, considering that the mill has verticalized its operations in three forms: it purchases directly from farmers in the region at least 20% of its wheat grain and wants to increase this amount as much as it can; it has an industrial bakery division that industrialises the flour for supermarket's in-store bakeries and their brands; it has a feed meal industry that absorbs the low-quality wheat (not used in their bakery or by their flour clients), wheat bran and other waste.

The CE practices identified in both organisations of Supply Chain B include reduction of waste and inputs, redesign of products and processes, reclassification, repurpose, education and training of staff and managers for sustainability practices, certification that has environmental requirements. Farm B pointed to soil protection and fertility as the bases for a sustainable farm. A circular process executed in the farm include the use of waste from a neighbour tree pruning business, waste from a turf company belonging to a family member plus cow muck, turned into compost for increasing soil biological matter and fertility. It is also starting to use no-tillage agriculture (a form of straw-reuse for soil protection).

Transactions in Supply Chain B are also based on long-term non-formal relationships. One example of this is the composting done by the farmer, without any contract, but based on personal relationships. The farmer also expressed the desire to formalise an agreement with two or three neighbouring farms for sharing machinery (cooperation), instead of each one of them having the complete set of tractors, combine harvesters, etc. The mill verticalization was connected to risk-reduction since the participant identifies it as a highly risk-averse company, not to reducing transaction costs. On the contrary, the mill has increased its transaction costs by its directive of direct-purchase of wheat from farmers (reducing purchase from grain merchants).

Supporting organisations: according to the organisations that support the links in the supply chain, legislation plays a major role in driving the adoption of sustainability practices. At the same time, safety requirements (e.g. soil contamination), are also monitored by the government and other entities so not to jeopardise food safety downstream in the supply chain. This means that the government can play a role as both driver and barrier of CE practices adoption. Following legislation and assurance requirements are not cited as problematic since the participants consider this just part of doing business.

There are major differences regarding the potential to use renewable energy sources in the wheat food supply chain. Sources already used vary from water-powered mills to wind, solar and other forms of on-site energy production. This is because energy consumption is a major part of milling costs in the UK. Commercialisation efforts by the organisations are connected to a constant supply of wheat for the mills, that also need to output flour throughout the entire year to supply their customers (especially the bread-making industry). The location also plays a major role in both the selling of wheat (to the nearest mill) and flour and reduction of transportation costs. This affects farmers, storage cooperatives and mills. For example, lorries that transport flour cannot transport anything else, thus they return empty to the mills, and the cost to transport grain to a site, not near the farm can make wheat growing not viable (financially).

Some CE practices identified in the literature, such as redesign (of products, services or processes) for CE, redistribution for different markets and maintaining prices of new pro-sustainability products, were not immediately understood by the farmers interviewed. Risk/uncertainty plays a vital role in the way that wheat is commercialised in all the links of the supply chain, according to the interviewed organisations. From weather issues to international commodity prices, and industry requirements for safety and homogeneity for products and processes, these elements are connected to the transactions chosen by the organisations interviewed. Examples cited include marketing strategies by the farmers, the use of assurance organisations and wheat quality concerns. Market pressure from end-consumers for the adoption of CE practices is not directly being felt by the supply chain actors interviewed so far.

Discussion

The preliminary results of this research suggest that the participants interviewed so far consider financial costs and gains as the main driver to adopt CE practices. The literature regarding the adoption of CE practices (The Ellen MacArthur Foundation, 2013; Govindan and Hasanagic, 2018) has the pro- economic/financial dimension as one of the main drivers for its implementation in supply chains. However, other important points made in CE-related theory need to be addressed carefully. For instance, soil as a resource that needs to be protected for a sustainable farming system was highlighted by the farmers and the extension agency. This shows that soil, in its various dimensions (structure, fertility, organic matter, etc.), has a fundamental role in CE-related to agri-food systems and should be more prominently discussed in CE theory. Crop rotation was a tool for reducing operations, and agrichemical usage can also be included in the CE practices relating to food systems.

The amount of transformation required for the wheat grain, as a commodity, to become something perceived by the end-consumer as food (e.g. bread, pasta, biscuit and cakes) reduces the pressure felt by the upstream supply chain actors. However, this does not mean that CE practices are not required by clients in any form; only that consumer pressure can act as drivers different depending on the supply chain. Most research in circular food supply chains are build based on short-supply chains (one intermediary at the most, between farm and market), with little processing in it (e.g.

fresh fruits, meat, coffee, etc.) (Gallaud and Laperche, 2016; Weetman, 2017; Vlajic, Mijailovic and Bogdanova, 2018). The present research, on the other hand, is being developed in a long supply chain, and this can influence how the end-consumer market acts as a driver for CE adoption affects the supply chain.

The assurance organisations play an essential role both in the transactions for wheat flour purchase, and for the adoption of practices linked to CE. This points to an indirect connection between transactions and CE adoption for wheat and flour purchase since CE practices are not directly required in the purchase contracts, but the contracts require the assurance, and the assurance requires these practices. It needs to be pointed out, however, that these operations (e.g. traceability, contamination prevention, etc.) are not explicitly acknowledged as CE, but since these practices reduce waste and are connected to sustainability (social, economic and environmental), it can be argued that there is a direct connection between CE and food assurance schemes.

Among the different dimensions of transactions investigated in this research, risk/uncertainty was the most cited dimension of the transactions in both supply chains. Third-party assurance schemes play a role in this risk mitigation. Both as grain and as flour, wheat did not require investments in specific assets for selling to clients. However, the current program aimed at eliminating liquid nitrogen to increase protein in the grain in exchange for a premium on the grain price can be connected to CE, since flour made with this input, will require more inputs to correct the problem, and can lead to increased waste. It also reduces the need for other machinery operations.

Formal transactions were also found to be enablers of CE practices in the study. Three examples were: leasing lorries instead of purchasing a fleet; plans for sharing machinery between farmers requiring a contract; and the existence of a storage cooperative, reducing the need for silo ownership and increasing grain storage efficiency. On the other hand, two elements were also identified as barriers to CE: the lorries used to transport the flour cannot be used in anything else (food safety), and standards requirements for the wheat can increases the chance of waste (Célio et al., 2018)

Final Considerations

The research objective was to clarify the role of transactions between organisations in the adoption of CE practices in the wheat food supply chains. Preliminary results discussed here suggest that the role is varies depending on the actors of the supply chain and the type of practice. It can play an indirect role as a driver to adoption via requirements for certification for farmers, a direct role as a barrier given quality standards for mills, enablers as contracts for cooperation and assets sharing, and can also have no role at all, by not clarifying CE-requirements in purchases of commodities. Other links in the supply chain, further downstream, can have a different perspective, such as a direct requirement for CE-related practices in contracts (both for purchase or overall commitment).

This work attempted to link the static nature of TCE and the dynamic characteristics of CE diffusion. To that end, the identification of characteristics of the transactions, and the role that they can have in the decision to use CE-related operations was paramount. With that information, future researches can better identify transaction costs and have a clearer picture of overall costs to implement CE, since it complements operational and investment costs. It also allows the identification of best contractual types in circular agri-food supply chains, given the potential to have different forms of contracts in different stages of the supply chain for circularity.

The fact that some of the organisations interviewed did not recognise some of the practices linked to CE in the literature (Kirchherr, Reike and Hekkert, 2017; Weetman, 2017; Jesus and Mendonça, 2018), suggests that there is still need to develop CE theory for the food context further. Some the possible ways to do that include better nomenclature that is more adapted to farming (e.g. avoid ‘R’ terminologies), quantitative research adapted to different farming contexts to identify variations based on industry, increase researches with agronomists included in the food supply chain discussion. It is also needed to be recognised that several practices in farming can already be classified as connected to CE (e.g. no-tillage production, reduction of waste, etc.), without the need to complete new agriculture as some authors have suggested (Jun and Xiang, 2011; Borrello et al., 2016)

By understanding the possible variations of the role of transactions, transaction costs can be reduced, and avoid the potential of transactions to act as barriers in the diffusion of CE. The present research can help institutions determined to promote CE (via products, services or operations) since it clarifies details to help on the identification of costs to implement CE, considering not only investment and operational costs but future transaction costs (e.g. negotiation, opportunity costs, partner search). While case studies are very useful in exploratory research such as this, and to clarify details in particular settings, there is a limit to its capacity for generalisation. Therefore, future research should use quantitative methods to verify how the findings of this study are applicable to other transactions and dyads (buyers-suppliers).

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Circular economy initiatives in the textile industry – A current assessment of Scandinavian outdoor clothing manufacturers and an analysis towards systemic change

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Abstract

Purpose – The purpose of this paper is twofold. First, to establish a useful framework based on Unruh`s `Biosphere Rules´, because they are currently under-researched in the circular economy domain. Second, is to analyze the current practices of how the outdoor sector of the textile industry is managing sustainability in the sense of circular economy principles.

Design and methodology approach – To fulfil the research objectives the authors apply a qualitative approach to explore four cases in terms of their adoption of circular economy principles. In addition, a cross-case comparison is used to illustrate data that has been extracted from secondary sources.

Findings – It was found that the highest activity in the sense of circular economy was the use of recycled fibers and material, that circular economy principles are not linked to each other and that participants within the supply chain are hardly involved.

Research impact – The paper adds knowledge to the field of circular economy implementation and practices in the context of the textile industry.

Practical impact – The authors argue that a holistic and systemic change and implementation of circular economy is required to succeed with the sustainable requirements of economy, environment and social aspects.

Keywords – Circular economy, Biosphere rules, Systemic change, Sustainability, Supply chain

Introduction

According to the United Nations (2017) the world's population is expected to reach 8.5 billion in 2030 and increase further to 9.7 billion in 2050. This will inevitably lead to an increased demand for basic commodities such as food, housing and clothing (Khatun, 2017). Whilst each on their own and also all together play a significant role in a sustainable, economic and socially responsible future. Textiles has always been at the forefront of sustainable initiatives and increasingly now also in circular economy principles (Moorhouse & Moorhouse, 2017).

The textile industry is still one of the most important around the world and it accounts for $ 748.1 billion of value in 2016 and is expected to reach approximately $ 961.0 billion in 2021 (Lu, 2018) (Segran, 2019). Ethical and sustainable textiles has garnered much public attention in recent years particularly as commercial and marketing efforts of companies ranging from low-price provider, like Walmart to high-fashion brands, like Gucci have increased (Russell, 2018). However, the recycling rate of used and worn clothes is tremendously low, only twelve percent is recycled in total and just one percent of recycled garments and fibers are used to produce new clothes (Butler, 2018), and the phrase `Throw away garments´ within the fashion industry has become a major issue of concern as it's seen as a huge contributor to climate change (Ellen MacArthur Foundation, 2017).

The outdoor clothes industry is in most cases a frontrunner or early adopter for the enhancement of good environmental behavior, because they actually want to preserve and protect the nature their customers are in (Bergans Retail AS, 2019). This differentiation of the outdoor industry clothes and the fast fashion industry has been described as quality, durability and longevity (Pope, 2018).

The aim of this research is to analyze the current practices of how the textile industry is managing sustainability in terms of established circular economy principles. In order to shed light on this topic a multiple case study is conducted. The case study focuses on the outdoor clothing industry and considers Scandinavian companies, namely TrimTex, Bergans, Norrøna and Haglöfs. The focus is on a micro-level adoption of circular economy principles that could lead to a systemic change and spread over the boundaries of a company.

For the purpose of analysis, we develop a framework established of the biosphere rules from Unruh (2008) (2018)



(2010) and the activity system view of business models of Zott and Amit (2010). The biosphere principles are chosen because of its application to nature which is considered as one of the most self- sustaining ecosystems. The framework provides the opportunity to research how the textile industry is currently managing the issue of sustainability in the sense of circular economy principles. It also gives advice for future enhancement and to help guiding what actions companies should take under consideration for implementation based on their effectiveness.

The remaining paper is structured as follows. A literature review regarding circular economy, the biosphere model and the activity system for business models is conducted. Subsequently the link between the two models is made. Furthermore, information regarding the case study`s methodology is provided and the findings from the four cases are presented. Based on the findings, a discussion is conducted followed by preliminary conclusions.

Literature Review

Circular Economy has a widespread field of activities and includes a variety of disciplines, models and concepts (Merli, et al., 2018). The roots of the circular economy concept are in industrial ecology or eco-industrial development (EID). The main premise is that a healthy economy and environmental health are equally important and need to be achieved simultaneously (Geng & Doberstein, 2008).

There is no commonly accepted definition, but several different definitions are put forward. The Ellen MacArthur Foundation for instance defines circular economy as follows: “A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of- life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models (Ellen MacArthur Foundation, 2013, p. 7).”

This suggests that the circular economy is more than efficient material recycling and rather a comprehensive means to enabling sustainable economic growth through optimization of natural resource consumption. This contains a change in the production chains, models of consumption and a re-design of industrial systems. Additionally, the service economy can also be interlinked to a great extent to circular economy. The idea here is that the outcome achieved is more relevant rather than the ownership of a particular product (Sitra Studies 121, 2016). In general, there is a redesign to maximize the value of resources by decoupling economic growth and resource use (Ghisellini, et al., 2016).

Furthermore, feedback processes in terms of mimicking natural ecosystems are important to the concept of circular economy (Geng & Doberstein, 2008). The basis of circular economy is a `win-win´ philosophy of a healthy economy and environmental health (Geng, et al., 2012).

The Biosphere Model

Unruh (2008) introduced the concept of `Biosphere Rules´, which are based on continuously ongoing natural occasions, within a business context. There he described for the first time a business model and management approach for the establishment of sustainable principles in a closed loop system. This system is based on nature rules and in his early work he extracted three main principles for a circular system: material parsimony, value cycles and sustainable product platforms (Unruh, 2008). In his book `Earth Inc. – using nature`s rules to build sustainable profits´ from 2010, Unruh later added two more principles to his framework by including `power autonomy´ and `function over form´ (Unruh, 2010). Unruh (2010) claims that we know what a sustainable system looks like and how it operates,

because we are confronted and interact in a system like this every day. By this statement he refers to the earth’s biosphere (Unruh, 2010). Moraru (2015) perceives the biosphere rules as an eco-strategy, which includes many methods to pursue sustainability. This aligns with Heaton`s (2018) view of the biosphere rules, which he sees as a management strategy to align with nature and perform as nature would do.

Another aspect is that this thinking goes beyond the scope of the company and considers and includes the buyer and supplier within a larger system (Unruh, 2010) (Wilkinson, 2013).

The following section provides a short overview over the main principles.

“The materials parsimony rule guides a rethinking of input sourcing decisions and a dramatic simplification of the number and types of material used in products (Unruh, 2010, p. 7).” Most importantly `material parsimony´ and material effectiveness is of superior importance for the pursuit of closing loop circles (Unruh, 2010), like circular economy does (Ellen MacArthur Foundation, 2017). Additional benefits that come with the principle, is the reduction of risk linked to little knowledge with respect to material composition as well as cost advantages with respect to recycling (Unruh, 2010).

Most Industries are still heavily dependent on fossil fuels and the majority of energy supply is governmental regulated. In contrast, nature entirely relies on sun power. A reduction of risks and an addressing of environmental issues can be followed by the power autonomy of the biosphere rules. Power autonomy can be categorized in three levels. The first is facility and supporting business functions, the second is core production processes and third the products themselves (Unruh, 2010).

The value cycling approach is aiming for use of materials “from one high use to another (Unruh, 2018, p. 101).” This is in meaningful contrast to the linear make, buy and dispose way of economically extract value of manufactured products (Ellen MacArthur Foundation, 2013). In the biosphere principles it is assumed that the quality of recycled material can be at least maintained (Unruh, 2008). In nature all plants, animals and materials share an underlying design, which is a general- purpose platform. This platform has been a ground principle for the huge biodiversity and adaption to all kind of conditions on the planet. In the business context it can be beneficial to construct products with the concept of platforms in mind because platforms can be extracted,

updated and rebuilt into the product. It also can be shared in different product types. The best way to exploit benefits is that materials are considered as platforms. They can be integrated in components and final products (Unruh, 2008).

The principle "function over form" is mimicked from nature where innumerable species have been evolved to cover each kind of niche. It illustrates the importance and individual adaption to a specific time, climate and other circumstances and highlight that on "the higher level, it is not the form the solution takes that matters, but the function (Unruh, 2010, p. 1859)." The implication of a value cycle system is that the function is of matter and create the value for the customer and not the ownership of the form (Unruh, 2010).

The Activity System

Zott and Amit (2010) created a conceptual construct in their research for the analysis of business model design. They state that business models are systems of interdependent activities and have a scope that exceeds the boundaries of the focal firm to create and share value. Their framework is dominated by design elements and design themes. The design elements include three units, named content, structure and governance. The first one is dealing with the selection process of the activities which then are going to be performed in the company. The second unit is `structure´ is dealing with the linkages of activities and their importance for the business model. The last unit of interest included in the activity system is the governance aspect and who performs the activities selected (Zott & Amit, 2010). In this research we use the design elements for characterization and further analysis, because they describe accurately the processes of business model activities performed.

Towards a framework connecting the biosphere rules to business design

For the purpose of connecting the biosphere rules to business model design we will use Zott´s and Amit´s (2010) activity systems view on business model design. Their conceptual construct is beneficial

in the sense that it focuses on the systemic properties of business models, which fits well with the objective in this paper to consider systemic change. Thus, the biosphere rules can be linked to the established activity system of Zott and Amit (2010) for business model design analysis. This will bring a more holistic and overall view in the sense of a systemic change of the business model to a circular system. Zott and Amit (2010) advice to managers to "look at the forest, not the trees - and get the overall design right, rather than concentrating on optimizing details (Zott & Amit, 2010, p. 223)." Everybody of society and industry needs to be involved, work together and change their mindset to achieve an implementation and systematic change towards the principles of circular economy (Sitra Studies 121, 2016)." Also "a systemic shift towards circularity is a major productivity opportunity – both for individual users and society (Material Economics, 2018, p. 41)."

A framework out of the biosphere rules and the activity system has been created, where each of the biosphere rules are interlinked to the all design principles of the activity system for business model analysis.

Methodology

A qualitative approach with exploratory attempt is applied to get deep insight and description to the phenomenon researched. In addition, the use of a cross-case comparison seems to be adequate to analyze how different companies deal with the issue. There need to be a huge familiarity with each case to contrast similarities or differences between the cases of the sample (Eisenhardt, 1989).

Case companies where chosen by the following principles. They have to be clothing brands in the Scandinavian area and they must produce outdoor clothing. In addition, an environmental healthy vision and mission of the companies was required. The decision for the case companies have been made to illustrate what approaches and principles of circular economy are applied? The following firms are currently being targeted for investigation: TrimTex, Bergans, Norrøna and Haglöfs.

According to Siggelkow (2007) even "a single case can be a very powerful example (Siggelkow, 2007, p. 20)." We have chosen few companies mainly to illustrate deep insight to answer the posed research question.

A framework from literature of Unruh`s "biosphere rules" and Zott and Amit`s "activity system" has been created, where each of the biosphere rules is interlinked to the dimensions of the "activity system. This framework is then used to analyze exclusively secondary data, namely data which is available of the firms' websites (See figure 1).

Discussion

Material parsimony and content: The investigated firms are aware of the importance with respect to raw material choices. All of them use, in different extent, recycled fibers and fabrics made of polyester, cotton and wool. The firms strive to fulfill various goals within the usage of even more sustainable materials. This conceptualization of product design upfront should be in manufacturer`s attention to ease the way for closed loop circulation (Rogers & Hudson, 2011). A common goal is to phase out all fluorocarbon DWR treatment and to increase the percentage of recycled fibers and fabrics. Material parsimony does not only demand the usage of recyclable fibers and fabrics but also the minimization of types of materials used in products (Unruh, 2010). The fulfillment of this aspect is difficult to assess due to the wide product range within the outdoor clothing industry which range from 100 percent woolen t-shirts to rain jackets with several layers and therefore a variety of used materials.

Power autonomy and content: None of the firms investigated have true power autonomy thus the usage of renewable energy within this industry is by far not a standard. Norrøna and TrimTex have implemented some actions in order to increase their competences in terms of power autonomy. Norrønas headquarter operates entirely on renewable energy and TrimTex Baltic uses 100 percent renewable energy for heating. However, none of the considered firms use renewable energy for the production process.

TrimTex	Content	Structure	Governance
Materials parsimony	No usage of nano- silver; Used materials in accordance with ethical guidelines and minimized environmental impact; by 2025 only use Bluesign approved products; use recycled polyester for products; by 2030 100% recycled polyester; reduced usage of DWR treatments containing PFC (completely PFC-free by 2025)		Responsibility by company and supplier for short chained DWR finishes: TrimTex
Power autonomy	Trimtex Baltic: Building uses 95 % renewable energy for heating; energy saving lighting systems		TrimTex Baltic
Value cycles	Provides materials for repairing products/fabrics		TrimTex
Sustainable product platform	Usage of same materials for different products		TrimTex
Function over form			

Bergans	Content	Structure	Governance
Materials parsimony	Usage of bluesign approved fabrics (75 % by 2020) and sustainable raw materials (70%); Usage of 100% RDS certified virgin down; usage of organic cotton (no hazardous chemicals, pesticides and artificial fertilizers); usage of recycled wool (post-consumer recycling and pre-consumer recycling); usage of recycled polyester (Repreve and PrimaLoft Silver); usage of plant based polyester (ecodear – fully recycleable)	Material parsimony and value cycles: Usage of recycles materials constitutes a new approach in terms of material/sourcing and reusage.	Usage of materials and abstinence of harmful chemicals (The chemical group); Bergans
Power autonomy			
Value cycles	Accept customers worn clothes in order to resell or recycle them		Bergans
Sustainable product platform	Usage of same materials for different products		Bergans
Function over form	Rental service		Bergans

Norrøna	Content	Structure	Governance
Materials parsimony	Use of most environmentally friendly and highest quality fabrics on market; Recycle fibers and maximize the product lifetime; Use 100% reprocessed cotton (or certified organic cotton = currently 100% - without harmful pesticides, harsh chemical bleaches and dyes); polyester fabrics contain at least 50% recycled fibers 71% in 2018); other synthetics contain at least 50% recycled fibers (Nylon 71% in 2017); Usage of reprocessed wool; Reduced usage of fluorcarbons (69% in 2018)		3rd party certification of fabrics (bluesing, GOTS, Control Union, RDS, RWS, Oeko-tex); joined focus with fabric- and fiber suppliers on high quality recycled fabrics; Norrøna
Power autonomy	HQ is powered by entirely renewable energy		Norrøna
Value cycles	Provide repair-service in order to extent the product-lifetime		Norrøna
Sustainable product platform	Usage of same materials for different products		Norrøna
Function over form			

Haglöfs	Content	Structure	Governance
Materials parsimony	Usage of recycled fabrics whenever possible (recycled polyester, insulation material made of post-consumer recycled material, recycled wool (30-50%); phase out all fluorocarbon		Reduction of microplastic in collaboration with other Swedish
	DWR treatment by 2020; use "solution-dyed" fabrics – add the color to the fabric at the beginning of the production process – saves water CO2 and electricity		clothing brands and institutions; Haglöfs
Power autonomy			
Value cycles	"Leftover Sleeping bag" made of leftover material; Haglöfs Repairwear – sell false produced products at a lower price; recycle "ghost nets" to produce fibers		Haglöfs
Sustainable product platform	Usage of same materials for different products		Haglöfs
Function over form			

Figure 1

Value cycles and content: Haglöfs has implemented the most comprehensive approach in terms of value cycles. The firm offers a product (sleeping bag) which is made of leftover materials from other products. Furthermore, products that show deviation and do not entirely fulfil their quality standards from the production norm are sold at a lower price point, instead of ending up as waste (Haglöfs Repairwear). The firm is not only concerned about recycling its own leftovers but also engages in recycling so called "ghost nets" by transferring them into fibers for their products. A common activity within "value cycles" is offering of repair services in order to extend the lifetime of a product (TrimTex and Norrøna). Bergans encourages their customers by granting a 20 percent discount to return clothes that are no longer needed in order to recycle or resell them. However, Bergans does not provide any information regarding the percentage they are able to recycle.

Sustainable product platform and content: Sustainable product platforms exist within the outdoor clothing industry to the extent that firms use the same materials in order to produce different products (GoreTex). However, it is debatable what the driver behind this action is (profit vs. sustainability).

Function over form and content: Firms clearly lack actions with respect to this dimension. The only company considering this dimension is Bergans. Where only the function of a product is desired by the customer a rental service is a good solution. Bergans is offering this service to its customers, so they can only have the function of a clothing item when needed. After handing back the item a new customer can rent it out. Bergans makes sure that the clothes are in a functional condition and latest version. So, the governance aspect here is by the company itself. Structure: It is noticeable that the design element "structure" is not considered by most of the firms. This implies that the activities related to circular economy are poorly linked. The only company that links some of its activities is Bergans by encouraging its customers to return no longer needed items to them and recycling them. However, Bergans does not provide any information regarding the extent the firm uses the recycled fibers in order to produce new products. Governance: It is striking that it is mainly the outdoor clothing company itself that controls the actions with respect to circular economy. This implies that other participants within the supply chain are only not systematically involved within the circular economy actions. Firms do collaborate with other participants in order to reduce/out phase potentially harmful components from their used materials (TrimTex, Bergans, Haglöfs). In addition, Norrøna cooperates with fabric-and fiber suppliers. The main focus is on high quality recycled fibers.

Conclusion

The overall aim of this research was to analyze current practices of how the outdoor sector of the textile industry is managing sustainability in the sense of circular economy principles. The proposed framework of the `Biosphere Rules´ by Unruh and the `Activity System" by Zott and Amit is a suitable tool to do so. It did catch the company`s activities in a useful manner and it is a helpful tool for the analysis. However, the main difficulty steamed from the fact that the considered firms provided only limited information regarding their practices on their websites. Based on the given information the following conclusions can be drawn. Firstly, the most common current practices in the sense of circular economy principles is the usage of recycled fibers and materials. Secondly, the circular economy principles are not linked with each other (structure) which weakens the overall performance. Thirdly, the considered firms hardly involve participants within their supply chains (for example suppliers) in their activities linked to circular economy (governance). This implies, that the concept of circular economy is not truly integrated.

Therefore, the implications for future research are to work closely with companies in order to gain more information. It should also be investigated further how the circular economy principles can be linked with each other and how the participants within the supply chain can become more involved.

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Collaboration

Collaboration in Supply Chain Management: From Dyads to Triads

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Abstract

Purpose – The study seeks to examine how focal firms manage their collaboration for their buyer-seller relationships in triads involving information sharing along supply chains.

Research approach – Four triads, semi -structured interviews as a key source, four observation days and internal firm data are presented. An abductive approach, Transaction Cost Economic (TCE), is conceptually guides the analytical iteration stages between theory and data for this research. The case studies allow this fuzzy and undefined area to be clarified and existing theories to be empirically examined in the context of agri-food industr

Findings and originality – The study identifies three types of triadic approaches in supply chain, which are clustered into three levels: direct-dyad boundaries, indirect-chain boundaries and contracting- market boundaries. Focal firms select amongst these approaches based on the strength of observed contextual factors, where top management plays a pivotal role in creating and improving collaboration involving information sharing for better sustainability performance. This study proposes a new holistic conceptual framework for collaboration in triadic supply chains.

This study contends that focal actors involved in information sharing need to partner dyadic actors in their triads rather than do transactional processes. The study expands the application of TCE and extends empirically to the literature on sustainable supply chain. The multi-case studies that support the development of the framework provide real -life perspectives whose insights are a valuable practical reference for similar supply chain contexts.

Research impact – The outcomes of the study cannot be generalized beyond the case study boundaries. By illustrating TCE in foretelling SBSRs governance modes, the perspective is prominent to the triadic supply chain level of analysis. The conceptual framework therefore needs to be tested and validated in further studies involving large-scale surveys.

Practical impact – There appears to be an established connection between the levels of collaboration between triad actors: focal actors and two dyadic actors in information sharing for their sustainable relationships. The development of focal firm's relationships capabilities that match their collaboration profiles is illustrated in this study. The indicated factors influence these profiles where the proposed framework links the new approaches to the strength of sustainability performance.

Keywords – Buyer-seller relationship, Triads, Sustainable supply chain, Collaboration, Information sharing, Sustainable performance, Case studies.

Introduction

An understanding of collaborations based on information sharing between actors in agricultural supply chains is still highly underexplored. These attempts at ensuring that information sharing between such actors for the benefit of the total performance are referred to as collaboration in sustainable buyer-seller relationships (SBSRs). In this new age, information has taken on its own reality, which can be detached from the movement of products (Stewart, 1998). This is based on the assumption that a business's basic purpose is to create value for the users of its products . If information has become the primary ingredient of what we make, do, buy and sell (Busse, et al., 2017), then information sharing must play a role in value creation and entering the SBSRs and their triads. Consequently, focal actors have applied strategies to guarantee sustainable approaches adopted by their supply chain actors (for example, Esfahbodi, et al. (2016)).

Yet, the approaches of SBSRs are mainly considered by direct dyadic actors and ignored in their various relationships (Pagell and Shevchenko, 2014), and are once that is attracting increasing attention from both policy makers and academics. Prior research considering the cross-functional relationship for information sharing has suggested that these approaches exhibit many unclear characteristics (e.g. Xue et al., 2011; Niall and Rich, 2015). There is often an undefined association between information sharing and collaboration in SBSR triads, particularly in supply planning, pricing, revenue and market demand along the supply chain actors (Mena et al., 2013). These tensions have created the need to examine SBSRs from a multidimensional perspective (Esfahbodi, et al., 2016). Although the Jordanian industry of Fresh Fruit and Vegetables (FFV) has applied sustainable value chain approaches and this has grown dramatically over the last two decades (Jraisat, et al., 2013). However, improvements in production and marketing activities along the agricultural supply chains, especially enabled by unsustainable mechanizations and

unplanned collaboration in resource use and consumer added value, have led to negative environmental, social and economic impacts (Luzzini, et al., 2015). In response to these resources losses and negative added value, many focal actors have started to jeer in details into their overall supply chains and apply direct and indirect SBSRs for their triads. This leads to examine how a dyadic SBSR is affected by another one in a FFV supply chain which was ignored in the previous dyadic context.

To allow practitioners and academics to identify how collaboration is implemented via different SBSR approaches in a sustainable supply chain, it is necessary to identify the factors that can be utilized to influence this action, especially with information sharing. Although there have been a number of recent studies conceptualizing this scenario, they have been based purely on literature reviews or limited empirical results (e.g. Cho and Lee, 2013; Pagell and Shevchenko, 2014; Luzzini, et al., 2015). Thus, this study attempts to provide propositions in order to answer the following research questions:

RQ1. How do focal actors collaborate with their supply chain actors in their triads for sustainability?

RQ2. What contextual factors have an impact on these focal actors' selection of each SBSR approach to improve supply chain performance in practice?

The present study applies abductive multiple case-studies to answer these questions, following calls for theory development approaches in sustainable supply chains (e.g. Thiele, et al., 2011; Song et al., 2017). Accordingly, the use of TCE perspective has been applied to response to several calls (e.g. Reardon, et al., 2009; Jraisat, et al., 2013) in order to surround the study's findings by reflecting the perspective through its foundation when used for SBSRs in supply chains.

Literature Review

The growing interest in SBSRs in supply chains has led to the development of underpinning concepts to explain this term (e.g. Esfahbodi, et al., 2016; Tasca et al., 2017). Nevertheless, SBSR is defined as a set of direct and indirect dyads that includes collaboration between a buyer and a seller aimed at creating sustainable value by information sharing along the supply chain actors for better sustainability performance. Prior research is extremely focusing on direct SBSRs (e.g. Pagell and Shevchenko, 2014; Tasca et al., 2017) and some on indirect SBSRs (e.g. Formentini and Taticchi, 2016; Esfahbodi, et al., 2016) in their supply chains. Therefore, there are many important problems of social, environmental and economic sustainability link to indirect relation actors that influence the focal actors (Tasca et al., 2017). That, in turn, requires more effort being put into collaboration within various levels of dyadic actors along the food supply chains. Moreover, from a perspective of information sharing, focal actors should implement their visibility and sustainability strategies to detached SBSRs as triads further upstream and downstream in their supply chains.

Research on SBSRs has been linked to several themes, such as collaboration, cooperation, coordination, social networks, environment, quality, costs, satisfaction, investment, pricing and revenue. In this condition, authors argued that it is important to identify a well-established approach to both information sharing and collaboration, thus leading to improved sustainability performance for a set of actors rather than a single actor or a single dyad (e.g. a seller and a buyer in a SBSR) (Esfahbodi, et al., 2016). Although these authors do not ignore the importance of the business buyer in collaboration, they do not focus fully on the involvement of the business buyer in the mechanism of information sharing and especially in strategic issues such as pricing, revenue and contracting for creating sustainable value of products at a triadic supply chain level.

This study referees SBSR triad to be defined as the sustainable value that all three actors, the focal actor with other two actors, create in their products by collaborating in their transactions across the triadic supply chain (e.g. Choi, et al., 2009; Esfahbodi, et al., 2016). This sustainable value is about adding equal features to products by actors of triadic SBSRs and in return receive equal benefits to those actors (Porter and Kramer, 2011; Tasca et al., 2017). A triad is a three-way relationship where each actor is responsible for the quality of the collaborative relationship between the other two actors. With a triad evaluation, collaboration in SBSRs is broadly investigated by three dimensional relationship context rather than a liner two dimensional context for a totality of upstream and downstream supply chains (Wu, et al., 2010). Recently, an emerged approach for examining both information sharing and collaboration in SBSR has been established from the perspective of supply chain management with a focus on sustainable value of products (Tasca et al., 2017). The new approach is to consider how both buyers and sellers can move from a win-lose situation to a win-win situation, focusing on a mutually approach of SBSRs at triads (Jraisat et al., 2013; Esfahbodi, et al., 2016).

The present research suggests there is a need to understand this more complex scenario of collaboration for direct and indirect dyadic SBSRs, and in particular, to examine the association between information sharing (e.g. sharing strategies of pricing and revenue), collaboration and sustainable performance at a triadic supply chain level. For example, collaboration between the actors' triad should include sharing information on not just economic strategies but also on environmental and social actions. Indeed, rich insights on the several SBSR approaches available to focal actors and their contextual scenarios are still missing at present. This brings information as a collaborative tool to enhance the joint revenue and resilience along the dyadic SBSR approaches and ensure efficient information flow and product flow, where contracting between buyers and sellers is existing within the supply chains (Van der Rhee et al., 2010). Consequently, it is important to understand how SBSRs works in triadic supply chains with a focus on identifying for approaches of SBSRs attached to collaboration and actions of information sharing.

Besides, TCE explains the different costs of a transaction between supply chain actors, including the focal actors. This consists of exchanges of products, information, finances and examines the categories of transaction costs for collaboration, information sharing and contracting that are associated with these exchanges (Busse, et al., 2017). This transaction perspective develops a need for actors that implement a governance function including contracts where a neutral third player coordinates the suppliers' network (Reardon, et al.,



2009; Thiele, et al., 2011). Therefore, according to Williamson (2008), actors need to have a cost and pricing strategy for partner searching, gathering information and also analyse the information required for a transaction flow, contract establishment and a decision finalization in a supply chain. Also, TCE involves dimensions of asset specificity, uncertainty and frequency. For example, cooperation and coordination amongst non-market mechanisms can help market actors reduce transaction costs and be dynamic towards transaction risks. To become more clear, when asset specificity is linked to idiosyncratic investments opportunism raises as a key risk. Hence, high levels of asset specificity linked to information symmetry can be governed via hierarchies, medium levels via hybrid modes and low levels via markets.

Lastly, the assumption of applying TCE is to provide a number of arrangements for focal actors in FFV triadic supply chains where they are attending to apply SBSR approaches. This is to provide a logical solution for focal actors to adopt opportunity costs and governance challenges attached to fix their positive position, keep filling orders, decrease total costs and increase equal returns for focal actors and their relationships in the triadic supply chains. Hence, the perspective of TCE provides the present research with a foundation basis to several SBSR approaches in triads in relation to the opportunities that could work positively towards the costs, pricing and revenue, thus having managerial implications.

Research Methodology

The research is based on a qualitative methodology. It follows an inductive case-based approach with abductive reasoning to modify the logic of the general theory to reconcile it with contextual features (Ketokivi and Choi, 2014). A triangulation approach is applied by the use of existing research studies and multiple-case studies to ensure research quality and provide propositions. Accordingly, TCE guides the exploration of the present enquiry in order to theorize the selection of SBSR governance modes.

Four case studies of SBSRs have been selected on the basis of theoretical sampling to provide new insights into an emergent theory. These cases are identified as sustainable collaborative relationships as triads by certified bodies and each actor should have information sharing and collaboration functions in FFV supply chains. This sampling process confirmed variance in the dependent and independent variables within and across BSRs and is assumed to allow the recovery of different SBSR approaches (Wilhelm, 2011; Luzzini, et al., 2015). However, the FFV supply chains in Jordan is characterized by key features: sector structure of vertical and horizontal collaborations, product features as these are perishable products and sometimes seasonal products, actor types as this chain includes a variety of collaborative firms (e.g. importer, retailer) and also dealing with international actors (e.g. supplying exporter). Hence a collaborative SBSR approach is vital for the Jordanian FFV supply chain.

Primary data were collected from 36 semi-structured interviews as a key source and four observation days on different supply chain sites were applied within each SBSR for triangulation purposes. Each case was involved three actors forming a SBSR triad. A case study protocol was applied for all cases for better research reliability. The protocol stipulated triadic rational issues by focusing on the uncovering of collaboration mechanisms, information sharing schemes, and how and why the mechanisms and schemes were applied for each actor within the case of a SBSR triad.

For each case, data collection started with a gatekeeper firm (a focal actor) which was provided with an invitation letter, information sheet and consent form, explaining the inquiry of the current research and the need for all three actors in a triad to comply with them. The aim was to gain answers on how far collaboration in information sharing goes, what the roles of information sharing in the price process and revenue approach are within the FFV supply chain, how top management regard this collaboration in linking supply with demand with better information and product flows, and how collaborations affect sustainability performance. The Interviews were conducted and recorded by the author in person, who were asked the same questions. The interviews were also transcribed and then sent to the managers for revisions. The approved interviews were used to develop the case studies, which were analysed through cross-case analyses. In addition, secondary data from firm annual reports, sustainability records and related data were collected for a triangulation purpose.

Data analysis mainly followed two approaches: the first is the nested approach to analyse data gathered from each case and the second is the cross-case approach to analyse the commonalities and differences between the cases. The process was iterative exploring what their supply chain was like before the sustainable collaboration, how and why they started to change. Following the method of iterations between data coding and theory elaboration (Miles et al., 2014), the benefit of this analysis method was to allow the development of insights into the theoretical association from the empirical findings.

Findings and Discussion

At the cross case level, the eight SBSR approaches are provided according to direct, indirect and contracting levels: direct-dyadic triad boundaries (total cost strategy, pricing strategy and revenue strategy) and indirect-chain boundaries (information flow, product flow and finance flow) and contracting-market boundaries (formal contract and informal contract). These approaches are organized in line with collaboration mechanism and linked from high to low strength of information sharing.

In the four cases, triads are compared in terms of their sustainability performance level and applied approaches. Once the triad is established, all the roles merge, requiring each actor to contribute to and receive from the other two actors. Cases 3 and 4 have high degree of sustainability performance and also reflect high degrees of each individual contextual factor. The actors in these cases apply direct approaches at high levels, in addition to follow indirect approaches at high level with formal contracts as the most important governance approach, which are all linked to high strength of information sharing. Case 2 follows medium degree of sustainability performance and has high-medium degrees of each individual contextual factor. The case has

direct approaches at high levels, indirect approaches at medium level with mixed governance approach of formal and informal contracts, which are all linked to medium strength of information sharing. Also, case 1 involves low levels of sustainability performance and has medium-low degrees of each individual contextual factor. The three actors mainly chose direct approaches at high levels and indirect approaches at low levels, which require them to rely on informal contracts as the most important governance approach with low strength of information sharing.

The findings propose that the dyadic triads that reflect high sustainability performance in their supply chain have high symmetric information actions between the actors, which are applied in their direct and indirect collaboration mechanisms can be governed via hierarchies. These findings are in agreement with previous studies (e.g. Luzzini, et al. (2015)). The findings are in accordance with previous research, which suggests that dyadic triads have medium levels of sustainability performance obtained from direct and indirect collaboration as hybrid governance modes. These triads have medium symmetric information in direct and indirect collaboration that can reduce information searching and relationship costs for the bonded actors (Formentini and Taticchi, 2016; Esfahbodi, et al., 2016). Furthermore, collaboration amongst market modes can help triad actors reduce transaction costs and be dynamic towards transaction risks (Williamson, 2008). These findings propose that the dyadic triads are linked to low levels of sustainability performance and have low symmetric information actions, which are applied in their direct and indirect collaboration that can be governed via markets.

The three themes of TCE, namely assets specificity, uncertainty and frequency, are used to group the contextual factors. For instance, cases 3 and 4 show high level of dependency of facilities and joint operation investment as cultivated and concentrated collaboration between the three actors; the focal actor and the other two actors in their closed triad. In contrast, Cases 1 and 2 display medium level of dependency of facilities and joint operation investment as directed collaboration between the focal actor and each actor in their open (case1) and transactional (case 2) triads. All the cases collaborate based on strategies of pricing and revenue, which are based on action of information sharing in SBSRs related to specific assets investment. The differences appear in collaboration on total costs whereas cases 3 and 4 illustrate that three actors jointly work on minimizing their operation costs, opportunistic behaviour and information searching costs to benefit their social and environmental performance.

The key findings have highlighted how supply chain complexity and product salience are key factors, which are variable and important between the three actors in their triad. Cooperation has become the starting point for information flow as a necessity (Busse, et al., 2017). Collaboration between actors takes various forms, such as the use of information technology and/or other traditional ways such as current plan sharing and exchange of resources and experts, possibly between chain members and service providers (Esfahbodi, et al., 2016). The case studies found that most of interviewees recognized the importance of developing information flow as a communication approach, including the process of an interest base for information sharing. Most of the managers in all dyads displayed evidence of these themes between the dyadic actors through the development of cultivated and concentrated collaborative SBSRs in their triads. There was negotiation in many relationships about what is jointly possible and desirable. A few relationships showed little evidence of good information flow and cooperation in exchange information, and these relationships were the least effective in directed collaboration as shown in case 1.

Conclusions and Contributions

This research has applied a multiple-case study examining four SBSR triads in FFV supply chains. The research has shed the light on implementing collaboration in buyer-seller relationships by examining triadic chains. Previous research highlighted that focal actors work with their dyadic partners for extending sustainability, however, the literature illustrates that few focal actors apply effective SBSR approaches due to these are ignored by management at triadic supply chain level. Hence, the research questions have been answered to identifying of SBSR approaches for collaboration and the three sets of propositions. As this an abductive approach, TCE is employed to provide answers regarding the contextual factors that have impacts on actions of information sharing and sustainability performance.

This research provides and explains SBSR approaches in triads, which built around the collaboration term, which is theoretically associated to actions of information sharing. Our findings have countered three key propositions on the different approaches of collaboration and especially the focal actors in triads.The key findings consider the three dimensions of sustainability, namely economic, environmental and social aspects, as one package as they reveal different strengths at each type of collaboration and SBSR approaches. This research validates the earlier observations that the dimensions of the triple bottom line need more triadic collaboration strategies in SBSRs in supply chains. The research confirms also their links to information symmetry and cost reduction as seen in cases 3 and 4. The dyads in cases 3 and 4 were the actors that most reflected sustainable performance and also achieved the highest indicators in terms of their industry norm and had a healthy market share, positive social impact and efficient environmental activities, whereas cases 1 and some in 2 exhibited the least collaboration between dyadic actors and had the lowest profit and a weak market share, minimum social interaction and limited environmental results.

On the other hand, Focal actors could follow the new conceptual framework as a guideline to form and describe collaboration between actors based on information sharing in order to improve sustainability performance. Focal firms would apply direct SBSR approach at dyad level to understand collaboration types with asset investment and symmetric information between the three actors in each triad. Then, focal firms would develop collaboration between the triadic actors and the chain actors at chain level to share information as symmetric and asymmetric in various uncertain situations. Finally, at the market level where many chains are available, focal firms would gradually have contracts as formal and informal with triadic actors and also other actors in the chain to take the responsibility of implementing sustainability in environmental, social and economic aspects.

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Coopetition in fashion supply chains

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Introduction

This paper reports on an empirical study exploring motives and areas of coopetition interaction among fashion supply chain actors and the tensions that exist in such relationships. Coopetition is a process of simultaneous cooperation and competition between companies and has emerged as an influential competitive strategy for achieving growth and competitive advantage through knowledge and resource sharing, developing innovation capabilities, training and skills development, risk reduction and minimisation of different costs (Bengtsson et al., 2010). However, coopetition processes also entail diverse challenges, such as identifying appropriate relationship opportunities, balancing coopetition interactions, and managing tensions in such paradoxical relationships (Wilhelm, 2011). Accordingly, within the context of the UK fashion industry, we explore why fashion supply chains engage in coopetition relationships and what inherent tensions they face in coopetition relations.

Literature Review

The following section sets out the theoretical background to the study, considering the nature of fashion supply chains and the concept of coopetition.

Fashion Supply Chains (FSCs)

FSCs are highly global with garment manufacturing fragmented across small and medium-sized (SME) plants mainly in Asia, and retailing traditionally concentrated in Europe, but increasingly expanding to emerging markets (Perry et al., 2015; Chan et al., 2017). Fashion is a broad term which typically encompasses any product or market where there is an element of style which is likely to be short lived (Fernie & Grant, 2019). FSCs have received increasing interest in academic literature across multiple market levels due to their dynamic, complex and volatile nature (Chan et al. 2017). The fashion industry is characterised by short product life cycles, high demand volatility, low predictability and high impulse buying (Masson et al., 2007). Fast fashion retailers have achieved phenomenal growth by rapidly translating famous fashion house and street styles and celebrity trends into new collections at competitive prices allowing consumers to constantly refresh their wardrobes. Garment manufacturing is comparatively low-tech and labour intensive with low barriers to entry (Perry et al., 2015), which results in outsourcing of production to lower labour cost countries, resulting in longer lead times, increased complexity, lower supply chain visibility and control, ultimately leading to increased risks for brand reputation from ethical and environmental scandals (Rafi-Ul-Shan et al., 2018).

Due to fashion product characteristics and the highly complex and global nature of the industry, FSCs need to be agile and responsive to on-trend demand (Masson et al., 2007). Fashion garments are designed to capture the mood of the moment and selling windows are short and seasonal, often measured in weeks. Demand for fashion garments is nonlinear and rarely stable, often influenced by the vagaries of weather, films, pop stars, footballers and celebrities (Barnes & Lea-Greenwood, 2010). Therefore, FSCs agility, responsiveness and reducing shipment lead times are key to retail success, given increasing consumer expectations of 'see-now, buy-now'. Advances in information and communication technologies, including social media, have made fashion consumers increasingly demanding in their tastes and preferences (Fernie & Grant, 2019). So, FSCs must be proactive in determining trends and sufficiently reactive to bring them to market in a timely manner with minimum stock-keeping units in order to maximise margins during the selling window of the trend (Masson et al., 2007). Otherwise, retailers may incur extra inventory costs and unsold items may have to be marked down, reducing profit margin (Hartman et al., 2012).

To achieve these performance objectives and address challenges resulting from the nature of FSCs, the literature emphasises management structures based upon internal and external integration and process alignment, use of highly responsive communication channels, increased flexibility and collaboration with FSC partners (Fernie & Grant, 2019). In the dynamic and global fashion industry, the ability to integrate processes across the functional boundaries of a firm is considered key to competitive advantage (Sull and Turconi, 2008). It is important for firms to share a common goal and work in the same direction to achieve supply chain integration.

However, relationships in fashion supply chains are based largely on current market needs and aim to generate the highest margins by capturing demand in a timely manner, by reducing cycle times (Rafi-Ul-Shan et al., 2018). Requirements for smaller quantities, larger varieties and more frequent shipments encourage fashion retailers to use a large number of suppliers for greater flexibility, therefore traditional long-term alliances and partnering relationships have been diluted (Masson et al., 2007). However, key supplier relationships are also important for retailers to better manage their FSCs, and there has been a consequent shift to supply base rationalisation and greater cooperation and collaboration with key suppliers (Perry et al., 2015). Accordingly, many retailers are developing long term strategic, cooperative and collaborative relationships with networks of supply chain partners to better manage supply chain issues (Perry et al., 2015).

Coopetition in supply chains

Management research and business practice has placed an increased emphasis on coopetition, which is simultaneous cooperation and competition between two actors (Dorn et al., 2016). The coopetition concept attained popularity in game theory and was understood, conceptualised, defined from diverse perspectives and multiple levels of analysis (Bengtsson et al., 2010). From a contextual perspective, coopetition implies that the competitive organisations can interact in rivalry due to conflicting interests and cooperate due to common interests to create mutually beneficial exchanges and enhanced values (Chin et al., 2008). From a process perspective, coopetition is "a process based upon simultaneous and mutual cooperative and competitive interactions between two or more actors at any level of analysis" (Bengtsson et al., 2010:200). Cooperation is commonly conceptualised as the joint pursuit of common goals whereas competition is a fight for scarce resources among structurally equivalent actors (Wilhelm, 2011). In the strategic alliance literature, cooperation and competition are traditionally seen as opposing forces. In contrast, the emerging coopetition perspective tries to integrate the two paradoxical logics into a common construct (Bengtsson et al., 2010). The emerging perspective is to depict cooperation and competition on two separate continua, distinguishing between different forms of coopetition with varying combinations of low to high cooperation and competition respectively (Luo, 2007).

Luo (2007) and Dorn et al. (2016) highlighted some characteristics of coopetition. First, competition and cooperation is always between the same firms, as opposed to competing with one firm and cooperating with another. Second, coopetition is different from cooperative alliances, as building an alliance with key competitors will only emphasize cooperation. Third, under coopetition competition occurs in one period and cooperation takes place during another, hence, they occur simultaneously. Lastly, coopetition can occur at different levels such as at individual, corporate, firm or department, depending on organizational needs and strategic intent (Dorn et al., 2016).

Firms' pursuit of coopetition is influenced by certain external environmental circumstances, such as stakeholders' involvement and technological demands. Coopetition can be driven by the structure and growth level of an industry sector; however, firm instability and industry uncertainties are also drivers for firms to cooperate and compete (Padula & Dagnino, 2007). Similarly, quick erosion of a firm's core competencies reduces its control over its destiny, which compels the firm to join competitors to establish some security. Firms are therefore motivated to develop relationships with competitors that possess superior and useful capabilities and resources which could help them achieve mutual objectives (Gnyawali & Park, 2011). In most cases, firms pursue coopetition with other firms that have distinct and complementary resource profiles (Luo et al., 2008). Furthermore, a firm's internal motives may lead to coopetition initiation. Firms also combine their resources and share their knowledge with their competing partners to increase their bargaining power and enhance their competitive capabilities (Gnyawali & Park, 2011). Lack of resources is another driver for firms to cooperate with their competitors, in order to create value from the partnership. Additionally, when exploring prospective strategies, organisations cooperate with partners who are capable and can assist the organisation to achieve a high position in the value chain, penetrate new markets and enhance its performance (Golnam et al., 2014). Finally, organisational structure, culture and management commitment are essential drivers for any initiative's success, including coopetition (Dorn et al., 2016). Management involvement reflects the level of support dedicated to coopetition strategy. Open and clear communication between partners may act as a key success factor in driving coopetition as a strategic pursuit. Therefore, continuous communication is essential during the initiation, implementation, monitoring and evaluation stages of coopetition (Dorn et al., 2016).

One significant barrier to coopetition is the lack of trust between cooperating competitors and consequently, lack of trust between coopetition partners and unreliability when choosing partners may cause a coopetition strategy to fail (Pathak et al., 2014). Another barrier is the challenge of integrating cooperation and competition activities in a balanced manner (Tidström et al., 2014). In practice, it is difficult to decide an optimal level to be labelled as balanced cooperation and competition. The imbalance creates tensions because employees usually tend to revert to their previous behaviours. Industry characteristics also influence the emergence of coopetition. Relatively high R&D costs, short product lifecycles and frequent technological innovations put pressure on firms to react and adapt quickly and flexibly with high investments. However, this can also be a driver, as firms confronted with such pressures are driven to partner with even their fiercest competitors (Gnyawali and Park, 2011).

Regulatory bodies or laws present other antecedent issues as their influence could either hinder or favour the formation of coopetative relationships between firms (Mariani, 2007). Governmental bodies can also force competitors to work together, e.g. to create purchasing efficiencies and efficient resource utilisation (Mariani, 2007). However, laws can also hinder competitors to cooperate, for example, in terms of anti-trust. Some extant research focused on properties of the relationship between firms that are crucial for coopetition to emerge (Dorn et al., 2016. Several contributions explaining the motivation for entering coopetative relationships refer to resource dependence theory and the resource-based view (RBV) (Gnyawall and park, 2011; Dorn et al., 2016). Mutual trust-building activities between parties demonstrate commitment to the partnership and counterbalance the inherent risk of opportunistic behaviour (Tidström, 2014).

When a coopetitive relationship has been established, it must be managed and potentially reshaped. There is great potential for tensions and conflicts in coopetition due to the conflicting logics of competition and cooperation (Tidström, 2014). Both issues can endanger the relationship's success and influence activities and processes within coopetition. Conflict is aggravated when either cooperation or competition is dominating within a relationship. Various causes of coopetition tensions include lack of trust between coopetitive partners, task or process conflicts, incompatible ideas or opinions and value systems, cultural and emotional differences, ambiguities or disagreements between role and responsibilities, lack of information and knowledge sharing, power imbalance and dependence, and opportunistic behaviours (Tidström, 2014).

Tensions are generally viewed as negative occurrences; however, the outcomes of tensions could also be positive or mixed (Tidström et al., 2014). For example, they may lead to new ideas, methods, processes or new products that could benefit all coopetitive partners. Most extant research has highlighted types of tensions without highlighting underlying issues and the process for the identification, evaluation and management of tensions (Tidström, 2014). Further, different causes of coopetition tensions and their management process in volatile and unpredictable marketplaces, such as the fashion sector, are relatively unknown. With a focus on the UK fashion industry, arguably one of the world's most competitive fashion markets, our empirical research questions are:

1. Why do companies in fashion supply chains engage in coopetitive relationships?

2. What are the different coopetition tensions between companies in fashion supply chains?

Methodology

An exploratory multiple case study (Yin, 2013) of seven UK-based fashion companies (spanning large and SME apparel and footwear retail, wholesale, manufacturer and distributor businesses), allowed exploration of coopetitive interactions and tensions. Data were collected using semi-structured in-depth interviews conducted with forty relevant managers in charge of supply chain, design, sourcing and operations within the companies. Lasting an average duration of fifty minutes, interviews were recorded with respondents' permission, transcribed and later verified by respondents. Thematic narrative analysis was used to interpret the data and report findings. Respondents requested confidentiality and case companies are therefore referred to as CC1-CC7 in the data analysis below.

Findings

Coopetition relationships: Three main reasons explain why case companies engage in coopetitive interactions, namely: capacity sharing, risk reduction and information sharing.

Capacity sharing: Time-based competition, demand volatility, increased disruptions and retailer pressures are some of the reasons that stimulated fashion companies and supply chains to share capacity. However, case companies also believed that high supply chain cost led them to benefit from each other's resources in supply chain operations, leaving competition for the shop floor or customer service. CC1 respondents spoke of an occasion when they had to replace their 'plasticisers' and during this process used competitor 'plasticisers' and hides. CC1, CC2 and CC4 respondents mentioned that their companies benefit from competitors' assistance in the international market to source skilled labour, in case of full capacity. They also mentioned the sharing of machines, use of raw materials, technology, warehouse, containers, testing facilities and other facilities at competitors' plants in different countries: "We can't do everything on our own, especially on a global basis, so we talk to our colleagues and if they have those facilities we will ask their help; we will pay less and they will get what they have invested for" (CC1 Supply Chain Manager). CC2, CC3, CC4 and CC5 respondents suggested that problems of quotas, price fluctuations, raw material shortages, customs and distribution could be overcome by sharing materials and capacity with competitors: "If China goes over their export quotas we could be left with fibres stuck in China indefinitely until the quotas have re-balanced so the interim is managed by sharing materials with competitors here in the UK or in our suppliers' markets" (CC2 Sourcing Manager).

Risk reduction: Respondents from CC5 described many instances where coopetition emerged when disruptions occurred. One disruption shut down trading completely, but CC5 was able to resume trading in just two days, partly due to the help from its competitors, customers and outside service providers. Another high street retailer offered space in its warehouse, yet another sent its workforce to help evacuate materials and yet another sent containers, while a service provider converted all standard orders into next-day delivery. Within CC5 itself, drivers were willing to work extra hours, even at weekends, and some other departments also sent their workforce to help the logistics and distribution functions which were most affected most by the incident. Respondents from all case companies also spoke of the frequent use of competitors' containers, materials, suppliers, factories and vehicles, and even some facilities at the supplier markets. CC3 and CC5 respondents maintained that success in fashion, and particularly in fast fashion, requires having as many resources as possible, as this will help businesses to increase the number of options. This helps companies to explore alternatives and substitutes, ultimately minimising risks such as dependency and improving customer service: "You need to talk to your partners, talk to your competitors, talk to those who have the slightest relevance to what you do; you need to be open minded; this will increase your options and then you can say yes, I can sustain, I can continue" (CC3 Ethical Compliance Manager).

Information sharing to build relationships: Motivations of cost savings, resource development, being pro-active and to develop supply chain knowledge drove case companies to engage in information sharing, building relationships with competitors and organizations outside the industry. Case companies shared many practices and processes, demonstrating an increased move to share information and build relationships with competitors. CC1, CC2, CC3, CC4 and CC5 established close relationships and constantly shared information with companies that were previously perceived as biased against the industry or were competitors, such as NGOs, third-party testing and auditing companies, industry working groups, and material and service providers. This helped respondents to manage complex issues such as legislation, working standards, ethics, national and international regulations, country laws and law on chemical use, testing and auditing and develop supply chain knowledge. CC2 and CC4 respondents explained how their company also tried to build strong relationships with similar UK-based SMEs to support the development of a common strategy by the government, in order to help revive the UK textile and garment industry: "As an industry we're joining together, whether we are joining together with our competitors or what could be perceived to be a competitor or not, it doesn't really matter, the fact is we are joining together to pool our resources in terms of trying get some help from the government" (CC4 Supply Chain Manager). Although CC5 respondents expressed concern about sharing trends or design-related information with some similar-sized

competitors, they admitted that the company also gets help from its competitors: "He (supply chain manager) will pick up the phone and let them know which trend is in demand, which colour customers like; in the beginning I found it unusual but then I saw some of them coming to us and asking for some units to try" (CC5 Design Manager).

Coopetition tensions: Three types of tensions arose in the case companies: retailer pressure, organisational culture and lack of resources.

Retailer pressure: The advent of fast fashion, plentiful supply, emergence of new supplier markets and development of existing markets enabled and shifted power to retailers. Consequently, retailers became more demanding in terms of passing cost, price, margins, discounts, capital expenditures, certifications, product development and distribution cost pressures upstream onto suppliers. Respondents from all case companies acknowledged that most retailers are manufacturing in developing countries where operating costs are lower than the UK, but still expect the same price, quality and service level from UK-based suppliers. Respondents felt that if their company were to speak to the retailer about its own issues, the retailer would not respond positively and would probably go elsewhere instead, since overseas suppliers are plentiful: "I think that's the nature of the business they're in, they are there to make money, if you talk about your own issues or cost or growth you will never hear back from them, they're gone to someone else" (CC1 Sourcing Manager). CC2, CC3 and CC4 respondents mentioned that retailers do not want to discuss product or service specifications and most of the time their companies have to decide themselves. Consequently, very often retailers ask for changes or cancel orders close to delivery. They also mentioned unreasonable demands from retailers to fulfil orders in an unreasonable time, claiming their behaviour was very autocratic and ignorant of the suppliers' capabilities: "I think it's, you know, what they want but they don't really know what the rest of the companies can do for them and rather than asking them, 'what can you do for us?', sometimes, it's 'we want this, this, and this" (CC4 Technical Manager).

Organisational culture: Being stagnant and resistant to change, organisational culture was the major source of tensions in coopetition relationships. The decline of the UK fashion industry following the abolition of the MFA negatively impacted the companies. Factory work began to be perceived as boring and non-progressive; therefore, no newness came into the garment industry and ultimately the industry became dependent upon its existing workforce. In most case companies, the average worker was in their late 40s or early 50s. This substantially impacted organisational culture, making it stagnant with huge resistance to change. Most working practices were more than two decades old, but still perceived as the best way to progress. Resistance to change greatly impacted customer service, cost, resulting in slower response and greater risks. CC1, CC2, CC3 and CC4 respondents spoke of the prevalent attitude that if something is not broken then why try to fix it, and the difficulty to get all the people in the company to understand and believe that change is needed. Some supplier respondents acknowledged that some personnel in their companies were behind the times, as they did not understand where the fashion industry is and how dramatically it has changed over the last few years. While retail customers want new designs, colours and fibres, certain company personnel seemed to prefer old ways of doing things: "In our company and the whole fashion industry in the UK, there is probably an attitude of just take it for granted that the product will always be there and I think it's something that needs to be looked into more heavily" (CC1 Supply Chain Manager). CC2, CC3 and CC4 respondents also mentioned foreign cultural issues which impacted on relationship building, e.g. bribery, bureaucracy, corruption and language problems in India: "If I'm going to India, there is a very Indian way of doing things which is not about English language, rather culture, bribery and corruption sort of issues" (CC3 Ethical Compliance Manager).

Lack of resources: The lack of organisational resources was a source of tension in coopetition relationships in four key areas, namely: shortage of a technically skilled workforce (which lead to opportunistic behaviour), small size and weak financial position, lack of knowledge.

Shortage of technically skilled workforce: Large scale outsourcing and offshoring manufacturing led UK retailers to abandon UK manufacturers, suppliers and workers. During this decline, universities reset their priorities and stopped providing technical training courses to the garment industry. As a response to this, the industry started training people itself, which increased cost and prevented management from spending more time on strategic issues. Respondents from all case companies noted that the greatest area for lack of capacity was the shortage of technically skilled workforce both in the UK and at their suppliers' premises in Far East Asia: "The biggest pressure we have at the moment in our supply chain is the availability of labour within China" (CC1 Sourcing Manager). Some companies introduced apprenticeships in UK operations and worked in partnership with manufacturers and suppliers in Asia to build capacity, but others behaved opportunistically to attract technically skilled workforce in the UK by offering good packages and hiring their coopetitive partners' workers, further exacerbating the shortage. The Production Manager at CC4 noted: "it took us 5 years to train our design translator, but she left in the sixth year because they (CC4's coopetitive partner) offered her a lucrative package". Similarly, the Logistics Director at CC5 admitted: "We hired an ethical compliance manager from (CC5's coopetitive partner) because she worked in their supplier markets for many years and brought useful experience in our company". This negatively affected the recruiting, training and development costs for the case companies and increased tensions in the coopetitive relationships: "ethically, they shouldn't have even talked to our Technical Manager and our Technical Manager to them…but what should we do? This has become a norm in our sector and always worries us" (CC2 Production Manager).

Small size and weak financial position: CC1 and CC3 respondents believed that lack of resources, especially the weak financial position of the company, cost issues and slow growth did not allow their companies to have a dedicated person, department and processes to strategically manage different partners at different levels. CC4 and CC5 respondents explained how due to their smaller size, it was difficult to get credit from banks, have dedicated teams and manage relationships with bigger companies in the supply chain effectively and efficiently: "We're smaller, our volumes are smaller; if our volumes were as big as those of global corporate businesses, the Burberry, Louis Vuitton or our

retailer M&S then things would have been different, definitely" (CC1 Quality Control Manager). CC2, CC4 and CC5 respondents also mentioned size as a key barrier in managing supply chain relationships. For example, CC5 uses small manufacturers and suppliers but over time, this can cause supply chain disruption if these either go out of business and cease to exist or are unable to manage capacity: "The problem is, the real problem, some of our suppliers could not manage capacity over the time that we needed" (CC5 Sourcing Manager).

Lack of knowledge: Respondents did not possess complete knowledge about their supply chain, in terms of supply chain partners, sourcing markets, target markets and the major corporate strategy of their company, but maintained that complete knowledge about supply chain or business partners was a key element in the success of their business. Most respondents in CC2, CC3, CC4 and CC5 acknowledged very limited knowledge about their business partners, their products, operations and processes. CC3 and CC4 respondents felt that sometimes even management does not understand what they are looking for, as they do not have complete knowledge about their departments, functions and processes. Lack of a clear strategy and focus was also an issue for senior management at CC3 and CC4, with a consequent need to involve knowledgeable and skilled individuals to design a relationship management strategy. CC3, CC4 and CC5 respondents also mentioned that they passed customer requirements to supply chain partners, particularly suppliers and manufacturers, but did not know much about partners, their operations and processes and how supply chain partners are managing their orders: "How do we do this? Well our sourcing manager does it on our customers' request, I will ask him to explain it for you" (CC5 Supply Chain Manager).

Conclusions

The challenging trading environment and intense competitive pressures of the global fashion industry drive supply chain actors to cooperate with their competitors in certain areas, primarily in terms of capacity, in order to save costs and shorten lead times. Coopetitive behaviour occurs behind the scenes in the supply chain, primarily in production and distribution capacity-sharing in cases of scarce resources, and to some extent in sharing design trends, but not in consumer-facing functions such as in-store or customer service. There was a shared sense of supporting each other for the greater good of a struggling industry sector and supply chain actors recognised the mutual benefits of a coopetitive approach in terms of overcoming crisis situations and being able to meet order deadlines, but this did not present opportunistic behaviour to overcome shortages of technically skilled staff. Coopetitive relationships were built on personal connections between actors and despite recognition of coopetitive benefits within companies, there was no explicit strategy in place to manage and exploit them. The challenging nature of the industry sector also drove firms to partner with competitors, despite the inherent risk of opportunistic behaviour. There is an opportunity for coopetitive relationships to be strategically managed to integrate cooperation and competition activities in a balanced manner. Companies need to formulate processes to identify, evaluate and proactively manage tensions in coopetitive relationships, in order to maintain and develop trust between coopetition partners in order to maximise benefits of coopetitive trading relationships and avoid opportunistic behaviours.

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Supply chain initiatives: Antecedents for liquefied natural gas supply chain financial performance

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1. Introduction

Liquefied natural gas (LNG) supply chains are networks used to produce and deliver gas to consumers, through value chains encompassing exploration and production, liquefaction, shipping and regasification (Scheig, 2009, 15). The linkages in Nigeria LNG (NLNG) networks highlighted the implications of SCM strategies for financial performance through improving revenue and curtailing costs. Optimising supply chain initiatives that drive financial performance is a vital NLNG SCM strategy given the highly capital-intensive LNG midstream value chain (Werner et al., 2014). Following the 2008 financial crisis, reductions in issuance debt and increased finance costs have restricted corporate liquidity (Zubairu et al., 2018). Solutions and programmes to optimise financial flow have embraced supply chain finance strategy (Caniato et al., 2016) to improve working capital, reduce costs and time, and to enhance sustainability and value for investors. This research analyses the impact of supply chain strategies on financial performance and measures the relationship between supply chain initiatives and financial performance in NLNG networks, where supply chain participants need to know whether supply chain practices contribute to financial performance, and how to direct investments to enhance supply chain management (SCM) and maximise financial results.

2. Literature review

2.1. The linkages between supply chain management and financial performance

Emerging studies strengthen the link between SCM and corporate financial performance (Martin and Patterson, 2009). Supply chain practices are increasingly complex and strategically important processes for creating and maintaining firms' competitive advantage (Ellinger and Ellinger, 2014). Modern supply chain design and management generates a major source of competitive advantage for companies (Okongwu et al., 2015), and improving SCM practices impacts financial performance positively (Johnson and Templar, 2011). Firms now realise the strategic significance of SCM and appreciate the unique competitive advantages that a well-managed supply chain brings (Stevens and Johnson, 2016). SCM plays an important role in creating or destroying shareholder value due to its influence on financial performance (Ellinger et al., 2011). Managers need to identify supply chain initiatives that create the most value for shareholders (Losbichler et al. 2008). Supply chain managers are duty-bound to demonstrate how SCM contributes positively to financial performance, to justify associated investment (Shi and Yu, 2013). This need for enterprise efficiency is compelling executives to identify, review and adopt supply chain initiatives and strategies that drive corporate financial performance (Zubairu et al., 2018).

2.2. Challenges associated with liquefied natural gas financial performance

Increased requirements to manage LNG supply chains reflect growing demand and imports (Özelkan et al., 2008). However, the economic feasibility of LNG supply chains is driven by requirements to minimise the cost of LNG (Berle et al., 2011), to maximise the volume, to minimise the inventory of storage gas (Özelkan et al., 2008) and to optimise liquefaction plant utilisation (Berle et al., 2013). Rising numbers of participants in the LNG industry has increased supply and prices have fallen. This study investigates how NLNG can embrace supply chain strategies to optimise financial flow in LNG networks.

3. Description of problem

Natural gas is the fastest growing fuel globally, increasing at 1.6% p.a., with oil and coal growing at 0.7% p.a. and 0.2 p.a. respectively (BP, 2017). The most efficient way of transporting gas is by liquefaction into LNG (Özelkan et al., 2008). However, this study did not find any prior statement of SCM competencies that drive financial performance in LNG networks. Considering the importance of SCM strategies and competencies to business survival and growth, in this study, template analysis is utilised to study existing literature to identify key drivers that enhance financial performance, to propose an explicit framework for SCFP. Further, the study employs analytical hierarchy process (AHP) to prioritise the relative influence of the key supply chain initiatives that drive financial performance in NLNG networks to guide practitioners.

4. Research work

This study combines multiple methods over two stages: template analysis (King and Brooks, 2017; Brooks et al., 2015) and AHP (Saaty, 1982).

4.1. Evaluation of literature using template analysis

In study stage one, template analysis was used to evaluate existing literature between 1999 and 2018 to identify key strategies and sub-strategies that drive financial performance. Template analysis 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). Similar to a study by Zubairu et al. (2018), predetermined categories for SCFP were established deductively as higher-order themes, subsequently, template analysis identified various supply chain drivers of financial performance. Typically template analysis is applied to interview transcripts but any kind of textual data is appropriate. Further, template analysis 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, template analysis 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).

4.1.1 Development of a template analysis framework

Themes for the initial template were derived deductively from a sub-set of qualifying articles. 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 1). 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
Sourcing strategy
Information technology and automation
Integration and collaboration
Sustainability

Table 1: Higher-order themes for final template

4.2. Prioritising supply chain initiatives in NLNG systems using analytical hierarchy process

In study stage two, AHP, a multi-criteria decision-making method, assisted empirical evaluation of the relative influence of each of the supply chain initiatives established in study stage one on NLNG networks' financial performance. A hierarchy was developed consisting objectives; criteria; and alternatives (Mohsen et al., 2010). The ultimate objective of this study is to establish and measure the impact of supply chain collaborative strategies on NLNG networks. Study stage one findings presented four measurement criteria comprising revenue growth; cost reduction; working capital efficiency; and fixed asset utilisation, represented as C1, C2, C3, C4, which are utilised as criteria in a pairwise comparison matrix to determine ranking of each criterion to financial performance in NLNG networks. Results from stage one suggested sourcing strategy; information technology and automation; integration and collaboration; sustainability as drivers of financial performance in NLNG networks, represented as A1, A2, A3, A4 which are adopted as alternatives for paired comparison matrix of alternatives with respect to criteria.

5. Results and discussion

5.1. Study stage one results

Consistent with Zubairu et al. (2018), the final template (Table 1) identified sourcing strategy, information technology (IT) and automation, integration and collaboration, and sustainability as higher-order themes that drive SCFP. Sourcing strategy and IT remain similar to the base definition, but integration and collaboration combine both system integration and external relationships. Sustainability emerged as a new higher-order theme which develops from further data from qualifying literature.

Template analysis revealed sourcing strategy as a higher-order theme for SCFP. In conformity with TCE, efficient supply chain sourcing strategy should lead to improved financial performance. Sourcing strategy allows supply chain partners to focus on their key competitive advantages which result in win- win situations for all supply chain participants (Shi and Yi, 2013). There are strong relationships between strategic purchasing and supply management, customer responsiveness, and financial performance such as return on investment, 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. IT and automation is established as a higher-order SCFP theme. IT-based SCM systems make positive contributions to financial performance (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 facilitates technology adaptation and application.

Template analysis depicted 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 financial performance (Shi and Yu, 2013). Integration and collaboration is vital to optimise SCFP. Supply chain integration facilitates supply chain flexibility which improves financial benefits especially during market unpredictability, including demand uncertainty and financial crisis. However, the performance of integration and collaboration could be affected by the level of trade digitalisation, concentration and duration of the supply chain, product and market complexities, and mutual trust (Zubairu, et al., 2019). Table 1 reveals sustainability in supply chains as a higher-order SCFP driver. Sustainability in competitive global supply chain networks 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). Supply chain 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 supply chain sustainability reflects concerns with climate change and ecosystems which necessitate environmentally friendly practices as a competitive supply chain strategy (Ntabe et al., 2015). Social and environmental sustainable supply chain practices have positive effects on the economic dimension of sustainable supply chain, which is strongly linked to financial performance. Sustainability in supply chains is more efficient when implemented jointly by all supply chain participants. However, the financial benefits of sustainable networks vary between regions and industries. Additionally, economic challenges such as a financial crunch could affect sustainable SCFP.

5.2. Study stage two results

Study stage two measured and prioritised the supply chain strategies and financial measures established in stage one in NLNG networks using quantitative survey data collected from 23 strategic decision-makers at NLNG. The prioritisation was conducted using AHP as a multi criteria decision- making method to measure the relative weight of each of the identified strategies on NLNG systems (Table 2).

	C_1	C_2	C_3	C_4	Composite weight	Priority
Criteria weight	0.3206	0.3013	0.1756	0.2025		
A_1	0.3142	0.3155	0.2605	0.2552	0.2892	1st
A_3	0.2705	0.2901	0.2992	0.2282	0.2729	2nd
A_2	0.1906	0.2174	0.2258	0.2916	0.2253	3rd
A_4	0.2247	0.1770	0.2145	0.2451	0.2127	4th
Total weight	1.0000	1.0000	1.0000	1.0000	1.0000	

Table 2: Evaluation of supply chain initiatives and determination final ranking

Empirical results established that integration and collaboration is the highest-ranking SCFP capability in NLNG due to its superior ranking in terms of its influence on revenue growth and cost reduction, as well as a very good ranking in relation to working capital efficiency as measures for financial performance. AHP analysis revealed that sourcing strategy is the second highest-ranking SCFP initiative in NLNG systems as a result of its superior ranking concerning working capital efficiency, as well as a very good ranking in terms of its influence on revenue growth and cost reduction as financial performance measurement criteria. Despite the role of IT and automation as an enabler for integration and collaboration, which is the dominant driver of SCFP, empirical analysis established that IT and

automation is the third ranking SCFP initiative in NLNG owing to the superiority of sourcing strategy concerning revenue growth, cost reduction and working capital efficiency. Analysis of study stage two revealed that Sustainability is the lowest ranking SCFP driver in NLNG systems due to its poor ranking in terms of its influence on revenue growth, cost reduction and working capital utilisation as financial performance measures in NLNG systems.

5.3. Supply chain financial performance measures in NLNG networks

Previous studies show how SCM practice drives firm financial performance in terms of revenue, operating costs, and working capital, fixed assets utilisation. Findings from study stage two present revenue growth as the most important factor for consideration when measuring supply chain financial performance (SCFP) in NLNG networks. Cost reduction is the second most important measuring criterion. The third ranked measuring criterion is fixed asset utilisation. Working capital efficiency was ranked fourth and considered as the least important SCFP measurement criterion by experts at NLNG (Table 2).

6. Conclusions, Implications and directions for future research

SCM practice contributes significantly to corporate performance, including financial performance. This study proposes a clear framework for SCFP based on systematic literature reviews undertaken using template analysis, which reveals that appropriate supply chain strategy drives financial performance positively. The drivers of 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 is fundamental to optimising SCFP. AHP established that supply chain integrative and collaborative initiative is the major driver of financial performance in NLNG networks. Findings ranked sourcing strategy, IT and automation, and sustainability as second, third and fourth in terms of their relative influence on SCFP in NLNG systems. This study revealed that supply chain integrative and collaborative initiative and sourcing strategy should be prioritised ahead of other established SCM practices. SCM strategies improve financial performance metrics including revenue, cost, working capital and assets utilisation. This paper represented SCM initiatives as an iterative organisational supply chain strategy, whereby each network participant is analogous to a value chain. Optimum NLNG SCFP strategy assumes that all participants implement strategies collectively as none of the initiatives is a standalone driver of financial performance.

6.1. Practical impact

This study contributes to SCM and financial performance research by developing a framework based on clearly defined theoretical and methodological foundations and identifies a combination of SCFP drivers and measures to guide supply chain participants. Results highlight the need to incorporate SCM as part of corporate strategy, because supply chain capabilities affect financial performance in both the short-run and long-run. Template analysis 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 systems to achieve supply chain competitive advantages. The method assists practical identification of SCFP strategies that drives SCFP positively. AHP as a structured technique for organising and analysing complex decisions offers a guide for organisations to gain supply chain advantages. The methodology assists practical application of supply chain cooperative initiatives, which if prioritised and safeguarded will result in financial gains to supply chain participants.

Researchers with access to other energy exporting countries can collect relevant data from which to capture practitioners' tacit knowledge, reality, and values to verify whether these financial drivers are applicable under different environments, or if otherwise, to identify other appropriate SCFP measures.

6.2. Research impact

Two methodologies were applied to achieve varied objectives ranging from hypothetical to empirical applications of the framework. Template analysis successfully captured the high variation of outcomes often reported, and identified common and shared themes. Application of these methods enables the identification and modification of generic supply chain strategies, which extend supply chain finance literature by providing an updated framework for SCFP. Further analysis facilitates testing of the SCFP initiatives in an industrial context, phenomena that have never been explored before.

The generic SCFP framework presented here can be applied to other sectors where no reliable typology for SCFP drivers and measures are missing. A methodology for framework development is presented based on systematic selection and analysis of published texts, guided by template analysis.

6.3. Directions for future research

The research procedure is generalizable and replicable, and future work is required to test the results in any of the major LNG exporting networks and other emerging energy sources including fuel cells, hydrogen and lithium-air batteries supply chains. The role of digital technology is increasing in the energy sector, it is of paramount importance that future studies consider the impacts of technologies such as big data, blockchain, and artificial intelligent on NLNG networks' financial performance. Other supply chain variables should be empirically examined regarding their implications for financial performance in LNG networks. Existing studies employ conventional accounting measures as surrogates for SCFP, creative efforts are needed to design SCM-specific performance measures for assessing the financial performance of supply chains and supply chain participants.

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Consumer markets

Multi-parcel crowd-sourcing last-mile delivery: A model to assess economic benefits

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Introduction

In recent years the diffusion of Business-to-consumers e-commerce has been increasing in many industries (Mangiaracina et al., 2016) and in both mature and emerging markets (Vakulenko et al., 2019). In 2018, worldwide online sales have been worth about € 2.500 billions, showing a +20% increase with respect to the previous year (B2c eCommerce observatory, Politecnico di Milano). While the early stages of online commerce have been characterised by the diffusion of services (e.g. ticketing, couponing, hotel booking), the latest years have seen the growth of the products, whose online sales are becoming more and more significant. With respect to intangible goods, products introduce remarkable logistic challenges for retailers, which are in charge of both picking and last-mile delivery (LMD) activities that on the offline channel would otherwise be carried out by customers (Mangiaracina et al., 2018). LMD constitutes the final leg of the order fulfilment, aimed at delivering the products ordered online to the final consumer (Lim et al., 2018). It is very critical, in terms of both efficiency and effectiveness. On the one side, this process is very expensive. Orders are typically composed by few lines and few pieces, and destinations may be very dispersed (Macioszek, 2017). Moreover, B2C delivery attempts may fail if customers are not at home to collect the parcels, and re- scheduling missed deliveries entails very high costs. As a result, LMD costs can amount up to half of total logistic costs (Vanelslander et al., 2013). On the other side, expectations of online customers in terms of delivery performances are increasingly demanding. Online customers look for both punctuality and delivery speed (Savelsbergh and Van Woensel, 2016), but they are typically not willing to pay for a better service (Borsenberger et al., 2016).

These being the premises, companies selling products online have been striving to find solutions to efficiently and effectively cope with the challenges of B2C last-mile delivery. Some authors focus on options that have been already implemented by different players, such as parcel lockers (lockers usually grouped into structures located in public places, where customers are able to retrieve their parcel using a one-time password) or pickup points (institutions such as stores providing storage services) (Wang et al., 2014). Some other works propose instead more innovative options, which are still not widespread, e.g. robots – self-driving road vehicles that move on determined and controlled paths (Boysen et al., 2018) – or underground delivery – i.e. capsules containing the parcels moving within an underground pipeline system (Slabinac, 2015). Among the proposed options, crowdsourcing logistics has been recently gaining the attention of both the academic and the managerial communities. It consists in applying crowdsourcing to logistics "through collaborative platforms and mobile apps that connect individuals and firms to peers (travellers, movers, authorized drivers, owners of empty storage spaces, etc.) in order to make the best use of distributed, idle logistics resources and capabilities. Crowd logistics calls on individuals to perform basic logistics services on an ad-hoc basis" (Carbone et al., 2017). Despite academics recognise crowdsourcing logistics as one of the most promising sources of innovation in the last-mile delivery field, works addressing this solution are still scarce (Carbone et al., 2017). This "paucity of academic contributions" is colluding with the fact crowd logistics has been recently spreading in the business world, with many successful initiatives in different industries and markets (e.g. Deliveroo for food in Italy, Amazon Flex for parcels in USA).

In this context, the application of crowdsourcing logistics to B2C e-commerce last-mile deliveries emerges as a very promising field of study. Research opportunities in this area are open, and contributions in this direction could be beneficial for both academics and practitioners.

Literature review

One of the first definitions of crowdsourcing logistics found in the literature is by Mehmann et al. (2015): "Crowd Logistics designates the outsourcing of logistics services to a mass of actors, whereby the coordination is supported by a technical infrastructure. The aim of Crowd Logistics is to achieve economic benefits for all stake- and shareholders." This statement highlights two key factors of crowdsourcing logistics. First, the presence of the "crowd", i.e. the mass of actors to which activities are outsourced; second, a "technical infrastructure" used to reach those actors and to coordinate their work. These two elements are also present in the more recent and comprehensive definition by Rai et al. (2017), according to whom crowdsourcing logistics represents "an information connectivity enabled marketplace concept that matches supply and demand for logistics services with an undefined and external crowd that has free capacity with regards to time and/or space, participates on a voluntary basis and is compensated accordingly". Beside the technological infrastructure and the crowd, the authors identify five additional elements needed to define crowdsourcing logistics. They are: (i) free capacity of the crowd, in terms of space/time, which is the resource they aim to "sell"; (ii) externality from the company, since people from the crowd are not employees and they do not undergo a traditional formal hiring process; (iii) undefined identity of the people from the crowd; (iv) compensation, which represents the economic incentive offered to the crowd based on the amount of space/time they sell; (v) voluntary engagement of people, who are free to choose if and when they want to perform a task.

While these definitions allow to exclude initiatives that may not be considered crowdsourcing logistics, they still are not specific and precise. The framework by Carbone et al. (2017) identifies four main types of initiatives, based on the outsourced activities. First, the crowd storage that implies the provision of space, usually in garages or courtyards, to store products (e.g. furniture). Second, the crowd local delivery that consists in outsourcing short-distance deliveries of parcels or food to riders, who are typically required to ensure high speed. Third, the crowd freight shipping that refers to the delivery of odd-sized parcels covering both domestic and continental deliveries. Fourth, the crowd freight forwarding that still refers to the delivery of products, but mainly for intercontinental distances (in this case riders usually move by planes or boats).

Among those models, the most diffused one – both in literature and in industry – is the crowd local delivery. The technological infrastructure behind it is usually an online platform that can be accessed through an application by both the customers – who issue orders – and the riders – who give their availability and accept the tasks. Riders typically rely on their own mean of transport, which may be a van, a car, a scooter or a bike; nonetheless, there are also cases in which they move just walking, or relying on public transport means. Outsourcing the last-mile delivery emerges – according to both practitioners and academics – as a very suitable option in the B2C e-commerce field (Castillo et al., 2017; Frehe et al., 2017), allowing to perform low-cost and fast deliveries as well as to gain high flexibility.

Despite referring to crowd local delivery, scientific literature highlights the presence of different types of initiatives, characterised by specific peculiarities – and thus entailing different benefits with respect to traditional by-van deliveries. More in detail, four main models may be identified.

For-free deliveries, in which people collect and deliver parcels for friends or acquaintances, typically with a very little detour from their original route (Devari et al., 2017; Suh et al., 2012). The main advantages of this model are social (social cohesion) and environmental (very low emissions, since it relies on people who have to deliver the parcel without a significant additional distance to be travelled from their original path).

Occasional – usually remunerated – deliveries performed on the behalf of other members of a community (e.g. for college mates) (Paloheimo et al., 2016; Kim, 2015). In this case, the main advantage is again social, since providing the delivery service allows to strengthen relationships with community-mates.

Hybrid solution, in which an e-commerce player integrates its own van fleet (traditional model) with a group of occasional riders performing crowdsourced deliveries to exploit working opportunities (Dahle et al., 2017; Macrina et al. 2017). This model mainly entails economic benefits (flexibility), since companies may rely on the crowd to deal with demand peaks, which would otherwise require the activation of ad-hoc vans (thus implying higher fixed costs).

Deliveries performed by an ad-hoc created fleet of riders, whose operations are centrally coordinated and optimised (Chen et al., 2018; Kafle et al., 2017). In this case, there are advantages in terms of both efficiency (due to the higher flexibility of the crowd with respect to van drivers performing 8-hours delivery tours) and effectiveness (since online platforms allow offering value added services, such as geo-localisation and real-time order collection).

Despite the application of crowdsourcing logistics to B2C last-mile deliveries has already gained the interest of the academic community, there are still different aspects that could be further investigated. More in detail, literature analysis highlighted gaps that may be attributed to two main areas. First, many works perform high-level or qualitative analyses (e.g. framework) aimed at providing a clear understanding of a specific solution, its possible configurations and the benefits stemming from its implementation. This is particularly true if considering the first papers about the topic, and it typically happens when the studied phenomenon is recent (as crowdsourcing logistics is). Second, among those contributions proposing an economic analysis of the solution, the majority focuses on the hybrid fleet

– both owned vans and occasional drivers – in which the crowd delivers just few parcels, generally on the home-job path and, also in this case, with a high-level of analysis. Despite the chance to aggregate several parcels in the same delivery and assign it to one rider is identified as an effective and efficient opportunity by different authors, detailed economic analyses about the implementation of the fourth crowd local model seem to be missing.

Objectives and methodology

The exploitation of a wide base of riders working on-demand to deliver a large set of parcels is starting to be perceived as highly significant not only by academics, but also by practitioners. Amazon Flex (i.e. one of the main initiatives that relies on common people to fulfil the LMD of e-commerce orders according to flexible working shifts) represents a clear example of the important adoption that crowdsourcing can achieve, being this project implemented in different countries, both in the US and in Europe (Arslan et al., 2016). Nonetheless, this model is still under-investigated in the literature and often only cited as a potentially promising option, for which no detailed analyses are performed.

Focusing on this type of solution through the development of a quantitative model, this work tries to fill the two main gaps emerged from the literature analysis: i) the scarcity of detailed realistic economic analysis and ii) the low interest for multi-parcel crowdsourced deliveries. More in detail, the following research question is addressed:

RQ. What are the performances of multi-parcel crowdsourcing last-mile delivery if compared to those of traditional delivery?

In order to reach the defined research goal, two steps are performed. First, an analytical model is developed that, after the generation of customers' demand and the assignment of deliveries to the available riders, computes the delivery costs of multi-parcel crowdsourcing logistics. In addition, also the costs associated to traditional van-deliveries are computed, to compare the two options. Second, the model is applied to a realistic case in Milan, Italy, to get numerical insights about the economic performances of crowdsourcing delivery with respect to those of the traditional delivery. To support the model development and application, three additional

methodologies are used: literature review, semi-structured interviews with practitioners (e-commerce retailers and logistics service providers, mainly express couriers) and the analysis of secondary sources (e.g. e-commerce websites, journals of logistics practitioners, reports).

Model development

The architecture of the model (see Figure 1) is composed by four main building blocks. The corresponding variables and parameters are derived while combining the three mentioned methodologies.

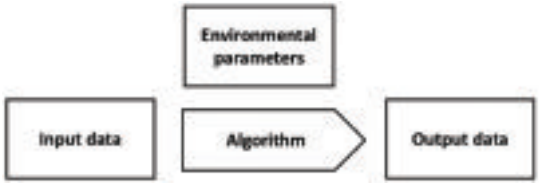


Figure 1: The model structure

"Input data" are the values of the variables that describe the last-mile delivery problem. Eight variables have been considered:

- Delivery area and sub-areas – overall geographical area where deliveries have to be performed. The area is then divided into different sub-areas. In fact, the model is developed in order to support a multi-hub delivery option, in which each sub-area is served by a different warehouse.
- Number and location of warehouses – number and location (in terms of geographical coordinates) of the hubs.
- Demand – total daily number of parcels to be delivered in each considered area.
- Time slots – number of time slots in which the daily delivery time is divided.
- Number of riders – dimension of the crowd, i.e. overall number of riders available to perform deliveries during the day. The model relies on the assumption that the number of riders is higher than the one needed.
- Distribution of riders per shift – percentage distribution of available riders over the different shifts (i.e. the different delivery time slots). The model takes into account that the riders may give their availability for different time windows (e.g. some may work for four hours, some may decide to give their availability for just two hours).

"Environmental parameters" are those elements related to the context in which the problem is applied (e.g. legal or social regulations). Six parameters have been considered:

- Daily demand distribution – percentage distribution of the orders to be delivered in the different time slots of the day. Demand is considered not to be evenly distributed over the day and the model concentrates deliveries in the latter part of the day. As a matter of fact, the flexibility entailed by crowdsourcing allows to schedule a high number of deliveries when they will most likely be successful (i.e. when the customers have a higher probability to be at home). Interviews revealed that it corresponds to the afternoon/ evening hours.
- Working shifts duration – duration of the possible working shifts offered to the crowd.
- Couriers' wage – compensation paid to the riders. Based on the analysis of both literature and real initiatives (e.g. Amazon flex), riders are paid depending on the expected time needed to accomplish the delivery tasks (i.e. no variable remuneration).
- Stops duration – fixed time required by the stops, both at the customers' home (to perform the needed activities, e.g. park the transport mean, ring the bell, deliver the parcel) and at the hub (at the beginning of the tour to load the parcels, and at the end of the tour to take back those parcels not delivered due to the absence of the customer).
- Failure delivery rate – percentage of deliveries not successfully accomplished due to the absence of the customers at home. Based on both literature and interviews, the model considers different percentages depending on time slots of the day (i.e. lower failure rate in the afternoon/ evening).

"Output data" are the results of the model, achieved through the application of the algorithm. The main output are the average delivery costs per parcel for each time slot (computed as the total cost of the riders working in each slot by the number of successful deliveries). The overall daily average delivery cost per parcel may then be derived as the average of the cost of the different slots, weighted by the corresponding number of delivered parcels.

The model "Algorithm" is made of all the major steps and analytical computations needed to achieve the outcome. More in detail, five main stages may be identified.

1. Demand generation: based on the overall daily number of orders to be delivered, on their distribution along the day and on the overall considered delivery area, the model is initialised. More in detail, all the orders are associated to the addresses of the customers (in terms of both latitude and longitude).

2. Clusters creation: depending on their geographical distribution over the delivery areas, the orders are then divided into a set of clusters, each one representing a delivery tour to be accomplished by one single rider. Clusters are built to maximise the delivery density per tour, leveraging on the centre of gravity principle.

3. Theoretical routings optimisation: the routing is then optimised for each cluster (i.e. for each delivery tour). The sequence of customers in the tour is defined to minimise the overall travel time. In order to reduce the time needed for the computations, this step is performed based on the rectilinear distances among the different destinations (i.e. just considering the coordinates, and not the real distances).

4. Actual travel time computation: the actual travel time needed for the delivery tour is then computed. The distances as well the traffic conditions considered in this step are the real ones, which are integrated by means of the Google Maps Distance Matrix API (Application Programming Interface). In addition to the travel time, also the time needed to stop both at the warehouse and at each customer house have been considered to compute the overall durations of the tours. Based on this actual total time, each tour is then assigned to one available rider, minimising the non-operative time: among

those riders whose availability is higher than the required one, the algorithm selects the one for which the difference between availability and time needed is the lowest.

5. Cost estimation: based on the number of assigned riders and on the duration of their working shifts, the overall cost for performing the deliveries is computed for each cluster (multiplying the working hours by the hourly pay and summing up the values referred to the different riders). The cost per delivered parcel may then be derived dividing the total cost by the number of accomplished deliveries.

Model application

After its development, the model has been applied to a realistic context in Milan (Italy). The main goal of the model application is to evaluate the effect of crowdsourcing logistics on LMD cost, and to compare it with a traditional delivery solution based on vans. This two-step methodology (i.e. development of analytical model and implementation to a realistic context) is widely adopted in literature dealing with LMD innovations (e.g. Qi et al., 2018).

The application context is defined based on assumptions and data mainly derived from interviews to logistics service providers – express couriers – but also relying on literature and secondary sources. Table 1 shows the values referred to the crowdsourcing logistics case, while Table 2 summarises data of the traditional by-van delivery option. The majority of the hypotheses are the same for both the cases, but some need to be adjusted for traditional deliveries.

The results of the model application in terms of delivery cost per parcel – for both the crowdsourcing and the traditional delivery cases – are shown in Figure 2. The three warehouses are separately analysed in the three sections of the graph.

Input parameters	Delivery area and sub-areas	240.28 Km² divided in three areas (80.85 – 77.44 – 81.99 Km²)
	Number and locations of warehouses	3. Coordinates: (45.522; 9.175) – (45.435; 9.1) – (45.435; 9.245)
	Demand level	20.000 parcels/day
	Time slots	8.00-12.00 – 12.00-16.00 – 16.00-20.00
	Distribution of riders per shift	30 % (120 min) – 35 % (180 min) – 35 % (240 min)
Environmental parameters	Daily demand distribution	25 % (8.00-12.00) – 30 % (12.00-16.00) – 45 % (16.00-20.00)
	Working shifts duration	120 min – 180 min – 240 min
	Couriers wage	14 € / hour
	Stops duration	4 min per customer – 5 min at hub
	Failure delivery rate	18 % (8.00-12.00) – 18 % (12.00-16.00) – 10 % (16.00-20.00)

Table 1: Crowdsourcing logistics case

Input parameters	Time slots	8.00-16.00
	Couriers availability	100 % (480 min)
Environmental parameters	Daily demand distribution	100 % (8.00-16.00)
	Working shifts duration	480 min
	Cost per courier	150 € + 0.01 € * Travelled Km

Table 2: Traditional delivery case

The obtained values lead to two main considerations. First, the crowdsourcing logistics option results to be more economic than the traditional delivery option. The average crowdsourcing delivery cost

per parcel is € 2.56, while in the traditional option it is € 2.89 (thus leading to 11.4% cost saving). The main reason behind this benefit is the flexibility crowdsourcing logistics allows to achieve in managing deliveries over the day. As a matter of fact, on the one side, deliveries may be scheduled considering shorter timeslots (120 to 240 minutes) with respect to the daily delivery tour of vans in traditional deliveries (480 minutes). On the other side, with crowdsourcing logistics a higher number of deliveries is allocated to the afternoon/evening hours. This increases the corresponding success rate (and thus the number of deliveries on which the total cost may be spread). Second, the savings for the different warehouses vary from 10.24% to about 11.88%. The differences among the three scenarios are linked to traffic conditions: warehouse 3 is located in a more central area, in which the travelling time per km is higher, due to traffic and congestion.

The model quantifies the economic benefits stemming from the implementation of crowdsourcing logistics in terms of delivery cost (i.e. cost of manpower and cost of transport). Though, it does not fully evaluate the positive effect of the flexibility it implies, which is twofold. First, considering short-term flexibility, it is possible – as previously stated – to rely on a higher number of riders in the afternoon/evening timeslot, and to accordingly schedule more deliveries in that moment of the day.

The consequent increased delivery success rate does not only result in a higher efficiency, but also in much greater customer satisfaction. Second, considering long-term flexibility, crowdsourcing logistics allows to more easily deal with demand peaks also during the year. Seasonality strongly affects online purchases, and being able to avoid additional delivery capacity related to the vans may entail great economic advantages.

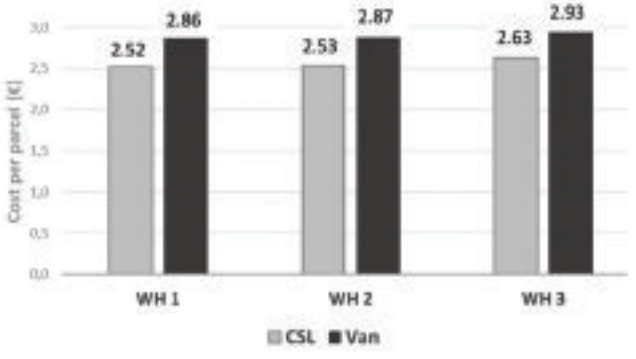


Figure 2: Results of the model application

Conclusions

This paper develops a model to evaluate the effect of multi-parcel crowdsourcing logistics on LMD performances (in terms of delivery cost), and to compare it with a traditional delivery solution based on vans. Its application to a realistic case in Milan (Italy) shows the positive impact of this innovative last-mile delivery solutions with respect to traditional by-van deliveries (thus answering the proposed RQ).

This work provides both academic and managerial implications. On the academic side, it contributes to the extant knowledge about crowdsourcing logistics for LMD. It develops and applies an analytical model to compare delivery costs of multi-parcel crowdsourced deliveries to those of the traditional van-fleet operating mode. Therefore, it allows drawing quantitative insights about a crowdsourcing logistics paradigm that – even if identified as promising by both practitioners and academics – was mainly addressed in literature by means of high-level qualitative methodologies. On the managerial side, this paper offers a useful tool to practitioners selling products online in evaluating the convenience of implementing multi-parcel crowdsourcing logistics in LMD, as an alternative to traditional delivery solutions.

This work has some limitations, which could be overcome through further developments. First, the model considers just one scenario for the its application. Further research efforts could be aimed at evaluating the effect on the LMD cost per parcel of potential variations in the values associated to the different variables and parameters (e.g. daily demand, wage and shifts of the riders). Second, the model relies on the assumption that the number of available riders is always sufficient to deliver all the parcels and this is not always true in real contexts. Future works could aim at evaluating the effects of riders unavailability on LMD performances. In addition, instead of considering the dimension of the crowd as an independent input variable, efforts could be made to integrate in the model a relationship between the compensation and the availability of riders (since the wage may influence a lot the willingness of riders to participate to a crowdsourcing logistics initiative). Finally, future works could quantify the impact (in terms of saving) of the long-term flexibility entailed by crowdsourcing logistics, which is mentioned in the previous section.



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Developing a conceptual framework to identify performance measurements for medical tourism supply chain management

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Abstract

Medical tourism is a promising industry with an increasing number of people are travelling overseas looking for alternative destinations to obtain medical treatment due to an increase in waiting time, difficulty in accessing physicians, and high medical treatment cost at home countries.

Though there have been several research studies on medical tourism industry, they largely provide marketing management perspective and not supply chain management perspective. No research has been undertaken so far to understand the relationship between the medical tourism and the service supply chain management (SSCM) performance measures. The purpose of this paper is to present a conceptual framework to identify the relationship among Service Supply Chain Management (SSCM), medical tourism and service quality dimensions as the performance indicators. Systematic literature reviews are conducted to understand the definition, dimensions and the impacts of medical tourism performance. Content-analysis is applied for reviewing seven-sub-fields of SSCM. We propose a conceptual framework to demonstrate how medical tourism supply chain is integrated with SSCM perspective and service quality dimensions as the medical tourism service performance. Considering a lack of research on medical tourism supply chain management, the proposed conceptual framework intends to provide a supply chain management model for future research on medical tourism.

Introduction

In recent years, the area of medical tourism have widely been researched due to dynamic changes in living standards, an aging population, healthcare accessibility, longer life expectancy and lifestyle of tourism. The medical tourism industry has been playing a promising role in the economic development of many countries. Medical tourism has been defined as an activity of people travelling across borders to receive medical treatments in less-developed countries (Carrera and Bridge, 2006). Medical tourists are satisfied to travel abroad in order to obtain healthcare treatment at a lower cost with reduced waiting times, easy accessibility to physicians pre- and post-treatment, where patients can benefit from the option to undertake a vacation in the host country (Cohen, 2008). As a result, there has been a steady growth in the number of people travelling abroad to seek medical treatment. This has caught the attention of both academics and practitioners in this industry (Abramovitz et al., 1987; Nwankwo et al., 2010 cited in Debata et al., 2015).

Though there have been several research studies on medical tourism industry, they largely provide marketing management perspective and not supply chain management perspective. No research has been undertaken so far to understand the relationship between the medical tourism and the service supply chain management (SSCM) performance measures. This study examines the relationship of service supply chain dimensions within medical tourism supply chain by proposing a conceptual framework in order to demonstrate the service quality dimensions as the service performance indicators.

Literature review

Medical tourism

Numerous scholars have attempted to define the term ‘medical tourism’ and there is no consensus on the typology of medical tourism. Bookman and Bookman (2007:p.1) define medical tourism as “an economic activity that entails trade in services and represents the slicing of at least two sectors: medicine and tourism”. Connell (2006) identifies medical tourism as niche area, where people choose to travel overseas countries to receive surgical and dental treatment. Carrera and Bridges (2006) suggest that medical tourism is a subset of health tourism and medical tourism is about people who travel outside’s their home country for the enhancement or restoration of their health through medical involvement. Jagyasi (2009) explain that medical tourism is about the set of activity of people who elect to travel long distance, to avail medical treatment with direct and indirect engagement in leisure, business or other purpose.

In this study, we define ‘Medical Tourism Supply Chain’ as “the network of suppliers and goods service providers, who are mainly associated with delivering medical treatments and tourism services to the foreigners in the specific country or their chosen destination”. The medical Tourism Supply Chain covers a wide range of participants such as medical tourists or foreigners, healthcare providers, and other from both public and private sectors. To analyse the medical tourism supply chain, the following elements are taken into account such as its chain structure, relationship between individuals (airlines, accommodations, healthcare providers, travel agencies, and

medical tourists), and the measurement of medical tourism performance (medical tourists' satisfaction with the healthcare providers and tourism attractions, financial performance, sustainable development of tourism, and operational efficiency) (Slusarczyk, Smolag & Kot, 2016; Tigu and Calaretu, 2013; Adriana, 2009).

Implementation of the Service Supply Chain Management

Supply Chain Management has become critical to every sector manipulating internal and external firms and dealing with the dynamic competitive marketplace. Supply Chain Management (SCM) has been defined by many academics and practitioners. For example, Chopra and Meindl (2016) define SCM as the involvement of all parties and functions such as manufacturers, suppliers, transporters, warehouses, retailers, consumers and so forth whose support the end user request. Slack et al., (2016) identifies the definition of supply chain management that SCM is the management of the relationship of the process and operations that shape the value in form of products and service to consumers. A number of scholar have conducted empirical research on Supply Chain Management from many sectors such as manufacturing, transportation, service. Over the years, much research has been conducted to determine the role of Supply Chain Management (SCM) in improving performance of various firms and industries. The study of SCM has become a key aspect of increasing potential benefits such as operations improvement, and performance development.

The service sectors have become increasingly crucial as the driving force in many countries, but research in the service sector is still scant because of its complexity and the characteristics of the industry's nature. Few attempts have been made to investigate the role of Service Supply Chain Management. There is an opportunity for both scholars and practitioners to study about Supply Chain Management (SCM) especially in the service sectors.

Most scholars agree on the importance of Supply Chain Management. However, the role of the literature regarding Service Supply Chain Management (SSCM) is effort in progress in many areas such as conceptual definitions (Ellram et al., 2004; Baltacioglu et al., 2007), SSCM process capabilities measurement (Boon-itt et al, 2017), Service Supply Chain Management (SSCM) implementation case studies (Giannakis, 2011) and so forth.

In the literature on traditional supply chain management processes relating to service processes, for example, the flow and return management process is replaced by customer relationship management process. Service cannot be recycled or reversed after delivering to customers as in the case of reverse management process in the manufacturing industry. However, in service industry, it would turn into customer relationship management and order process management. Ellram et al. (2004) and Baltacioglu et al. (2007) provided the earliest study of seven service supply chain management dimensions as Figure 1 shows.



Figure 1: Service Supply Chain Management dimensions
Source: Adapted from Baltacioglu et al., (2007)

Baltacioglu et al.'s figure (2007), above, identified seven major dimensions as identified below.

1. Demand management is the capability in estimating forecasts and managing customer demand by applying the information for accurate demand planning and shaping service capacity (Berry et al., 1979; Mabert, 1982; cited in Boon-itt et al., 2017:3).

2. Capacity and resource management is defined as the competence in balancing demand from customers and firm's service capacity at the optimum capacity (Baltacioglu et al, 2007; Boon-itt et al, 2017).

3. Customer relationship management is defined as the capability in interacting with internal firms and customers, creating the customer demand and developing long-term customer relationship by using real-time information technology. In addition, improving communication with customers and understanding the prediction of customer demand can also lead to customer relationship management (Boon-itt et al., 2017; Baltacioglu et al., 2007).

4. Supplier relationship management is the capability to manage and maintain a relationship between firms and its suppliers (Chopra & Meindl, 2004). Supplier relationship management is the core process for every business which supports, plans, sources material, and coordinates with suppliers (Baltacioglu et al., 2007).

5. Order process management is described as the competence in getting orders from customers, examining the order status and interacting with customer (Lambert et al,1998). This function is critical for service firms because the manufacturing goods can be produced before customer places the order, but service is delivered after the order is received.

6. Service performance management is the competence in managing, improving the performance of service process and fulfilling the customer requirement (Baltacioglu et al.,2007). It involves many aspects such as service delivery management, order process management and other activities.

7. Information and technology management is the competence in sorting customer demand, sharing information among the firm supply chain, establishing expectation, shaping the scope of job description, service and required skills for service firm, and following up the customer feedback regarding service (Ellram et al., 2004; Boon-itt et al., 2017).

Research Methodology

The purpose of this research is to develop a conceptual framework for the medical tourism supply chain within the Service Supply Chain Management (SSCM)in order to identify performance measurement indicators. To obtain the current state of medical tourism and Service Supply Chain Management, a systematic literature search of academic databases was conducted; Scopus, ScienceDirect, Google Scholar and Web of Science inputting the keywords of, “Medical Tourism Supply Chain”, “Service Supply Chain Management” , and “medical tourism”. It was found that medical tourism and service supply chain management are currently limited. There were less than 90 studies each year during over the timespan 2015-2019 on the Web of Science database and there were less than 110 research studies each year found in ScienceDirect Database.

A significant number of medical tourism supply chain works were published in 2017 (68 papers) and 2016 (85 papers). Figure 2 highlights the number of Medical Tourism Supply Chain Management (MTSCM), Medical tourism (MT), and Service Supply Chain Management (SSCM) research studies during 2015-2019 from Web of Science database.



Figure 2: Trend in research on midical tourism supply chain management

We developed a content analysis to identify the main focus of individual papers. Methodology and geographical study areas focusing on various regions are categorised for empirical research. The findings show that two-third of empirical studies were found on Southeast Asia, whereas one-third of studies were on Europe and America. Within Southeast Asia, studies were conducted on India, Thailand, Singapore, Taiwan, and Singapore. On the other hand empirical research on medical tourism in Europe was mainly in German, Spain, Turkey, and Hungary. It could be argued that almost all empirical researches on medical tourism tend to focus on the most popular tourist destinations.

This study, based on Piboonrungroj and Disney (2009), offers four approaches to define the medical tourism supply chain and the research framework.

1) Defining medical tourism industry

A number of scholars have attempted to provide their definition of medical tourism and they are unanimous on their definition. Thus, it is important to clarify the definition of medical tourism from a systematic review.

2) Specifying characteristics of medical tourism supply chain

Medical tourism is an extremely sophisticated industry and it has two distinctive characteristics. The researchers have separated it into 3 tiers with reference to healthcare supply chain and tourism supply chain; such as the 2nd tier of suppliers, the 1st tier of suppliers, intermediary and medical tourists as the end consumers as the figure 3 on finding part.

3) Identifying medical tourism service quality dimensions

The purpose of this research is to develop a conceptual framework to identify and develop performance indicators for medical tourism supply chains. A systematic review of literature is undertaken to gain insight into medical tourism and Service Supply Chain Management (SSCM) to identify the main constructs of Service Supply Chain Management. These constructs will be the building blocks for analysing the influences of Service performance dimensions that would affect patients’ satisfaction in medical tourism supply chains.

4) Outlining flows and process

The researchers outline flows and processes of medical tourism supply chain by including Service Supply Chain Management (SSCM) perspective and service quality dimensions measurement. As from the previous studies, it can be confirmed that a number of scholars have provided the framework on healthcare side only. So in this study, the researchers attempt to derive a clear combination of supply chains which are associated with tourism and healthcare provider’s chains as the Figure 3 on finding part.

Finding and Originality

The researchers have developed a conceptual framework on medical tourism through a Service Supply Chain Management concept on Service quality dimensions as can be seen in Figure 3. There are three major focuses in the framework under the concept of Service Supply Chain Management (SSCM) that consists of seven dimensions, the integration of healthcare provider and tourism as the medical tourism supply chains and the service quality dimensions of medical tourist satisfaction. This research is a part of an on-going investigation in that some service quality dimensions may be eliminated or added after testing the validation and reliability of each dimension.

The seven dimensions of SSCM are categorised into three parts. Firstly, the customer-facing process which is about direct serving to the customers and be at the service point. Secondly, the back-stage processes from the service provide is called the supplier process. Thirdly, the overlap section which is the combination between Demand management and Information technology management. The overlap section is the main part to use for both customer-facing and supplier processes (Baltacioglu et al., 2007; Ellram et al., 2004). The next section is the integration between the healthcare provider chain and tourism chain. Both are combined together because the researchers think that if only the healthcare provider is analysed, it will be arranged in the healthcare supply chain not medical tourism supply chain. These chains need to be analysed including the components of tourism in order to study which factor would encourage the medical tourist to choose the destination. The last section is the

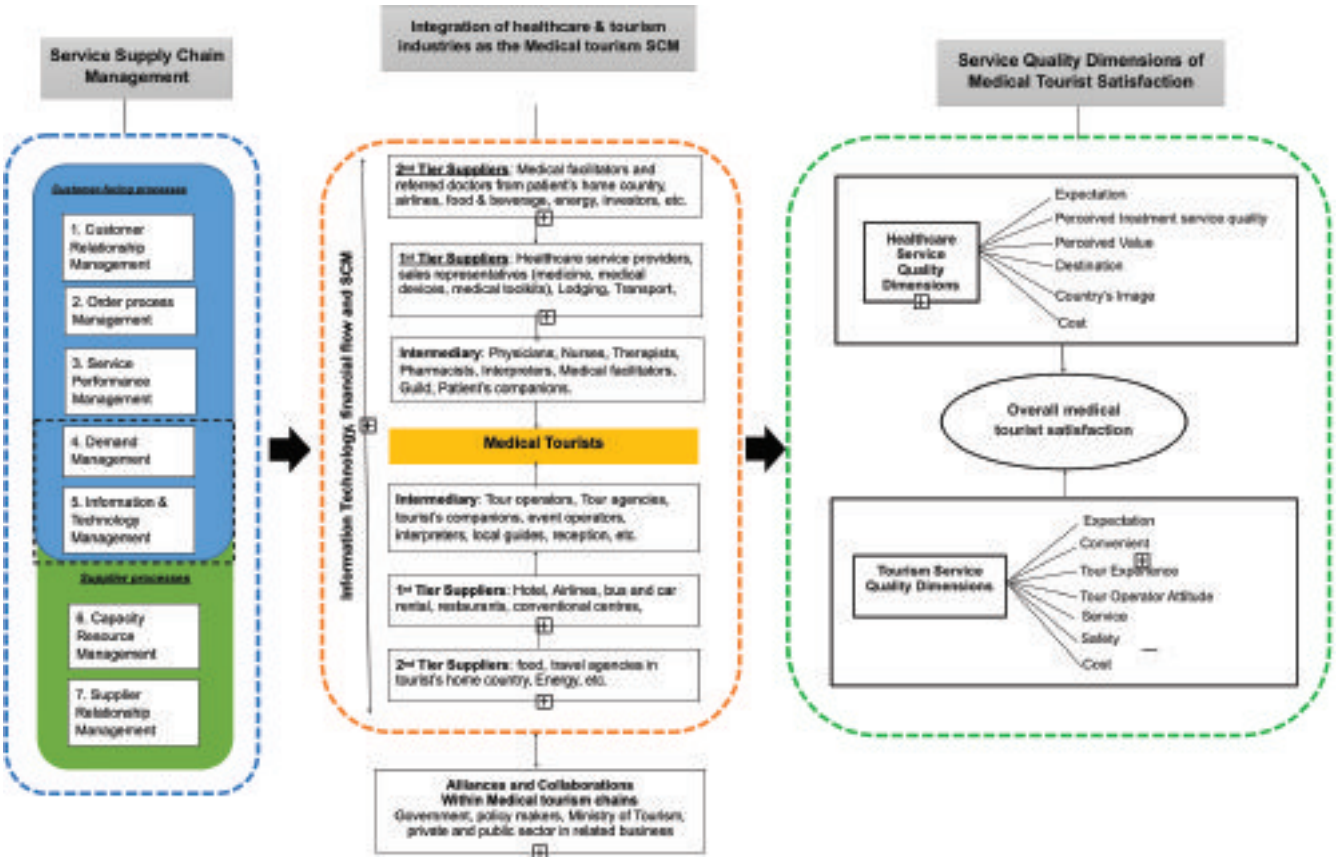


Figure 3: A research framework of Medical Tourism Supply Chain through Service Supply Chain Management (SSCM)

service quality dimensions which are mainly represented as the overall medical tourist satisfaction. We have conducted from many previous studies and divided into two-sub sections between healthcare service quality dimensions and tourism service quality dimensions (Momeni et al., 2018; Jain and Ajmera 2018; Debata et al., 2015; Lunt and Carrera, 2010).

Discussion and Conclusion

To sum up, this research identifies supply chain relationships in the medical tourism industry. The medical tourism supply chain management is the potential research agenda, which would enable a better understanding of the component of Medical tourism supply chain and the service performance indicators.

The research and findings are original and contemporary. Though there have been several research studies on medical tourism industry, scholars provide marketing management perspective by solely measuring medical tourist satisfaction and not service supply chain management perspectives. No research has been completed so far to understand the relationship between the medical tourism supply chain and the service supply chain management performance measures.

By all means, the proposed conceptual framework from this research has attempted to fulfil the gap in the literatures on service supply chains. In this regard, this research has developed a conceptual framework to encourage academics and practitioners in creating the awareness of measuring medical tourism performance within the service supply chain context.

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Decarbonisation

Investigating the road transport operators' challenges and obstacles in Egypt

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1. Introduction

Road transport plays a vital role in the economic development of any country. It is very obvious that without road transport, supply chain will not be achieved as the manufacturers will not be able to transport raw materials and components to factories, consumers will not be able to receive their finished goods and consequently, domestic and international trade will not be able to be performed.

Safe, well secured and smooth road transport will positively affect the countries' economy. The road transport industry is the backbone of strong economies and dynamic societies. Studied on ways to improve the transportation system are very broad and complex (Burks etal., 2010).

According to the findings of Paragon Software Systems' annual UK customer survey, 2018 on the most significant barriers facing the road transport sector in 2018, almost half of the respondents (46.4%) highlighted that the biggest challenges layed into lack of drivers and skilled workers. While transport cost was the second challenge (13.4), then congestion and lack of investments took the third place by 7.2% and finally urban transport restriction took the last challenge with 6.2%.

Highways are considered as the primary means of transporting people and freight in Egypt. However the vital importance of road transport all over the world and especially in Egypt, some major challenges are facing the road transport operators in Egypt and which negatively affect the road transport industry's performance.

The purpose of this paper is to explore the main challenges and obstacles that hinder the performance of road transport operators and consequently destructively affect the road transport industry in the developing countries and especially in Egypt. It also contributes in providing a proposed guidance on how these obstacles can be overcome in Egypt and it could be very useful for the other developing countries facing the same issues.

2. Literature Review

2.1. Economic Importance of Road transport sector in Egypt

As mentioned before that road transport plays a viable role in the countries' economy, Egypt's road sector is responsible for 97% of the freight movement where most of it is transported by private carriers compared with railway transport where the volume of cargo transportation by road has been increased from 1979 till 2010 to exceed the volume of freight carried by railway transport.

Road transport sector in Egypt carries about 53% of freight which is the largest share of freight movement in Egypt (Prospects for Egypt were challenging even before the recent unrest and political turmoil. Major obstacles include widespread poverty, rising unemployment, slow economic growth and a lack of investment. (https://www.pwc.com/gx/en/transportation-logistics/publications/africa- infrastructure-investment/assets/egypt.pdf).

According to Steyn et al., 2019, the major needs and drivers affecting the freight road transport cost have been summarized into the following table:

	Needs	Drivers
Infrastructure	Smooth Durable Safe Roads	Pavement condition
Vehicles	More economical vehicles	Lower Vehicle Operating Costs (VOCs)
Freight	Economic movement without damage	Demand for various types of freight
Congestion	Minimal congestion	Time
Logistics	Smooth roads from cradle to grave	Lowest total costs
Energy	Optimum transport system energy	Energy cost
Environment	Minimal environmental effects	Environmental impacts

Table2: Summary of the needs and drivers affecting road transport costs
Source: Steyn etal., 2019

Regarding to the previous mentioned factors affecting on road transport cost, and concerning the infrastructure item, the quality of road transport is considered as good in Egypt with 92% being paved. According to several studies, the densest road network is in the north east of the country linking Cairo to the ports as well as the rest of the Middle East through Sinai Peninsula. Plans to build a 32km bridge connecting Saudi Arabia and Egypt across the Gulf of Aqaba were recently revived following the change of political leadership in Egypt, but now appear to be a long way off. The bridge would be built to handle both rail and road traffic, and would use tolls to recoup the cost of construction, estimated to be in the region of US$3 billion. Egypt has 108,784 km of roads. A negligible amount of commercial goods move over any other mode, as estimates of trucking's share of the freight segment range from between 93% and 98%. (https://oxfordbusinessgroup.com/overview/prime-location-government- and-private-sector-are-working-expand-infrastructure-capacity-and-boost).

Egypt spent EGP 22.5 billion on roads and bridges that were completed between 2014 and 2017. These investments include 10 new roads worth EGP 12.8 billion as part of the National Roads Project as well as the further development of 2000 kilometers of existent roads at a cost of EGP 5.7 billion. These projects come in addition to the construction of four interchange hubs over the Nile at a cost of EGP

1.9 billion. EGP 2.1 billion were also spent on the building of a number of bridges, including along the Desert Road and the Cairo-Suez Road Zones (Ahram, 2018).

Although all these improvements and developments in the road transport sector in Egypt, still some obstacles are facing the road transport operators as the fluctuation in the exchange rate, the continuous increasing in the fuel prices which negatively affected the road transport in Egypt.

2.2. Issues and Challenges facing Road Transport Operators

2.2.1. Fluctuation of oil prices

The price of the crude oils is determined according to the supply and demand of the global markets, they are also the main determinant is the changes of prices as well.

It is known that the increasing in the crude oil prices affects the final price of some petroleum products as petro, kerosene and fuel oil. In road transport sector, the oil price is considered as a major part of the total fuel price which in return affects the transportation costs, distribution costs and the competition in individual countries. There are some major factors that contribute in the increase of the fuel prices which are the fluctuation in the US exchange rate, especially the devaluation of the Egyptian pound in front of the US dollar and the fuel related taxes as environmental taxes and stockpiling fees which are imposed by some European countries. Some countries levy fuel taxes in absolute value which means the quantity rather than the value and this in return affects the final consumer price of fuel.

It is obvious that the fluctuation in the oil prices affects the final pump price of the industrial production of fuel mainly the costs of raw material (Martino et al., 2009).

2.2.2. Impact of these factors on Road transport operators in Egypt

Despite a breakthrough in the recent period in the crisis of diesel and gasoline, road transport operators have confirmed the continuation of overland transport prices so far, which will be reflected on the prices of goods, especially imported from them. Road transport carriers attributed the increase to many variables, the most important of which is the increase in fuel prices, or sometimes scarcity, in addition to the successive increases in spare parts of cars and oils (IRU, 2008).

The diesel crisis and the high price of the euro and US dollar did not give road transport operators any chance of profit during the last period as most of the spare parts are imported from a number of European countries besides, the high prices of maintenance operations and the increasing of oil prices that are changed every 4,000 kilometres for cars (Ragab and Fouad, 2009).

Another challenge facing the road transport carriers is the decreasing in the trade volume either in terms of exports and imports which led to a surplus in the non-operating road vehicles which led many road carriers to stop a large number of cars because of the small volume of trade traded internally adding that the accumulation of cars in front of diesel fuel stations during the recent period led to exhaustion of drivers, making them demand to raise wages to compensate for this and all the burdens that fall on The transport contractor.

The absence of training centres for drivers in Egypt, which result in their non-qualification in a way that ensures that they did not commit accidents, led to a high incidence of accidents on the roads. The driver is not scientifically and psychologically qualified to face the sudden dangers, especially since most drivers use drugs to have the ability to drive at night. Thus, it is very important to establish centres for the rehabilitation and training of drivers, which had been in place for several years and was cancelled after that.

Another factor is that most of road transport operators in Egypt land depends on individuals with very few companies operating in an organized manner so it is recommended that road transport industry must rely on specialized companies to control their performance and be a means for the Egyptian market to transfer about 90% of the volume of Egyptian trade.

Statistics showed that 95% of accidents on roads caused by heavy transport vehicles, in addition to the damage caused by transport vehicles from road cracks, pointing to the need to establish centres to train and qualify drivers to reduce these terrible incidents and the need to establish restrooms on various places on all roads to rest By drivers while walking.

Finally, the road transport carriers are obliged to increase the road transport tariffs in response to the raise in the fuel prices, the spare parts prices and the increasing prices in tires (Almal, 2013)

2.2.3. Toll Roads

Toll roads is considered as another burden on the road transport operators and which resulted in increasing the operational costs which is negatively affected on to shippers when haulage companies are in a position strong enough to negotiate such demands. In the past decade, long distance transport has shown the lowest price increase (11%) in comparison with other transport services. Cost pressure is high in this market sector and aggressive competition lowers the prices. According to the German Trucking Association (BGL), the price of operating a truck in Germany is around €1 per vehicle-km (including driver, vehicle and fuel). The German toll is approximately 10% of this cost. Hauliers can pass on the majority of tolls for loaded headings to shippers and forwarders; the resulting cost increase remaining with the trucking business is 2% to 5%. According to Euler-Hermes (2015), current profit margins are as low as 1% for SMEs, while they reach 6% for the big players in road transport. Some small haulage companies have become bankrupt. However, considering that the 2008 financial crisis occurred during this period, the bankruptcies cannot be directly attributed to the toll. The recent one year anniversary of the Belgian road toll showed how the haulage companies have not been unduly impacted by the toll. Transport & Logistics Flanders reported that 85% of toll costs are passed onto clients. This means that tolls do not have to overly burden haulage companies as the shipper is the one who ultimately covers the cost.

According to some studies in Germany, it was estimated a share of transport costs at production costs between 2% and 3%. Thus, an increase of toll costs that would lead to an increase of transport costs by 15% would only impact the overall 5 a briefing by product costs by 0.5% on average. Therefore, the impact of the toll on actual product prices is so small that aggregated statistics cannot show an effect (Transport and Environment, 2017).

3. Research Methodology

This study is an exploratory research aiming to increase understanding of the phenomenon under consideration (Robson, 1993). This paper uses unstructured interviews as a qualitative research method for data collection. The interviews were conducted to six trucking companies and 4 individuals who own very few numbers of trucks where these trucking companies outsource from those individuals. The companies were chosen on size base and the number of trucks owned, all inside Egypt. All the interviewed companies and individuals are private sector, the trucks owned by public sector are few and only work inside port area, they do not travel between cities and sometimes outsource

from the private companies. The following table shows a brief description on the interviewed companies.

Company name	Interviewee title	Number of trucks owned by the company
Egyptian Saudi company for importing and transport	Chairman of Board of Directors	33 truck
Elbahnasy company	Company owner	6 trucks
ElAttaal company	Company owner	40 truck
Abd elrahman abdelhamid company	Chairman of Board of Directors	40 truck
El Ruwait	Company owner	20 truck
Elhwan owes company	Chairman of Board of Directors	20 truck
Maher Elgarby	Individual	One truck
Rabeh batran	Individual	2 trucks
Taha ebada	Individual	5 trucks
Ebrahim zarea	Individual	2 trucks

Table 1: Overview of the one-to-one interviews with trucking companies in Egypt

The method applied was gathered through interviews of ten industry professionals in Egypt. The structure of the interview questions were based upon loosely and spontaneously generates questions based on their reflections guided by a list of questions, called an aide memoire or agenda (Minichiello et al., 1990; Briggs, 2000; McCann & Clark, 2005). Questions was asked to explore the major problems and challenges faced after the Egyptian revolution. The interview started with an open question on the fuel prices impact and its major consequences, followed by a question on the new military fees in addition to the road toll. Then asking about tax calculation before and after the revolution followed by a discussion of the lack of drivers' problem, then closing the discussion with an open question for any additional information the interviewee may add.

4. Results and Discussion

The conducted interviews revealed that the majority of transport operators has been affected by the increase in the fuel prices over the last three years. Fuel cost is only one of the main components of total transport costs and its role in total freight transport costs differs by type of shipment, distance, load factors, but also per country. But the problem is when fuel price increase all related items in the transportation process also increase such as spare parts, tires, oil, etc.

The tires prices that are in continues increase, Alexandria company for tires have a monopolistic position in Egypt because the exported tires are very expensive and without warranty but this company offer their tires with warranty.

After the Egyptian revolution all related bodies that deals with transport operators increase their prices; seaport entrance fees, load scale, port storage, port authority and road toll. In addition to the main costs related to the transport operation.

The latest increase in the fuel prices was 16th of June 2018, it increases by 35% than the original price which will leads to many conflicts between cargo owners and transport operators. Cargo owner may insist to pay the freight agreed upon the annual contracts on the other hand transport operators will add the fuel surcharge on the freight. Also, this increase will again increase all transport operation components (tires, spare parts, etc.).

Before the revolution road operators only pays road toll that are govern by the ministry of transport but now the Egyptian armed forces obliged road operator to pay a military fees. Military fees is a main financial problem that are not standardized and differs according to the type of the product. Medium truckload (50 tons) for imported products, the fees vary between 350 and 700 Egyptian pound for steel Billets, from 2000 to 3000 pounds for cold rolled Sheets, from 3000 to 4000 steel profile, from 7000 to 12000 for oil-producing industry equipment and from 4000 to 7000 for transport equipment etc. Steel prices vary according to its thickness. Then they added that all these prices are not legalized. Transport operators asked several times to have a legal documents for this military fees that contains definite price for each product but they fail to have it. However, these expenses should not be calculated as a burden on the carriers side because it should be played by shippers as mentioned in the literature above but in Egypt and some developing countries, the business culture differs; the shipper refuse to pay extra money especially if they have annual contract and lots of conflicts raised whenever there is an increase.

All the above challenges emerged under the circumstances of lowering the imported goods. Imports are now less than before the revolution by 60% which means that the amount of work decreased and this is because of the increase in the sea freight and the increase of the steel prices. In1998, steel price was 900 pound per ton, immediately after the revolution in 2011 it increases to 6000 pound per ton and now 2018 its price reaches 13000 pound per ton. This means that the importers capital cost decreased. That's why they are buying less quantity.

Egypt now suffers from a lack of drivers, because under the law, first class licence takes from 4 to 5 years for the drivers to acquire it. Moreover, insurance prices on trucks and drivers increased, truck licenses fees also increased and however, the most financial burden is taxes, tax authority are assessing taxation not according to the amount of work as before but according to a quota that ministry of finance wants to collect annually whether the amount of work increased or not.

The following table draws a suggested conceptual framework as a preliminary guide for Egypt to overcome the above problems.

Problem/Challenge	Suggested solution	Enablers
Increasing fuel prices	Increasing fuel prices should increase gradually and on long periods, the problem is fuel increased in Egypt from 3 years, then from a year and a half, then this month (June 2018) then next expecting increase will be after 4 months which affect negatively the market stability.	The Egyptian government should wait between periods and spread information on price increase to transport operators at the beginning of the year so that contract and freight pricing could be settled correctly.
Increasing tires prices	Importing tires shouldn't be restricted on certain firms and also customs should be reduced to compete the local monopolistic company.	Custom authority under the supervision of the ministry of transport is responsible to adapt this issue
The military fees	This imposed fees should be legalised and documented and well known for all users in the transportation process.	Egyptian armed forces is responsible for taking this decision of documentation and apply it on the transportation system.
Tax calculation	Tax should be calculated on the amount of work achieved annually not as a targeted quota.	Ministry of finance should apply taxes as before on the amount of work annually
Scarcity in drivers	To develop a truck driving school and drivers training centres that train educated person whom have the desire to be drivers for few months, so that they can be more qualified and can acquire the licence in shorter period of time. In-addition this will increase job opportunities in Egypt.	This needs to change a decree in the law that stating the process of gaining first class licence then traffic department can develop driving schools that gives authorized licences.

Table 3: Conceptual Framework to Overcome Road Transport Operators

The above table concluded and proposed the major challenges facing trucking operators in Egypt, their suggested solution and who are responsible and have the right to solve these problems.

5. Conclusion

In conclusion, road transport has crucial importance in the freight market and plays a vital role in the economies of the countries. However, trucking companies are facing a lot of problems and challenges that increased recently after the Egyptian revolution. Fuel prices increased several times and will continue until the da3m will be removed completely, this leads to an increase of all related items in the transport operation. In-addition, taxes, port authorities, spare parts, tires, road tolls, etc. are increased, on the other hand, size of freight importation decreased. Last but not least , Egyptian government should pay attention to those problems in order to facilitate fright movement and encourage transport users to increase work capacity which in turn will affect positively the Egyptian economy.

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A framework for sustainable road freight decarbonisation in South Africa

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Abstract

Purpose – Local and international governments are becoming more aware of carbon emission outputs and the damage that these emissions are inflicting on the environment. The extraction and use of fossil fuels are now becoming one of the key drivers for air pollution, public health issues and the depletion of forests and freshwater resources. This research developed a road freight decarbonisation framework for South African companies to help lower road freight carbon emissions, by incorporating the main road freight challenges South African companies face.

Research approach – Both qualitative and quantitative data were gathered for the research. Thus, a mixed method research design was used. The nature of the research was exploratory, with the research being divided into three stages. The first stage consisted of an overview of the McKinnon framework. The second stage consisted of interviews with road freight professionals to discuss the McKinnon framework and to identify what opportunities exist for the framework to be adapted for the South African environment. The third stage consisted of data questionnaires, which were sent out to all the registered road freight companies in South Africa.

Findings and originality – The research developed the first South African decarbonisation framework, which highlights the road freight challenges South African businesses face on a daily basis. The research identifies, for industry professionals, what the current, main carbon-intensive constraints are in South Africa. This will assist management in focussing on these costly and highly intensive carbon emission influences and being aware that the constraints are not isolated events, but can affect all road freight companies in South Africa.

Research impact – The research quantifies, for the first time, by what percentage road freight kilometres and carbon emissions can be reduced by focussing on specific road freight carbon variables by eliminating and reducing carbon-intensive activities in South Africa.

Practical impact – The study identifies road freight activities in South Africa that can be targeted to reduce road freight emissions.

Keywords – Carbon reduction, Decarbonisation, Road freight, Road freight challenges

1. Introduction

Population growth has led to increased urbanisation with over half of the global population now living in cities (World Economic Forum, 2014). While urbanisation can lead to better living conditions, it can also result in infrastructure challenges, such as housing, electricity and increased transportation (World Economic Forum, 2014). Urbanisation has brought about traffic congestion, which is reported as a common hurdle to overcome, together with an increase in freight traffic (Bretzke, 2013). Demands and expectations of freight transport are changing as the world is becoming more dedicated to consumerism. Globalisation has ensured customers receive goods and services faster, cheaper and more reliably (Coronado, 2015). The increase in demand and, thus, supply for transport and freight has resulted in more significant amounts of harmful gases being emitted into the atmosphere, such as greenhouse gases. Greenhouse gases include carbon dioxide, methane gas, nitrous oxide and fluorinated gases (Environmental Protection Agency, 2017). Carbon dioxide (CO_2) is the primary gas responsible for greenhouse gases (GHG) (Environmental Protection Agency, 2016a). By producing more CO_2 emissions than what the earth can absorb, the natural balance of the earth's atmosphere is being distressed, warming the earth's surface and the lower atmosphere (Environmental Protection Agency, 2016b). Global temperatures will continue to rise for decades to come due to greenhouse gases emitted by human activities (NASA, 2015). There is a global need to decarbonise road freight, which is one of the major contributors to carbon emissions.

2. McKinnon's road freight decarbonisation framework

McKinnon's framework places comprehensive focus on road freight logistics and revolves around road freight decarbonisation by targeting parameters such as transport intensity, freight modal split, vehicle utilisation, empty running, energy efficiency and the carbon intensity of the energy source. The decarbonisation of road freight can be targeted by crucial parameters, defined by McKinnon (2010) as transport intensity, freight modal split, vehicle utilisation, energy efficiency and the carbon intensity of the energy source. The intensity of freight transport is mostly due to the broader sourcing of supplies and the centralisation of economic activities (McKinnon, 2010:2). Sourcing from

international suppliers, which already increases the long haul distances, will be challenging to reverse, but companies are already starting to near-shore some of their production (SupplyChainBrain, 2015). Companies still find it challenging to move back to local sourcing or decentralised systems due to cost trade-offs not being realised (McKinnon, 2010). Carbon tax laws may force companies to near-shore some of their activities to save costs. A further option to reduce the carbon intensity of freight transport is shifting to a lower carbon-intensive mode of transport.

The carbon intensity of a transportation mode is expressed in the volume of carbon emissions produced per tonne-km. The biggest stumbling block for South Africa is the limitation of the various modes of transportation. South Africa does not have low-cost inland waterways and rail transport is unreliable. Thus, road transport must be used. To lessen the degree of carbon emissions for transportation, various options are available. These are: switching to more carbon 'friendly' modes of transportation, increasing current vehicle utilisation and raising the energy efficiency of freight transport operations.

Switching to more carbon-friendly modes of transportation includes rail, pipelines and water transportation, but the trade-off with these types of transportation modes may be lower flexibility, accessibility and slower transit times (McKinnon, 2010:4). Vehicle utilisation requires improving the way the vehicles are loaded by increasing the capacity of loading. Increasing the loading capacity can

reduce the CO_2 emissions being emitted per tonne-kilometre (tonne-km). Vehicles are making frequent deliveries with low capacities being utilised, which increases the CO_2 emissions per tonne- km (McKinnon, 2010:4). Improving CO_2 emissions can also be done by raising the energy efficiency of vehicles. New technologies in vehicles reduce the CO_2 emissions being emitted (McKinnon, 2010:5).

3. Research problem and rational

Greenhouse gasses (GHG) constitute a significant contributor to climate change, negatively impacting the global impetus towards sustainable development. CO_2 is the primary gas responsible for GHG. Globally, the road freight sector accounts for about one-third of transport's final energy demand and transport-related GHG emissions. Several developed countries have ratified agreements and/or policies to decarbonise the road freight sector. However, no established framework currently exists in South Africa to facilitate the transition to a low-carbon freight sector. Therefore, this research develops a road freight framework for South Africa by adapting an existing road freight decarbonisation framework to South Africa's unique road freight criteria.

4. Research questions

4.1. Main research question

How can McKinnon's road freight decarbonisation framework be adapted to fit the South African road freight industry?

4.2. Sub-questions

To answer the main research question, sub-questions needed to be investigated and answered:

1. What gaps and opportunities exist within the McKinnon framework?

2. Can the adapted South African decarbonisation framework be quantified?

5. Research methodology and design

Both qualitative and quantitative data were gathered for the research study. Thus, a mixed method research design was used. The nature of the research was exploratory with the research being divided into three main stages. The first stage consisted of an overview of the McKinnon framework. The second stage consisted of interviews with road freight professionals to discuss the McKinnon framework and to identify what opportunities exist for the framework to be adapted for a South African environment. This enabled a new South African decarbonisation framework to be developed.

The third stage consisted of data questionnaires, which were sent out to all the registered road freight companies in South Africa. The data questionnaire was used to populate the developed South African road freight decarbonisation framework. The reasons for the population of the framework were to quantify what amount of carbon emissions can be reduced linked to each identified road freight challenge within the South African framework.

6. Developing a framework for South Africa

Interviews were held with 20 management professionals in the road freight industry to discuss current road freight operational practices and McKinnon's road freight decarbonisation framework. The interviews were a means of understanding what additional improvements and opportunities exist that can be added to the McKinnon framework. Themes of supply chain sustainability, decarbonisation and

road freight challenges unique to South Africa were discussed. Themes which were identified during interviews can be categorised into either being a McKinnon identified theme or a new theme identified within South Africa's road freight environment (Table 6.1).

Identified as McKinnon	Identified within South Africa
Driver behaviour	Unnecessary trips
Logistics network efficiency	Slot time adherence
Average handling factor	Strikes and security
Empty loading	Hijacking
	Theft
	Culture of compliance

Table 6.1: Themes identified during interviews

To simplify the conclusions from the interview process, the themes identified were categorised into what can be referred to as the decision-making influences for South African companies. Each of the themes can be affected by management's decision to act upon by either improving or ignoring the theme. The decision can thus either have a positive or negative influence on the number of carbon emissions emitted.

The four decision-making influences were the foundation on which the South African road freight decarbonisation framework was developed. The four decision-making influences are modal shift, logistical network efficiency, operational efficiency and culture of compliance. These four decision- making influences were used to quantify the percentage of road freight kilometre reduction potential, and subsequently, carbon emissions, should these road freight challenges be eliminated or reduced within South Africa.

6.1. Modal shift

It is assumed that the first decision management will make is to determine how the freight will be delivered, which is the rail vs road decision (this is also defined in McKinnon's framework as the modal split parameter). This essentially means that the second, third and fourth decision-making influences will be made on a reduced fleet with a smaller total of annual road freight kilometres travelled.

To shift freight from road to rail, companies must take into consideration what type of freight is 'rail friendly' and the reliability of the lead times via rail freight. Once the freight that will be moved from road to rail has been identified and lead time reliability has been established, companies need to take into consideration the potential hurdles when moving freight by rail.

6.2. Logistical network efficiency

The second decision-making influence is the logistical efficiency of the network. McKinnon highlights this in the framework (handling factor, number of links, empty loading), but it was found that further carbon variables can be included in the network decision-making function. The variables slot time adherence, unnecessary trips and empty loading were added to the carbon variables in the decision- making influence of the logistical network efficiency. The decisions of logistical network efficiency will include executing route planning, taking into account the identified variables, as specific routes may be more efficient than others when taking into consideration the road infrastructure, congestion and safety of the route.

Labour unions in South Africa can play a significant role in strike actions taking place. These strikes disrupt daily commuting and road freight activities and have an impact on whether deliveries can take place or not. Should negotiations take place for a planned strike, the affected company can plan ahead, so that the strike does not have a significant impact on customer service and deliveries.

However, when strike actions take place without warning, companies suffer as a result of road freight deliveries not taking place. In some cases when a strike is known in advance, transport companies still neglect to plan routes away from dangerous routes where the strike is taking place. Strikes in South Africa can become violent with trucks being set alight. On occasion, truck drivers have been threatened with death should work, and deliveries continue. South African companies must be aware at all times of the strikes taking place that can hamper deliveries and threaten the lives of their employees.

Slot times are allocated to customer deliveries so that trucks will arrive at a predetermined time that was allocated for delivery. The slot time is to aid receivers to efficiently plan the receiving bays, the workforce needed for offloading, total truck deliveries for the day and making sure all deliveries are not delivered in the same time frame, which can cause a backlog at the receiving bays. Some companies cannot accommodate multiple deliveries at the same time, because receiving areas are limited due to space constraints. Trucks must thus arrive at allocated slot times for ease of off-loading and planning. Missing this slot time may result in a re-scheduled delivery, even if the truck was already at the premises of the client.

To decrease the number of unnecessary trips, companies must start to actively investigate what the root causes for these trips are. It was found during the research that companies tend to not track or quantify the impact that these trips have on the company. Together with the financial impact of driving more than necessary, the extra carbon emissions due to these trips can also be limited.

Empty loading can either occur when a truck has not been utilised to full capacity upon loading, or it can occur when a truck returns empty to its warehouse after the day's deliveries have been completed. For the research, the focus was placed on empty loads returning to the warehouse as the carbon emissions per tonne-kilometre are much higher when a truck is driving with no load. Empty loading may be due to market-related decisions, regulatory obligations, inter-functional decisions, infrastructural hurdles or equipment-related difficulties. Empty loading is one of the largest carbon contributors for South Africa, and it can also have a sizeable financial impact when trucks return empty to a warehouse, especially when the truck has travelled long distances. There were also instances mentioned by participants where trucks were denied loading due to health and safety regulations of the truck not having been met. To avoid empty trips, collaborative initiatives can be considered by management to utilise trucks on the return journey. This can take place in the form of recycled goods being returned to the supplier or the use of matching services.

6.3. Operational efficiency

Following logistical network efficiency, two carbon variables can be altered, which can be executed in parallel with one another, namely the mechanical efficiency of the truck and the ability of the driver to drive more efficiently, thus the driver's behaviour. This will fall into the scope of operational efficiency and in the McKinnon framework, under energy efficiency.

The driving behaviour of a driver and the vehicle efficiency can influence fuel consumption. During the interviews, it was discussed that the compliance towards regulations in the road freight industry can still improve and that companies tend to neglect or not comply with regulations. Companies can make use of various driver-training courses as the benefits of training drivers cannot only decrease carbon emissions, but will also have a positive financial impact for the company.

6.4. Culture of compliance

It was observed that the Road Transport Management System (RTMS), theft and hijacking are unique carbon variables in South Africa. Companies commented that there is a culture of non-compliance (as also mentioned by Nordengen and Naidoo (2014)) or an inherent rebellious nature in South African transport companies and drivers.

The culture of compliance was a prominent theme during the interview process. Many companies still feel that the workforce is not compliant with company rules, policies and procedures. Culture also forms part of Hawks' (2001) fourth pillar of sustainability. This pillar states that culture must be taken into account for environmental responsibility and economic viability. RTMS will address the non- compliance culture South African companies are facing today by providing more incentives to drivers to perform well in the business environment.

RTMS was included in the South African decarbonisation framework as it is believed, based on interview discussions, that RTMS will become more prominent in future legislation and company dealings in South Africa. It was observed in the interviews that there are already customers forcing suppliers to become RTMS compliant in order to remain a partner in business transactions. In addition, RTMS provides numerous benefits to companies implementing this system such as lowered fuel usage and CO_2 outputs, fewer traffic fines, fewer kilometres travelled and fewer mechanical breakdowns.

Hijackings are taking place on high-valued goods in transit or trucks carrying high-demand items such as maize and canned goods. This, in turn, leads to deliveries being retaken due to the load either being rejected by the customer or in the case of goods being stolen, redelivery taking place. Companies must take into account high-security risk areas that are prone to hijacking or in-transit theft. Should the area of delivery not be avoidable, proper or extra security precautions must be taken. Route planning can also be done to avoid taking high-risk routes.

The safety of the drivers can also affect the business operations as it could be argued that drivers would be hesitant to deliver goods in areas that have a known history of theft and hijacking. Tarps that are cut while trucks are idling in high-risk areas would also have a financial impact on a company as not only would the stolen goods have to be replaced, but the damaged tarp would be needed to be repaired or replaced.

7. Quantifying the four decision-making influences

In total, 132 companies responded to the questionnaire which was sent out to the population of registered road freight companies in South Africa. The majority of the respondents were bulk carriers (58.46%) with refrigeration having the lowest response rate (1.54%), as seen in Figure 7.1.

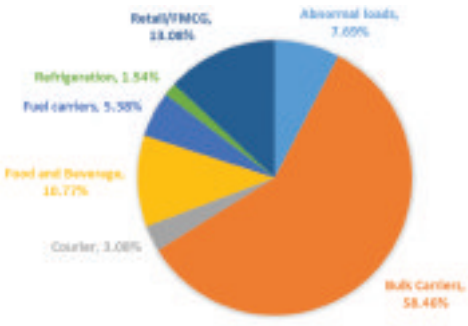


Figure 7.1: Companies from third phase data questionnaires

With the data population, respondents were asked key questions that were used to populate what road freight kilometre reductions can be expected when eliminating particular road freight challenges (or carbon variables) within South Africa. With this data, it was possible to develop and populate the South African road freight decarbonisation framework for South Africa to indicate by how much each road freight activity contributes to road freight carbon emissions. The four decision-making influences are indicated in Figure 7.2, with each contributing carbon variable indicated by a percentage. This percentage specifies by how much road freight kilometres can be reduced by, when eliminating the carbon variables within each decision-making influence. The reduction in road freight kilometres, will ultimately have a reduction on road freight carbon emissions as well.



Figure 7.2: The South African road freight decarbonisation framework

8. Conclusions

The research results present findings with regards to the quantification of the four decision-making influences and the presentation of the South African road freight decarbonisation framework. The data gathered during the interview phases, and ultimately, the quantification of the South African decarbonisation framework, enabled key considerations with regards to carbon emissions in the South African road freight industry.

The South African road freight decarbonisation framework was thus developed for South African companies to use the framework as an aid to indicate what road freight activities contribute towards a large amount of road freight carbon emissions.

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Environment

A model to assess the environmental impact of B2C e-commerce in the grocery industry

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Introduction

E-grocery has been growing in all of the main western markets over the last years although its penetration rates, i.e. online sales as a percentage of overall retail sales, are still low if compared with other e-commerce sectors (e.g. consumer electronics, fashion). As an example, the e-grocery market in Italy is worth about € 1.1 billion (+34% if compared to the previous year), displaying a 0.8% penetration rate (B2C eCommerce Observatory, Politecnico di Milano, 2018).

From an environmental sustainability viewpoint, particularly from a logistics perspective, it is unclear whether the online grocery shopping has an higher or lower environmental impact if compared with the traditional offline purchase. In particular, e-grocery displays some peculiarities which differentiate it from the other retail sectors. First, the order composition is different. While e-grocery typically displays large orders of multiple single-piece lines and a wide product range (including dry, frozen and fresh perishable items), other retail sectors (e.g. fashion, consumer electronics) orders are instead generally composed of few pieces (Agatz et al., 2008). Second, the distribution network is tailored on different needs. In particular, distribution centres for fulfilling online grocery orders are generally built close to customers to shorten the transport lead time (Hays et al., 2015).

This work aims to assess the environmental impact of the purchasing process in the grocery industry, in order to evaluate the significance of the environmental impact in such an emerging and peculiar sector. More precisely, the environmental impact is measured in terms of CO2e (i.e. CO2 equivalent) emissions. This objective is pursued through a model developed to assess the environmental impact of both the online distribution channel and the traditional "brick and mortar" distribution in this specific industry. In particular, precise data are necessary to feed the algorithms of the model. In this regard, data from companies need to be collected, thus the Italian context is considered by the present study.

Literature review

Several contributions in the literature measure the environmental impact of B2C e-commerce processes in comparison to the traditional offline channels. As an example, Edwards et al. (2010) proposed an analytical method for the assessment of the carbon intensity of e-commerce, with a specific focus on last-mile delivery and personal shopping trips. Herein, they also recognised that home delivery is likely to generate a decrease in emissions with respect to traditional shopping. Moreover, Mangiaracina et al. (2016) formulated an activity-based model for the assessment of the carbon footprint of the purchasing process in the apparel industry, presenting also a sensitivity analysis highlighting the huge impact of logistics on the total emissions. Similarly, Bertram and Chi (2018) analysed the environmental effects of apparel e-tailing versus traditional retailing in terms of carbon emissions, waste, and energy usage, concluding that online shopping is better for environment. However, attention is put on the fact that some intervening factors such as excessive packaging, shipping speed and apparel returns add more carbon footprint and waste to the environment (Bertram and Chi, 2018). According to Williams and Tagami (2002), that analysed B2C e-commerce against the traditional retail for the Japanese book sector, with a focus on urban areas, e-commerce seems to use more energy per book than conventional retail because of the high impact of packaging.

Anyway, contributions mostly focus either on generic shopping or on industries such as fashion (e.g. Mangiaracina et al, 2016) and books (e.g. Williams and Tagami, 2002). Similarly, the effect of grocery online shopping on environment has not been investigated by any model. E-grocery is often studied for its impact on traffic and pollution in cities (Cairns, 2005; Durand & Gonzalez-Feliu, 2012; Taniguchi & Kakimoto, 2003). As an example, a study shows that a direct substitution of car trips by van trips may reduce vehicle-km by 70% or more (Cairns, 2005). Taniguchi & Kakimoto (2003) presented instead models of vehicle routing and scheduling with time windows and traffic simulation for evaluating the effects of e-commerce on the urban freight transport and the environment. Literature also collects contributions on initiatives grocery operators have been undergoing to be more environmentally sustainable. Leyerer et al. (2018) discuss an alternative logistics concept for e-grocery operations using a urban network refrigerated grocery lockers. Koiwanit (2018) shows instead the changes supermarkets are undergoing to be more environmentally friendly, e.g. cutting discharges from refrigeration units, implementing new low-temperature system. Dealing with e-grocery, the broader food supply chain theme is at times mentioned. As an example, a paper identified grocery e-commerce as an important opportunity for carbon footprint reductions in the food supply chain (Siikavirta et al., 2003). Moreover, the introduction of e-grocery brings substantial changes to the food supply chain: producers and wholesalers are directly involved in B2C commerce, whereas intermediaries are skipped; anyway, extra work is required for the storage and transport of fresh food (Saskia et al., 2016). However, no author adopted a logistics viewpoint on the matter, evaluating the impact of the single distribution activities in detail. In order to assess the environmental impact of e-grocery, an ad hoc model should be developed, taking into consideration the peculiarities of the industry.

Objectives and methodology

Given the identified gap, the present study aims to contribute to the extant literature on environmental sustainability of B2C e-commerce in the grocery industry. The main objective is to develop a model to assess the environmental impact of both online and offline purchasing processes in grocery sector, with a particular focus on logistics activities. The core of the research is represented by an analytical model developed according to a three-step methodology.

Phase I - The first phase involved a preliminary definition of the reference process for both e-commerce and traditional channel. Each of the two processes is divided in macro-phases and the macro-phases are further divided into activities. Each activity generates a resource consumption and therefore an environmental impact. In particular, the activities can be clustered in five categories: communication, management, purchasing, transportation and warehouse/ handling.

Phase II – The second step regarded the construction of an analytical activity-based model, which computes the environmental impact of e-commerce and of traditional online shopping in terms of emission of carbon dioxide equivalents – which is the chosen unit for the analysis.

Phase III – The third step is the application of the model and the analysis of the results. It is possible to compare the impact of an order shipped through the online channel with the impact of a purchase in the traditional channel.

Model development

The development of the model grounds on the definition of the purchasing processes, which are in particular affected by the distribution network structure. The grocery merchant is assumed to have: (i) points of sales for the shopping in the traditional channel, (ii) a dedicated warehouse for fulfilling online orders and (iii) a central warehouse which replenishes both the points of sale and the dedicated warehouse.

E-commerce purchasing process

The definition of the e-commerce process relies on some assumptions. The main ones are:

- The order picking and assembly phase takes place in a dedicated warehouse for fulfilling online orders.
- The dedicated warehouse is divided into three areas: (i) a storage area optimised for picking; (ii) a stock-order area, where orders are assembled and temporarily stored; (iii) a packing area.
- The replenishment involves transferring the goods from the central warehouse to the dedicated warehouse for fulfilling online orders.
- The central warehouse is divided into three areas: (i) a storage area, (ii) a sorting area and (iii) a shipping area.
- Last-mile delivery route and returns pick-up are carried out through a diesel van (payload = 1,5 t).
- The replenishment flow transportation is carried out through a rigid truck (19t)
- The delivery point is the customer's home.
- 100% first time delivery success.
- Online product payment.

The generic e-commerce process is composed of five phases. Figure 1 illustrates the e-commerce process relying on the assumed distribution network.

Pre-sale and sale – The customer adds to the cart all the items of the grocery shopping list and the payment is performed. In the case of the e-commerce process, the pre-sale and sale activities are entirely performed online.

Order picking and assembly – The order is received and managed by the merchant. Later, the picking list is created, and the picking activity takes place in the dedicated warehouse. Before the delivery of the order, the product is typically packed manually, and the waybill is emitted.

Stock replenishment – The goods need to be transferred from the central warehouse, located upstream in the distribution network, to the dedicated local warehouse, located downstream. Therefore, a replenishment order is emitted by the dedicated warehouse and managed by the central warehouse. The activities performed to make the goods available to the dedicated warehouse are the same as in the order picking and assembly phase. Of course, the order profile is completely different. Goods are handled in large quantities and the unit loads are bigger (full cartons or pallets).

Delivery – After the order is fulfilled in the dedicated warehouse, it is directly shipped to the customer.

Post-sale – The product is picked up from customer's house and brought to the dedicated warehouse. Anyway returns are almost negligible in the grocery industry.

Each of the five macro-phases is further divided into activities, in order to compute the environmental impact on the basis of each single activity.

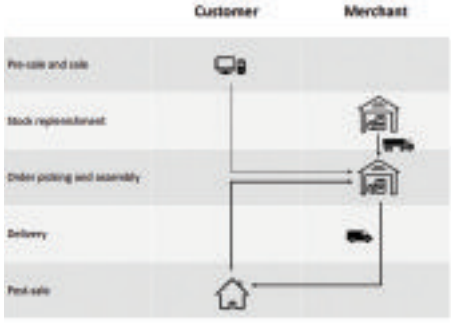


Figure 1 - Distribution network structure for e-commerce process

Traditional purchasing process

The main assumptions regarding the traditional purchasing process are:

- The replenishment of the points of sale starts from the same central warehouse described in the e-commerce section. The central warehouse is divided in three areas: storage, sorting and shipping. In this case, the goods are handled in the sorting area before the delivery.
- The point of sale replenishment is carried out through rigid truck (payload = 19t).

- The consumer goes to the point of sale by car. No use of public transport is considered.
- Only one point of sale is visited by the customer before purchasing.

Similarly to the e-commerce process, the traditional commerce process is divided into macro-phases and activities. The macro-phases are kept similar to the e-commerce ones, in order to make the comparison robust. A substantial difference involves the lack of an order picking and assembly phase, as it is performed by the customer himself at the point of sale. Figure 2 illustrates the traditional process relying on the assumed distribution network. The macro-phases are the following:

1. Pre-sale and sale – The customer leaves home with the intention of making a purchase and reaches the point of sale. There, all the products are collected and the customer pays the grocery shopping at the cashier. The pre-sale and sale phase does not only involve communication and purchasing, but also transportation activities.

2. Replenishment – When the stock level in the point of sale decreases, it is necessary to emit a replenishment order towards the merchant. The order is received and managed in the merchant's central warehouse and the goods are sent to the point of sale.

3. Delivery – The delivery in the traditional commerce process is equivalent to the return trip on the way back home of the customer from the point of sale after the purchase.

4. Post-sale – Also in the traditional process, the post-sale phase includes the return process. If the customer wants to return the product, he goes back to the point of sale, requests the change and returns back home with the new product.

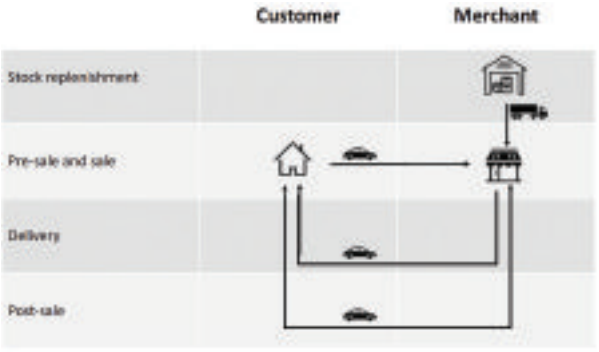


Figure 2 - Distribution network structure for traditional process

Model structure

The model is organised into five sections.

1. General input data – this section collects the input variables that can be modified by the user. The main clusters of data are: (i) customer data, both in terms of customer profile (e.g. number of interactions with the merchant, return rate) and average distance between customer house and point of sale; (ii) purchase profile, e.g. items per order, lines per order; (iii) packaging, e.g. type, size, capacity, weight, amount of raw material; (iv) features of the retailer central warehouse, e.g. size, number of orders fulfilled per day, energy performance; (v) features of the retailer dedicated warehouse; (vi) features of the retailer point of sale, e.g. size, energy performance.

2. Activity data – this second section includes all data regarding duration of activities (i.e. online, central warehouse, dedicated warehouse, point of sale and transportation activities).

3. Consumption data – it gathers all data regarding (i) energy consumption (kWh), in terms of conversion factors and (ii) consumption of facilities (i.e. building, machinery, means of transport) measured as $kgCO_2e$.

4. Model algorithms – it collects all the mathematical formulas connecting sections I,II and III to the output.

5. Output data – the output is the environmental impact generated by a purchase (i.e. $kgCO_2e$/order), either online and offline, in the grocery industry. The overall result can be broken down by macro-phase and by activity type.

Figure 3 summarises the model structure.

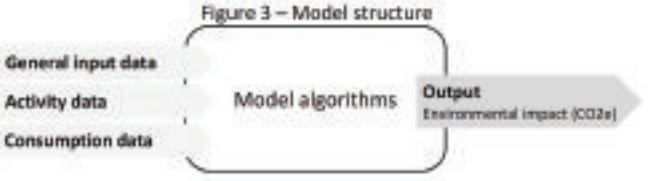


Figure 3 – Model structure

Results

Data on the Italian context were collected in order to apply the model. The main data regarding the general inputs and activities are listed above:

- Customer data – return rate is very low, almost null, in the grocery shopping. The average distance travelled by the customer to reach the point of sale is 2 km (the same distance is travelled in the way back home).
- Purchase profile – grocery shopping cart has, on average, 65 items per order (considering 50 lines per order and 1.3 items per order line).
- Central and dedicated warehouse – the total warehouse area is respectively 20,000 and 5,000 square metres. In a 4-hour delivery tour (i.e. from the dedicated warehouse to the customers home) 12 orders are delivered and 60 km are on average travelled.
- Point of sale – the area of the point of sale is 2,000 square metres.

The environmental impact in the online purchasing process is about 15% lower if compared to the offline shopping. In particular, emissions in the online and offline processes are respectively 7.34 and

8.66 $kgCO_2e$ per order. Figure 4 reports the emissions (measured in $kgCO_2e$) in both the processes divided by phase (i.e. pre-sale and sale, replenishment, order picking and assembly, delivery). Figure 5 illustrates instead the percentage repartition of the five macro-phases emissions. Finally, figure 6 shows the percentage repartition of the emissions based on the main clusters of activities (i.e. communication, management, purchasing, transportation, warehousing/handling).

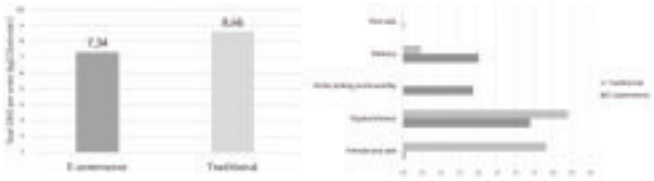


Figure 4 – Total GHG per order and total GHG per order by phase ($kgCO_2e$/order)



Figure 5 – Percentage repartition of GHG per order by phase

The replenishment activities cause most of the emissions in both the purchasing processes (i.e. about 50% of the emissions in the traditional process and 46% in the e-commerce case). Indeed, the transport of goods from the central warehouse occurs in both the cases. Goods are moved from the central warehouse both to the point of sale and to the dedicated warehouse. Moreover, emissions in the replenishment phase are higher in the traditional process if compared in absolute terms (i.e. 4.40 in traditional shopping and 3.38 in e-commerce). On the one hand, distances to be travelled to reach the two destinations may differ (the point of sale is typically further away from the central warehouse). On the other hand, truck saturation is higher when replenishment is towards the dedicated warehouse.

Pre-sale and sale is the second most impacting phase in the traditional purchasing process, and it accounts almost the 45% of the total emissions. This phase has two main sources of emissions. On the one hand, the travel towards the point of sale is considered. On the other hand, the energy consumption of the point of sale is included. Emissions in pre-sale and sale activity are instead almost null in the e-commerce phase. Finally, delivery phase accounts for about 5% of the total emissions. In the online purchase, delivery is instead the second most impacting phase (i.e. 28% of the total emissions), followed by order picking and assembly activity (i.e. 25%). Post-sale phase emissions, since return rate is almost null, are negligible in both the purchasing processes.



Figure 6 – Percentage repartition of GHG per order by activity

Warehousing activities represent a huge source of emissions particularly in the e-commerce case (i.e. 57% of the emissions). In the traditional purchasing process warehousing activities represent instead the 27% of the total emissions – they include indeed emissions on the behalf of the central warehouse only. It is indeed to be noticed that emissions related to the point of sale are not classified as warehousing activities but either as communication or purchasing activities. Transportation activities are the second source of emissions in the both the purchasing processes. They include both the transfer of goods in the replenishment phase and the last mile delivery activity (in the e-commerce purchase) or the customer travel (in the traditional shopping).

Sensitivity analysis

In order to test robustness of the results, sensitivity analyses on the main variables are carried out. In particular, the kilometres travelled by the customer to reach the point of sale and the number of

deliveries performed by the van in the delivery tour (considering the same mileage of the base case) are analysed. Figure 7 shows how emissions change by varying the distance – from 1 to 7 km – between the customer house and the point of sale. Reasonably, the higher the distance, the higher the emissions due to transport activity from the customer side. Environmental impact of the online purchase is 10% lower in the shortest distance (i.e. 1 km) and 30% lower in the longest considered travel (i.e. 7%). The former could be the case of an urban area, or a city, where customers are typically closer to a supermarket. The latter is presumably the case of an extra-urban, or more likely a rural area.

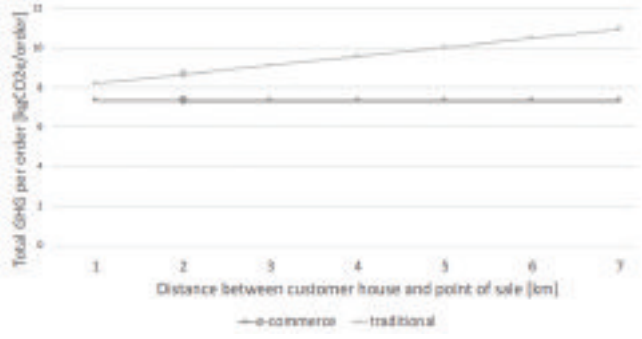


Figure 7 – Total GHG per order, distance between customer house and PoS ($kgCO_2e$/order)

Figure 8 shows the impact on the emissions of a different delivery density. Here, the distance the van travels in its delivery tour is kept constant (i.e. 60 km) and the number of performed deliveries is varied. Starting from the base case (i.e. 12 deliveries), 3 scenarios are explored (i.e. 10, 14, 16 deliveries). Reduction in emission varies from 10% (10 deliveries) to 20% (16 deliveries). Similarly to the previous analysis, the explored scenarios may refer either to a urban or an extra-urban area.

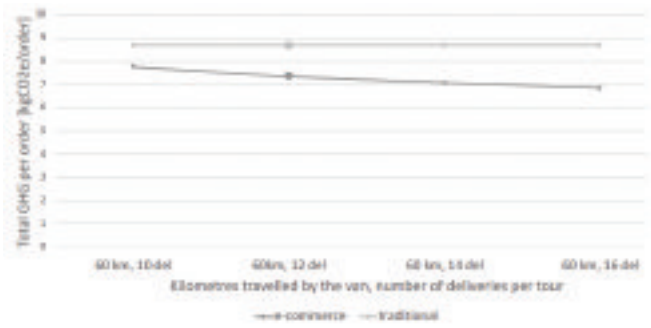


Figure 8 – Total GHG per order, number of deliveries, same travelled distance ($kgCO_2e$/order)

Conclusions

This work presents an activity-based model that can be used to assess the environmental impact of the purchasing process in the grocery industry, comparing the traditional offline shopping with the online purchase. Some key findings emerged. First, in the case applied by the present study the e- commerce process resulted to be more environmentally sustainable than the offline one. Second, activities related to the warehousing (considering also the point of sale in the traditional purchase) cause almost half of the emissions in both the cases. Third, transport-related activities – both in terms of distance travelled by the customer to reach the point of sale and delivery density – strongly affect the final result.

The model presented in this work has both academic and practical implications. From the academic viewpoint, the model represents a theoretical contribution in the definition of the online and offline purchasing processes, in the quantification of the environmental impact for each process phase in a peculiar sector as e-grocery is, and in trying to solve an open debate in literature. From a practical perspective, the model is intended to be an easy-to-use tool for merchants who aim to quantify the environmental impacts of their business and identify areas of action to reduce them. As an example, companies may act on transportation in order to make the online process even more sustainable (e.g. by using electric vans).

However, the model presents some limitations. In particular, a number of assumptions was necessary to build the model and make calculations. Moreover, the values used to feed formulas are considered as deterministic, partially envisaging their variability. Anyway, additional sensitivity analyses on key variables (e.g. related to warehouse activities, which emerged to be crucial) can make the result more robust. The employed mean of transportation (e.g. electric compared to fuel-based), both from the customer or the company side, could be also investigated in terms of impact on the final result.

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Finance and procurement

Strategic procurement: A dynamic capabilities view on public policy implementation

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Introduction

Public sector management has undergone significant change and sustained reform initiatives in Ireland over the last decade. Following the 2008 recession, the Irish Government committed to major fiscal consolidation to reduce its deficit, believing that future economic growth could only come from a solid and sustainable fiscal position, of which far reaching Public Service Reform is central. Thus, as public managers look for new strategies to address the challenges associated with limited resources (Malatesta & Smith, 2014), and they consider their increased dependence on supplier inputs and contributions, they turn to strategic procurement in their search for additional value generation (Bals, Laine & Mugurusi, 2018). This value generation can be achieved through improved supplier integration, supplier delivery of product or process innovations, or sustainability (Schiele, 2010; Caniato et al., 2012; Bals et al., 2018). However further research is need to consider how to support purchasing's growing importance and enlarged set of responsibilities, especially in the context of increasing market dynamics and volatility (Schneider & Wallenburg, 2013).

Strategic management is now playing an increasingly important role in effective performance delivery in public sector organisations (Hanson & Ferlie, 2016), recognising that it about doing more with less and delivery on public policy and goals. However, they note that strategic management theories need to be evaluated and appropriately applied to public sector organisations. Dynamic capabilities (DCs) are the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments, by exploiting "internal and external firm specific competences" (Teece et al., 1997: 510). On the other hand, Eisenhardt and Martin (2000) argue that DCs actually consist of identifiable and specific routines (e.g. alliances, innovations) which permit resource renewal and reconfiguration. Thus a DC is a process that impacts upon resources (Ambrosini & Bowman 2009) to give an organisation the capacity to purposefully create, extend, or modify its resource base (Helfat et al., 2007), in the manner intended and considered suitable by the principle decision-maker (Zahra et al., 2006), thus governing the rate of change in ordinary capabilities (Winter 2003).

As the research questions focus on how, taking a dynamic capabilities view, strategic procurement is designed and developed to deliver on public procurement policies, and how managers and leaders impact dynamic capabilities and organisational change, the case study was selected. Analysis uncovered, not only the important role played by DCs, but also the importance of micro-foundation dimensions when reconfiguring public sector procurement. Microfoundation mechanisms such as ICT, culture, and behavioural attributes are unpacked to discover how they enable DC development. Thus when reconfiguring resources and processes, the role that government decisions and policy play on the DC processes of search, seize and reconfigure are identified. The DCs framework developed proposes, firstly a three-level hierarchy of capabilities, with environmental dynamism, goal development, and intended strategy considered. Secondly, antecedent and microfoundation dimensions which impact change in ordinary capabilities were identified. Finally, the critical role of the manager, and their influence on microfoundation enablers is uncovered.

Literature Review

Dynamic capabilities

Researchers have categorised DCS into various clusters of activities, and process. That is, processes of sensing, seizing and reconfiguration (Teece, 2011; Teece et al., 2012), of reconfiguration,

leveraging, learning and creative integration (Ambrosini & Bowman, 2003). The sensing activity, which is comprised of scanning, learning and interpretation (Adam & Lindahl, 2017), refers to how an opportunity can be identified and assessed, and requires an entrepreneurial set of capabilities, managerial insight and vision (Teece, 2011), a continuous search for different technologies (Nelson & Winter, 1982). Secondly, seizing processes refer to how the sensed opportunity will be implemented, resources organised to address an opportunity and capture value from doing so (Teece 2011). Finally asset reconfiguration refers to the process by which organisations transform their resource base by altering its resources and operating capabilities as needed, in line with environment changes (Teece 2007; Helfat et al., 2007; Adam & Lindahl, 2017).

Prior research identified a hierarchy of capabilities (routines) to distinguish between lower resource base adjustments and deeper DC changes (Sune & Gibb, 2015). Winter, (2003) added a third capability level, microfoundations, which sits above ordinary capabilities to impact successful DC deployment (Ambrosini & Bowman, 2009). Moreover, each DC category is underpinned by organisational and managerial processes and routines, (Teece, 2007), and when we observe a DC in use, "we are observing the underlying processes" (Helfat et al., 2007: 31), which are shaped by the underlying individual-level and group level actions (microfoundations) (Eisenhardt, Furr & Bingham, 2010). Thus the microfoundation concept requires an understanding of how human behaviour generates and shapes higher-level constructs, and how an individual's structural embeddedness influences their lower

level behaviour (Barney & Felin, 2013). However, further empirical research is needed to provide a deeper of the concepts (Ambrosini et al., 2009), to consider the micro-level origins of these constructs (Felin, Foss, Heimeriks & Madsen, 2012).

Successful deployment of DCs is facilitated by an organisations' microfoundations, mechanisms (Winter, 2003) and the construct, enabler and inhibitor dimensions (Ambrosini & Bowman, 2009). Where a mechanism is the agency (means) by which an effect is produced or a purpose accomplished, and enabler (inhibitor) dimensions are internal and external factors which trigger (prevent) DC creation. External factors include the dynamic external environments and level of uncertainty (Ambrosini & Bowman, 2009). Internal factors include, the role played by managers, a firm previous paths, factors such as social capital, leadership, trust and culture (Ambrosini & Bowman, 2009), balancing learning by doing with learning before doing, cross functional (e-)business teams and developing new competencies across a wide range of staff (Daniel & Wilson, 2003).

Adner and Helfat (2003) suggest that managers making high level decisions may make different decisions due to differences in their DCs. Specifically, dynamic managerial capabilities (DMCs) "are the capabilities with which managers build, integrate or reconfigure organisational resources and competences" (p.1012). DMC differences are due to the underlying factors of managerial human capital, managerial social capital and managerial cognition, which reflect dynamic managerial capabilities. Adner and Helfat explain each of these elements: Human capital refers to learned skills, and requires an investment in learning, education and training, but may also be develop experientially. A managers social capital is "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" (Nahapiet & Ghoshal, 1998: 243). Finally, it is managerial cognition which refers to a managers beliefs and mental models, the cognitive base for their decisions.

In conclusion, research is vital on the relationship between DMCs and organisational capabilities, and their joint impact on organisational performance (Helfat & Peteraf, 2015; Adner & Helfat, 2003), the manager' role and leadership when implementing change (Pandza & Thorpe, 2009). Thus contributing to public management literature and the "debate in strategic management research about the nature, functioning and explanatory value of dynamic capabilities" (Piening, 2013: 2038).

Strategic Public Procurement

The first step in an organisations' strategy process typically consists of strategy formulation and the development of the strategic intent and objectives. The second step, strategy implementation, consists of the practices and actions which are needed to implement the defined objectives (Akın et al., 2018).

In recognition of its major spending capacity, the role of public purchasing within the EU has evolved, with politicians and public organisations now using their procurement spend in order to apply leverage to key policy objectives (Grandia & Meehan, 2017). Despite this trend towards strategic procurement and professional development in public procurement (Thai, 2001), the majority of the research has been in the private sector, with relatively little application to public sector procurement, its strategy and management (Murray, 2009). Furthermore, he argues that "at the level of the organisational strategy and management, the fundamental differences between private and public procurement has been largely overlooked in public procurement research" (p.92). Public procurement officers face a broader range and greater extent of unique challenges (Baldus & Hatton, 2019). Firstly, public procurement sits within a unique set of EU and National administrative, legislative and judicial frameworks, which provide a set of rules and guidelines which must be adhered to. Secondly, is democratic accountability and the pervasive influence that politicians (local, regional and national) have on public procurement policy and measurable indicators of performance (Murray, 2009; Cadwell, Walker, Harland & Knight, 2005). Third, because public policies are the outcome of complex interactions involving multiple groups and interests (Denhardt & Denhardt, 2000), public procurement often has to manage multiple stakeholder objectives, that may be contradictory, and which vary over time (Cadwell et al., 2005). Fourth is the lengthy purchase cycles, and the broad spectrum of goods and services bought by public procurement teams (Baldus & Hatton, 2019). A final unique context is the large variety of public procurement departments in terms of the size, scope, and structure (Baldus & Hatton, 2019), with frequent reorganisations based on wider political taking precedence over operational requirements for competitive markets (Cadwell et al., 2005).

Rather than defining purchasing as a set of practices deployed by the purchasing function to fulfil demand in the quantity, time and place required (Akın et al., 2018), purchasing strategy can be define as a profile of generic competitive objectives (González-Benito, 2010), with specific purchasing practices implemented to meet specific purchasing objectives. Following a literature review, Akın et al. (2018) noted that purchasing strategies were originally defined as single versus multiple sourcing, as local versus global sourcing approaches, with practices such as cost reduction, value analysis, supply base reduction and supplier development. However, as the purchasing functions potential strategic contribution grew, value-adding activities such as improvements in quality, specifications and functionality, relationship development and supplier involvement in innovation were added to the purchasing agenda (Akın et al., 2018).

Private sector purchasing adopts a variety of strategies based on competitive priorities such as cost and quality (Trent and Monczka, 1998), which deliver on objectives such as flexibility, delivery, and sustainability (González- Benito, 2007; Watts et al., 1995), and more recently innovation (Akın et al. 2018). While public sector procurement has traditionally had a cost management role, a cost strategy, where the focus is on cost reduction and cost avoidance, on reducing the cost of ownership, improving efficiency, and asset utilization (Akın et al., 2018; Baldus & Hatton, 2019). Nowadays, public procurement is expected to contribute to a public organisations' societal goals, to stimulate innovation, and provide local business and SMEs with opportunities, whilst stimulating a sustainable marketplace (Grandia & Meehan, 2017). Yet, the role of strategic objectives in defining purchasing strategies needs further examination (Akın et al., 2018), and the questions as to whether public procurement

is an effective policy tool has yet to be answered (Grandia & Meehan, 2017).

Alignment, impacts an organisations ability to translate corporate strategies into functional and business performance, to secure contribution from subordinate strategies to corporate and business strategic objectives (Hesping & Schiele, 2015). It is the degree to which purchasing strategies, other functional strategies, and business strategies are all unified (Akın et al., 2018; Murray, 2009). Thus purchasing strategy must be aligned to the core objectives set by public sector politicians, as "they make political choices in relation to the prioritisation and allocation of scarce resources" (Murray, 2009: 94). Recognising a purchasing function's increasingly dynamic and volatile environment, Schneider and Wallenburg (2013) identify strategic alignment as an area for future research. Furthermore, it is the politicians, not the internal departments who are procurement's clients (e.g. Erridge et al., 1998), and if ignored when designing the procurement and performance management systems, strategic alignment and the principle agent relationship are compromised (Murray, 2009). Another area which has received little research to date (Murray, 2009: 96).

Research Context

Following the recession, the Irish Government committed to major fiscal consolidation. By the end of 2015 Public Service numbers had fallen by approximately 5,500, with the gross pay bill reduced by over 15% since 2008 (DPER 2017), and savings targets for the years 2016-2018 set in the range of €80 million to €100 million per annum for the programme as a whole (PSRP, 2017). Reforms were implemented within the context of New Public Management (NPM) have introduced new economic perspectives and generic management theory into public organisations (Hansen & Ferlie, 2016), with public administrators expected to "be the entrepreneurs of a new, leaner and increasingly privatised government" (Denhardt & Denhardt, 2000: 549). In contrast, they argue that the New Public Service (NPS) approach expects public administrators to focus "on their responsibility to serve and empower citizens as they manage public organisations and implement public policy". Furthermore, public managers and senior executives will be held accountable for performance goals, for reengineering systems and new processes development (Denhardt & Denhardt, 2000).

Research Methodology

The study reported here used multiple qualitative data sources, collected from a single case study to identify the DC processes, their microfoundations, and the (dis)enablers of strategic procurement development. Applying dynamic capability theory, this paper aims to provide empirical evidence of a connection between strategic procurement, ICT and public policy implementation. It seeks to identify a dynamic abilities (DCs) antecedent and micro-foundation mechanisms, to uncover how factors inhibit or enable DC development, how resources are utilised and new processes implemented in the context of strategic procurement and public policy implementation. In doing so develop a framework of key dynamic capability (DC) constructs. This study is carried out in the context of the implementation of the Irish public sector strategic procurement programme

Case studies can be used to provide rich descriptions, to test or generate theory (Eisenhardt, 1989; Yin, 1994), and is the preferred strategy when how or why questions are posed, and the focus is on a contemporary phenomenon within some real-life context (Yin, 1994). The population for this dyadic case research is Irish Public Sector organizations, their support and client organisations involved in procurement delivery. The Office of Government Procurement (OGP) was the case study of choice. Ireland's public procurement evolved from a 'clerical' government supplies agency in the 1990's, through a separate policy unit (2002), a small operational unit, the National Procurement Service (2008), before being expanded to a whole of government strategic procurement initiative, the OGP in 2014. This paper focuses on the OGPs developing 'aligned' strategic procurement.

Theory-building researchers typically combine multiple data collection methods. That is, triangulation, made possible by multiple data collection methods, provides stronger substantiation of constructs (Eisenhardt, 1989; Yin, 1994).The primary data for this dyadic case study was gathered using in-depth semi-structured interviews, with a purposive qualitative sampling of respondents (Buchana et al., 2018) from all management levels within the OGP, support organisations and key client representatives (Table 1 below). Each interview followed an interview protocol, with probing questions based on research aims (Stake, 1995) in order discern the extrinsic reality through the perceptions of the interviewees (Healy & Perry, 2000). The interviews were, in the main, in the region of one to one and a half hours duration, recorded and subsequently transcribed. The additional instruments used to collect data were government and organisational documents

(policies, procedures, rules, reports), reviews, as well as archives, government and industry reports (Eisenhardt, 1989). These documents were analysed with the interview data to enable subtle differences in meaning, opinion or attitude to be gleaned (Buchana et al., 2018).

OGP CEO	Senior Mgrs	Portfolio Mgrs	Category buyers	Specialists	Education	Justice, Defence	Health	Total
1	5	2	5	4	4	4	3	29

Table 1: OGP & Client Body Interviewee Profile

Data from this research was organised and analysed using NVivo technology to enable synthesis and interpretation of data in terms of themes, concepts, ideas, their interactions and processes. Braun and Clarke's (2006) general process for thematic analysis was followed. That is, firstly the initial codes were generated, with comments and reflections (memos) added. The next step involved a search for patterns, themes, relationships, sequences and differences. An exploration of patterns followed, with possible generalisations elaborated on. Finally, generalisations were linked to body of knowledge to construct a framework, extending and revising theory. The developed themes, are an expression of latent context, where importance is dependent, not on some quantifiably measure, but on how it captures something related to the research questions (Braun & Clarke, 2006).

Results Analysis

Taking a dynamic capabilities view, this results analysis considers the first order capabilities of sense, seize and reconfigure, before examining second order micro-foundational mechanisms, enablers and inhibitors. The findings presented in this paper form part of a PhD study, with data analysis still in progress.

Following Irelands recession in 2008, the dynamic capability sensing activities were focused on the analysis and synthesis of the many economic and public reform papers which examined the organisation and management of public procurement across all state and semi state bodies, local authorities, and agencies so that strategic decisions about the organisations future developmental paths. Procurement was identified in many of the fourteen Public Service reform initiatives announced by the Minister for Public Expenditure and Reform in November 2011. While the An Bord Snip Nua (2008) advised the Irish government that reform of public sector procurement's organisation and processes. Following a recommendation by the NPS Director and the cross-sectoral Procurement Reform Steering Group (2011), the government engaged Accenture to conducted a procurement review. The Accenture Report (2012) recommended the establishment of a single integrated procurement function, which would be accountable for policy, sourcing and category management of common categories and support operations.

In order to translate these sensed opportunities into new processes and services, the Irish government needed to seize relevant activities and processes, to invest in implementation activities. Despite the many examples of good procurement practices, the Accenture Report (2012) recommended significant investment in procurement capability and capacity across the state. This began with the appointment of the first ever Chief Procurement Officer (CPO) in December 2012, who was tasked with implementing the Accenture recommendations. Following the CPO's implementation plan, the procurement functions were transitioned from the NPS into the new OGP organisation (OPW 2012). In addition, a cross-sectoral working group was established in September 2012 to examine how to deliver a standardised savings methodology across the public service (OPW 2012). The change agenda was about trying to get value for money and bringing a more commercial focus on "things" (Manager 1), to save €500 million in the first three years on a spend €6.9 billion on common goods and services (Manager 2). However a number of the interviewees highlighted the difficulty in setting and meeting cash savings targets as the Irish demographics were continually changing, which influenced procurement spend. Thus the goal evolved from cash reductions to benefits realised, cost avoidance.

In order to adapt the resources and competencies of the company and so create a better fit with its new environment, the Irish government required delivery of reconfigured procurement capabilities, activities and processes. The implementation of a centre led procurement model was agreed by government in April 2013, and established in 2014, with the objective of ensuring that the Public Service operates in a co-ordinated and efficient way, delivering sustainable savings for the taxpayer. Furthermore, it must align and monitor its strategic objectives and reform initiatives to ensure contribution to Government's strategy targets of cost reduction, sustainability, increasing innovation levels, and growing SME involvement. It will, together with four key sectors (Health, Defence, Education and Local Government), take "responsibility for sourcing all goods and services on behalf of the Public Service", as well as taking on "full responsibility for procurement policy and procedures". It is through the OGP and the sector-retained procurement functions, that "the Public Service will speak with "one voice" to the market for each category of expenditure, eliminating duplication and taking advantage of the scale of public procurement to best effect". This is in line with public and private sector best practice, and the continuing reform programme being driven by the Department of Public Expenditure and Reform" (http://www.procurement.ie/about-us).

In order to understand how DCs are shaped by the underlying individual-level and group level actions and interactions, the microfoundations are first considered under the three categories of individuals, social processes and structure (Felin et al., 2012; Felin, Foss, & Ployhart, 2015), before identifying and discussing the enabling and inhibiting themes.

The new structure was adapted from that proposed in the Accenture Report (2012), with the senior management staff recruited quickly and some NPS staff transferred into the new structure. Procurement's organisational structure was developed around specialist team structures, each with specific responsibilities. Within a year, the structure (Figure 1) appeared to be well established, with the CPO leading a staff of 226 from its Dublin HQ, and supported by OGP hubs in around the country. Additional support structures assisted in establishing its operations, included an oversight board, an executive and category councils, as well as sourcing teams. However, it is the contracts manager within Client Departments who, in line with agreed SLAs, ensure compliance with new contracts and ensure appropriate engagement (Manager 3). Standardisation and simplification of the whole tender process, the increased use of demand aggregation and frameworks agreements were set as key objectives, and required agreement from clients on the use of standardised specifications across public sector bodies. Client organisations also needed to develop processes on contract notification, drawdown and management (Manager 7). But this aggregation meant larger contracts, leading to an increase in legal challenges as incumbent and potential suppliers had more to lose (Manager 9). It also led to issues at a government level, as the aggregated contracts often precluded SMES from access to government contracts (OPW 12). This was later resolved with 'circulars' allowing for disaggregation at the call down stage. In terms of documentation, interviewees highlighted that standard templates and documents were developed and rolled out across the OGP and its clients. Although the NPS and the CSSO had initially developed some, they now included standard templates for project scopes and project plans, standard terms of reference and standard governance. Yet there was a call for more communication on how to use a framework and what is the drawdown mechanism (Manager 8), whereas Manager 7 said that this is available on the website.

Individuals: Although the objective was to bring together staff from procurement functions across the public sector into one organisation, to bring all that expertise together. This didn't happened (Manager 5, 15) leaving a key gap

in the OGP's available expertise. Many of the experienced NPS procurement staff wouldn't transfer to the OGP as they received insufficient assurances and were reluctant to report into DPER (Managers 1,3,5,18 &9). While there was a perception there that there was a lot of expertise out there. The new staff brought into the OGP, some promoted, either didn't have central procurement experience or public sector experience. The NPS staff (the antecedent

centralised procurement organisation) regularly provided staff with relevant education and training in order to develop a professional organisation (OPW 11 & 12). Moreover, many of the newly appointed senior managers had either similar procurement experience, but in the private sector. They did not have public sector expertise (Manager 1,5,8,3,19). Managerial and leadership positions require a certain amount of leadership strengths, but, the core piece of work that you do day to day, requires a completely different skillset (Manager 6).

Social Processes: The OGP has a lot of structures, many levels and a lot more resources, but it took longer than expected to develop policies and procedures, and standardization, despite the fact that it had more resources. (Manager 14). In addition, there was a lot of cooperation given to the OGP to assist it in every way possible (e.g. an executive group, steering committee). Many interviewees mentioned that the approach and communication style of some managers affected client buy-in during start up. Furthermore, there appeared to be a poor view of public service workers which also affected the motivation of some OGP staff. This led initially to a deterioration of the needed social process. Recognising that change is difficult, as the role of many in the client organisations was set to change, many interviewees explained that some in the OGP told the client organisations that the OGP will do the job better, that the client staff can now take on roles which are more core to their organisation, and that they didn't have a choice as the Government has mandated this. Yet manager 6 indicated that they were not mandatory in the early days. This did not lead to buy-in. Care needs to be taken with regards to language used in this environment.

Discussion: Microfoundation Mechanisms, Enablers and Inhibitors

Considering microfoundations in terms of individuals becomes problematic if the interactions among them, and the context of the organisation is ignored (Barney & Felin, 2013). It is the social processes, the communication strategies and events, the social capital of individuals which are key to implementing change, as they allow network members, with mutual acquaintance and recognition, gain access to resources (Hung et al., 2009). This section discusses key microfoundation themes, identified following data analysis and synthesis, which brought about change, which enabled (inhibited), which triggered (negated) successful DC creation. They are environmental dynamism, antecedent paths and positions, political commitment, change readiness, approach and dominant logic, and the manager as leader.

A key trigger for the move to strategic procurement was the environmental dynamism caused by the recession, as the government sought to balance its books and emerge from a bank bailout which impacted on every aspect of the government and public sector operations. It is a complicated multidimensional construct whose dimensions are affected by the trade-off between flexibility and efficiency in dynamic environments (Eisenhardt et al., 2010). Thus an unpredictable environment requires the established organization to not only decrease the amount of structure, but to also dramatically alter the mindset (Davis et al., 2009). The NPS, procurement's antecedent path and position, was smaller in its scale and scope. Yet it influenced the paths ahead (Teece et al., 1997), by shaping the underlying DC routines, learning barriers and micro politics (Piening, 2013). The perception was that 'things' would be done differently and better in the OGP, by building on from the expertise and structures within the NPS.

The theme political commitment encompassed the belief and knowledge by politicians that strategic procurement is a viable option in the long term, and was not just a short term solution. To implement the change required considerable allocation of monetary investment, despite being in the midst of recession. Government sets objectives and policies by which the success of strategic procurement would be measured, but needs to recognise potential misalignment across objectives and strategic procurement. Furthermore trust and social capital are important for cooperation between government administration and other public actors when developing and adopting common strategic plans (Percoco, 2016).

The change readiness theme illustrates the time needed to allow buy-in to strategic procurement concepts and practices in a respectful and trusting way. Allowing time for everyone to make sense of the new 'jigsaw' and negate the need for government mandated practices. The professional buyer needs time to build trust and confidence in their professional experience and knowledge. Many interviewees commented that the only real transition was the physical movement of a small number of staff, with needed learning and systems cast aside. Thus there were a lot of people doing things in an ad hoc manner, depending on their experience, as there were no real protocols, strategies, or policies in place around how things are done. Change is further undermined when new structures overpromise on delivery of contracts, before it is ready. The perception becomes a question of why the client companies should bother engaging with the new strategic procurement unit and it is harder to win them back. To implement stable strategic change, trust must first be built up as interpersonal trust, and then switched to interorganisational trust (Weiss, 2009).

To operate effectively, professional strategic procurement requires a 'whole of organization picture', which is enabled by effective communication and ICT, with common systems, process and data management. That is, an ICT system which gathers the 'clean', accurate and timely data needed to develop knowledge on potential and actual demand, on up-take of framework agreements, and supply market tracking. However, the OGPs business intelligence unit experienced difficulties due to how the information was categorised - garbage in, garbage out (Manager 2). They do a very good job investigating information, cleansing it so that they can produce information and now publish spend reports (Manager 4). Thus ICT systems should enable subsequent data analysis and information reporting. In summary an e-procurement system enables real-time, open communication of procurement objectives and policies, process ownerships and

responsibilities, documents and contracts to both procurement executives, clients and suppliers. Over time Procurement.ie, Construction.ie and eTenders.ie, while initially completely separate, were brought together (Manager 6). There needs to be a communication strategy, with SLAs, so that clients don't feel that they are being ignored.

The Approach is heavily influenced by the concepts of culture and dominant logic. Private sector culture as the dominant logic can clash with the public sector's 'public servant' culture. This impacts buy-in from staff and client organisations throughout the public sector, "with the potential for a civil servant to retreat to institutionalised norms to resist policy initiatives that might undermine them" (Newman, 2004:30). The top management team need to consider their language and communication strategies. For example, interviewees indicated a preference for OGP managers whose approach was 'I don't understand this, can you help me, can you explain it to me'. Rather than, I'm an expert in procurement, and we're going to follow this new process.

Finally, dynamic managerial capabilities requires the manager as leader, to bring balance between efficiency and flexibility within organizations as they aim to improve performance (Eisenhardt et al., 2010). The manager needs to continuously align procurement structure and strategy with political requirements, to focus on assembling and exploiting capabilities more entrepreneurially. They need to articulate a vision, establish the appropriate organisational culture so as to encourage identification and loyalty (Aungier & Teece, 2009). This requires managers to have both analytic an ability and an ability to take action, competence consisting of both perceptual skills (problem anticipation) and the analytical skills needed for problem-solving (Stamp, 1981).

Conclusion

This paper has identified the importance of each capability level. It has contributed to the strategic and procurement literature as it empirically identifies the components of the dynamic capability construct when developing and establishing a strategic procurement unit aligned to public procurement policies. These components have been integrated and a proposed framework is presented in the figure below. Although the framework is presented as a linear model, there is a recognition that, as a dynamic model, it will move backwards and forwards (vertically and horizontally) through the elements as the organisation constantly evolves and changes. The vertical components of the framework identify the flow as the DCs, the dynamic managerial capability act on the microfoundations to enable change in the ordinary capabilities, influenced by the environmental dynamism. The horizontal axes, begins with the antecedent variables which influence, not only the microfoundational mechanisms and enablers, but also the dynamic and ordinary capabilities. These mechanisms and enablers serve to effect change as the organisation first senses, seizes and subsequently reconfigures strategic procurement to deliver on public policy goals.

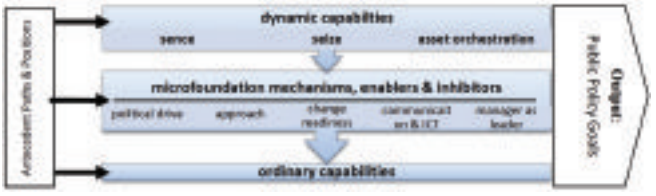


Figure 1: A Framework of Key Constructs Strategic procurement and Public Policy Implementation

This study has several limitations which may open up avenues for future research. While the study sought to select representative cases, and to use a representative number of informants from each organisation, it may not be possible to extend the ultimate findings to all contexts. Furthermore, there is recognised limits to generalisability due to the use of the case method and to the case being located in the public sector. These limitations could be overcome by the adoption of the survey method to test the applicability of the framework to a wider population. Empirical research on DC microfoundations still leaves many questions unanswered (Bendig et al., 2017), and the author does not contend that the micro-foundation dimensions presented in this study represent an exhaustive list. Considering these limitations, it is proposed that future studies adopt a mixed methods strategy, enabling a study which targets the breadth and depth of micro-foundation dimensions.

Practicably, the findings from this analysis suggest the need to not only contextualise elements of the DC framework, but to also consider the impact and role played by public sector constraints. The results from this research can be considered by change managers and leaders as it outlines microfoundation dimensions which they should consider when developing aligned strategic procurement. The important role played by managers and leaders in developing the relevant social and organisational change environment is identified. Managers underlying attributes, managerial cognition, human and social capital are acknowledged when explaining the outcomes achieved. Highlighting the value of leadership and the underlying attributes required when implementing change, signals areas for inclusion in management development programmes.

There are limited empirical papers on dynamic capabilities and their microfoundations when developing strategic procurement. And even less when applied to public sector procurement. This paper, in examining how strategic procurement alignment is developed and implemented to meet public policy, contributes to and extends the concept of dynamic capabilities to purchasing strategy and organisation, to public sector strategy, organisation theory, leadership and management. As each case study element is unique, it allows the commonalities and differences be identified. The DC model developed contributes to an understanding of antecedent and micro-foundation mechanisms and how they inhibit or enable dynamic capabilities. To how resources are utilised and new processes implemented. Finally, its unique contribution, is how the role of the manager, as a leader of change, influences dynamic capability development. These dynamic managerial capabilities outline the interactions of underlying attributes such as human capital, social capital and managerial cognition and help to explain the outcomes achieved when reconfiguring organisations.

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Broadening the perspective on the relationship between working capital and corporate performance: An empirical supply chain network analysis

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Abstract

Purpose – This paper analyses how the presence of financial constraint along supply chain networks influences a company's performance-maximizing level of net working capital (NWC). Based on the financial data of 1,986 industrial firms and their largest suppliers and customers, this paper provides pioneering empirical evidence that demonstrates the extent of the impact of financial constraint on corporate performance. The conclusion made is that the impact depends on the position of the respective actor in the supply chain (supplier, focal firm, and customer).

Research approach – The methodology of the presented research paper is based on data from the Bloomberg module SPLC<GO> in order to obtain the suppliers and customers of selected focal companies. Six hypotheses are tested to determine the relation between NWC and firm performance for every counterpart in the supply chain with regard to financial constraint effects. Regression analysis is performed to confirm the hypotheses. Additionally, robustness and sensitivity checks are carried out to test for both changes in the dataset and dependence on model specifications.

Findings and originality – In contrast to previous studies, this paper distinguishes between focal companies and their up- and downstream supply chain partners in order to allow for a more nuanced analysis. The results confirm the concave relationship between NWC and profitability of a firm in general. With regard to the optimum NWC, the introduction of a financial constraint factor shows differing influences on the three actor groups: focal companies, suppliers (upstream), and customers (downstream). Financial constraint decreases the optimum NWC for focal companies and customers while increasing it for suppliers. This could be due to decreased negotiation power of suppliers towards focal companies which can lead to prolonged payment allowances, decreased sales volumes that cannot be countered by lowering production output in the short-term, or tighter payment deadlines imposed by focal companies.

Research impact – The contribution of this paper to research is twofold. First, this paper confirms the concave relationship between the cash conversion cycle (CCC) as a proxy for NWC and return-on-assets (ROA) as a proxy for firm profitability. Second, it finds that effects of financial constraint differ with regard to a firm's position within the supply chain and thus demonstrates the need for a separated examination of suppliers, focal companies, and customers. While this paper regards the individual actors along the supply chain in isolation, further research should analyse the impact of financial- constraint-facing firms on the supply chain as a whole.

Practical impact – From these findings, concrete guidelines for industry professionals can be derived. Such guidelines can give valuable input for managing the trade-off between excessive and insufficient liquidity in collaboration with affiliated supply chain partners. By broadening the perspective towards a focal company's up- and downstream partners, this paper also demonstrates how companies with high liquidity can use their monetary resources to support supply chain partners that show productive investment opportunities but have restricted ability to obtain capital.

Keywords – Working capital performance, Cash conversion cycle, Upstream supply chain partner, Downstream supply chain partner, Financial constraints

Introduction

"(…) [M]anagement of [working capital] is claimed to be the beating heart of a business entity which pumps up the blood into the vessels of the organization" (Vahid, Elham, Khosroshahi Mohsen, & Mohammadreza, 2012, p. 1313). Not just since the financial crisis of 2008, NWC has received tremendous importance in corporations' financial strategy. As one of the first researchers of this topic, Smith (1980) analysed the trade-off between liquidity and the profitability of a firm by stating that working capital has an influence on a firm's performance.

The first aim of this paper is to confirm the work of previous researchers (Altaf & Shah, 2017; Baños- Caballero, García-Teruel, & Martínez-Solano, 2014) showing that NWC behaves concave with regard to firm performance. From these findings, decision makers can derive their firm's optimum NWC. The optimum NWC signifies the best trade-off between an insufficient level of working capital with the risk of losing potential income and an excessive level of NWC bearing the risk of bankruptcy. Based on this evidence, the second goal of this paper is to broaden the current perspective regarding this subject by adding the up- and downstream view on the supply chain. This is done since considering suppliers and customers in the supply chain has a positive correlation with

the focal company's performance (Zhang & Huo, 2013). Finally, this paper analyses the impact of financial constraint on the optimum NWC for focal companies, their suppliers, and their customers.

Since there are many possible measurement variables for the design of the data model, a literature analysis was conducted with high-ranked papers from relevant scientific publishers 1 . From this analysis, the most common variables were used to build the empirical research models.

The remaining paper is structured as follows: A literature review gives a brief overview about NWC and the relationship between NWC and firm's profitability. Based thereon, hypotheses are developed. In the next step, the data and methodology are explained, followed by the empirical evidence found. The paper closes with a discussion of the results and concluding remarks.

2. Literature review and hypotheses development

2.1. Net working capital in previous literature

Corporate finance can be divided into three important parts: capital structure, capital budgeting, and working capital management. Working capital management plays a very important role due to its relation to the profitability and liquidity of a firm (Ilyas, 2014). Well-managed working capital helps to ensure that the daily operations of a company are problem-free by supporting efforts to plan and control a firm's current assets and liabilities (Ilyas, 2014).

To measure and control the management of NWC, the concept of CCC was introduced to show how long cash is tied up in a firm's operations in the form of accounts receivables and inventories. A short CCC signifies that a company conducts its business very efficiently. CCC is based on three KPIs: days sales outstanding (DSO), days inventory held (DIH), and days payables outstanding (DPO), resulting in the following formula: CCC = DSO + DIH – DPO.

2.2. Net working capital and firm performance

Previous research on the relationship between NWC and a firm's performance can be divided into three different approaches (see Figure 1). They are as follows: attributing the two factors a positive linear correlation ("a higher NWC correlates with a higher profitability"), attributing the two factors a negative linear correlation ("a lower NWC correlates with a higher profitability"), and attributing the two factors a non-linear U-shaped or concave relation (with an optimum NWC to get the best possible firm performance) (Altaf & Shah, 2017). Considering the relationship between performance and NWC as a concave graph is a recent trend in working capital research. According to Altaf and Shah (2017), there exists a non-monotonic relationship between the two and therefore an optimum NWC. This optimum point displays the trade-off between cost and benefits of both high and low NWC.

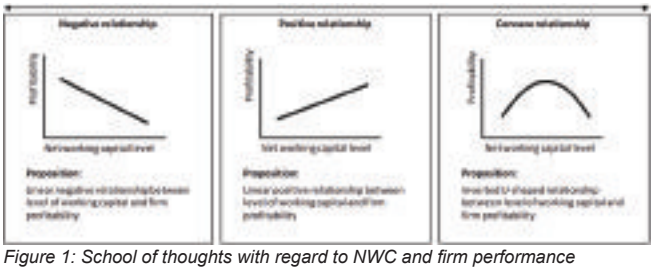


Figure 1: School of thoughts with regard to NWC and firm performance

An additional new approach that deserves attention is to include the companies' suppliers and customers in the analysis. This incorporates the cross-organizational relationship for the accounts receivable, inventories, and the accounts payable. For example, if a focal company delays its payment to the supplier, this enlarges both the focal company's DPO and the supplier's DSO.

Further, the influence of financial constraint on a company with regard to the optimal relationship between NWC and firm performance is not yet sufficiently studied in literature. Baños-Caballero et al. (2014) explored this effect by introducing a dummy variable that considered eight criteria as a proxy for financial constraint. They showed that financially constrained firms have a lower optimum of NWC. This can be explained by the fact that financially constrained firms face higher external financing costs due to asymmetric information between the firm and capital markets (Baños-Caballero et al., 2014).

Based on the findings from previous literature, the following six hypotheses were developed:

(H1/2/3a): NWC is positively correlated with a focal company's (FC)/ supplier's (S)/ customer's (C) profitability until an optimum and negatively correlated from thereon.

(H1/2/3b): The correlation between NWC and a firm's profitability for financially constrained focal companies (FC)/ suppliers (S)/ customers (C) is concave but with a lower optimum than in a non- financially constrained state.

3. Data and methodology

3.1. Data collection, sample selection, and outlier treatment

The empirical study of the presented research paper is based on Bloomberg data. This research considers focal companies in the category Industrials of the Bloomberg Industry Classification Standard (BICS), which resulted in a list of 16,836 firms. This list was further refined by excluding companies with revenues of zero or less. In the next step, the focal companies' maximum largest five suppliers (in % of cost) and customers (in % of revenue) were selected using the Bloomberg module SPLC<GO>. Data were pulled in U.S. dollars (USD). The research derived a sample selection of 1,986 focal companies with at least one supplier and customer. Historical data were pulled on an annual level to obtain panel data for the years 2013 to 2017. To avoid the influence of outliers, the dataset was cleaned for values that deviated more than three times the standard deviation from the mean and for companies not showing aim for profit generation (as indicated by a negative ROA). Finally, the

1 Among others Emerald Insight, Open Docs, Research Gate, Science Direct and Science Domain

outlier treatment resulted in 1,099 focal companies with 5,495 observations, 1,278 suppliers with 6,390 observations, and 990 customers with 4,950 observations.

3.2. Measures

This research paper is based on a literature analysis showing that ROA was mostly used as the dependent variable (see for example Afrifa, 2016; Lyngstadaas and Berg, 2016; Pais and Gama, 2015). For the independent variables, CCC and squared CCC were most often considered, as well as assets' natural logarithm as indicator for size of the firm, leverage and sales growth (see for example Afrifa, 2016; Lyngstadaas and Berg, 2016; Pais and Gama, 2015). These variables build the base of this paper's models. The effects of financial constraint will be analysed by adding a dummy variable for financial constraint.

Variable	Acronym	Formula
Dependent variable:		
- Return on assets	ROA	$\frac{EBITDA}{Assets}$
Independent variables:		
- Days sales outstanding	DSO	$\frac{Accounts\ Receivables}{Net\ Sales} * 365\ Days$
- Days inventory held	DIH	$\frac{Inventories}{Cost\ of\ Goods\ Sold} * 365\ Days$
- Days payables outstanding	DPO	$\frac{Accounts\ Payables}{Cost\ of\ Goods\ Sold} * 365\ Days$
- Cash conversion cycle	CCC	$DSO + DIH - DPO$
- Squared cash conversion cycle	CCC^2	$(DSO + DIH - DPO)^2$
Proxy variable:		
- Financial constraint	FINCO	Dummy variable with constrained (1) and unconstrained (0)

Table 1: Overview measures

Since this paper's data is influenced by different suppliers and customers for each supply chain, the weighted average has to be considered by taking the relationship amount of the up- and downstream counterparts. Thus, the weighted average was calculated for the suppliers' and customers' CCC and the squared value for the CCC^2 variable.

Baños-Caballero et al. (2014) were some of the first researchers analysing the influence of NWC on corporate performance under the aspects of financial constraint. They concluded that the optimal NWC level for corporate performance is dependent on financial constraint. Thus, the perfect NWC level is lower for firms that are more financially constrained. However, financial constraint is not directly observable (Altaf & Shah, 2017; Farre-Mensa & Ljungqvist, 2013). Previous empirical literature considered size, type, and investment-grade rating as indirect proxies to estimate the level of financial constraint (Farre-Mensa & Ljungqvist, 2013). It thereon follows that financial constraint characteristics

can be more often observed at small, privately-held firms and public firms with below investment- grade ratings (Farre-Mensa & Ljungqvist, 2013). Under these aspects, firm size and paid dividends will be considered to proxy financial constraint. Since financially constrained firms tend not to pay dividends, the absolute number of paid dividends as a proxy for the financial constraint will be considered (Baños-Caballero et al., 2014). Since this paper is interested in the dividend pay-out as a characteristic and not the value of the dividends, it dichotomizes this numerical variable into a dummy variable with binary options zero (0) for not being financially constrained with dividend payments over the median, and one (1) for companies that are financially constrained with dividend payments below the median (Johnson, 1995; MacCallum, Zhang, Preacher, & Rucker, 2002).

3.3. Methodology

In Chapter 2, six hypotheses are developed to figure out the relationship between NWC and a firm's performance for every counterpart in the supply chain. In each regression model, the parameters for numeric variables are defined as Θ and dummy variables as β, both consecutively numbered with indices. The first parameter β_0 indicates the constant value of the regression and therefore the performance of the company if all the independent variables are zero. Each variable is labelled by an abbreviation[2] and—given that this paper uses panel data—the variables are indexed by the variable index i and the time variable t. Finally, the models include the error terms γ (for the variables), δ (for the time series), and ε (for the residuals). For each of the hypotheses, the following regression models will examine the relationship between CCC and firm performance. The models for upstream (S) and downstream (C) supply chain partners follow the same pattern as for the focal company (FC) models displayed.

(H1a):

$$FC\_ROA_{i,t} = \beta_0 + \beta_1 FC\_CCC_{i,t} + \beta_2 FC\_CCC_{i,t}^2 + \beta_3 FC\_SIZE_{i,t} + \beta_4 FC\_LEV + \beta_5 FC\_SGROWTH_{i,t} + \gamma_i + \delta_t + \varepsilon_{i,t}$$

(H1b):

$$FC\_ROA_{i,t} = \beta_0 + (\beta_1 + \beta_3 FC\_FINCO_{i,t}) FC\_CCC_{i,t} + (\beta_2 + \beta_4 FC\_FINCO_{i,t}) FC\_CCC^2_{i,t} + \beta_5 FC\_SIZE_{i,t} + \beta_6 FC\_LEV + \beta_7 FC\_SGROWTH_{i,t} + \gamma_i + \delta_t + \varepsilon_{i,t}$$

Detecting a correlation in the data shows that fixed effects exist and the ordinary least square (OLS) method has to be applied. The most common strategy to figure out if the effects are fixed is the Hausman-test (García-Teruel & Martinez-Solano, 2007). Since for this paper's data the Hausman-test (1978) rejects the hypothesis to consider random effects as appropriate, the fixed effects have to be taken for further empirical analysis. Therefore, the OLS method will be considered in the additional research.

4. Results

Table 2 contains the results of the data analysis.

Model	FC_{nc} (H1a)	FC_c (H1b)	S_{nc} (H2a)	S_c (H2b)	C_{nc} (H3a)	C_c (H3b)
CCC	0.00224 (0.00334)	0.0121 ** (0.00435)	0.00140 (0.00270)	0.0191 *** (0.00489)	0.00403 (0.00258)	0.00958 *** (0.00283)
CCC*FINCO		−0.0122 *** (0.00350)		−0.0220 *** (0.00391)		−0.00982 *** (0.00276)
CCC^2	−0.000178 ** (0.0000843)	−0.000337 ** (0.000118)	−0.0000976 (0.0000725)	−0.000197 *** (0.000107)	−0.0000215 * (0.0000692)	−0.000446 ** (0.0000941)
CCC^2*FINCO		0.000178 (0.0000988)		0.000323 *** (0.0000947)		0.000485 * (0.0000717)
SIZE	0.585 * (0.206)	0.428 (0.296)	0.0371 (0.129)	−0.0125 (0.129)	0.301 * (0.134)	0.268 * (0.134)
LEV	−23.26 *** (1.361)	−22.87 *** (1.186)	−18.62 *** (0.771)	−18.42 *** (0.768)	−14.20 *** (0.754)	−14.18 *** (0.755)
SGROWTH	0.0287 *** (0.00249)	0.0200 *** (0.00267)	0.0407 *** (0.00245)	0.0407 *** (0.00242)	0.0225 *** (0.00208)	0.0240 *** (0.00209)
_cons	2.894 (2.925)	4.196 (3.009)	7.929 *** (1.467)	8.413 *** (1.464)	3.777 * (1.616)	4.032 * (1.616)
# of obs.	4,713	4,546	6,398	6,385	4,950	4,944
R^2	0.137	0.148	0.151	0.156	0.117	0.119

Standard errors in parentheses, nc = not constrained, c = constrained
**p<0.05, **p<0.01, ***p<0.001*

Table 2: Regression results

2. SIZE = firm size, LEV = leverage, SGROWTH = sales growth, FINCO = financial constraint

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4.1. Focal company perspective

The regression results for the model testing hypothesis H1a are shown in Table 2. As can be seen, the coefficient for the CCC is positive, whereas the squared CCC is always negative, indicating an inverted U-shaped relation for the CCC with the profitability of a firm. Since this paper is interested in the optimal level of CCC, the model testing H1a has to be differentiated with respect to CCC. This leads to the following formula:

$$\frac{-\beta_1}{2*\beta_2}$$

Applying this formula, the optimal level of NWC expressed in the CCC is 63 days. The regression results in the model H1a support the first hypothesis: The NWC has a positive impact on a firm's profitability until an optimum, from which it then decreases. Unfortunately, the coefficient of the CCC in the regression above is not significant. However, other papers, such as Afrifa (2016), have arrived at a significant value of 67 days, which is a value similar to the findings of this paper's analysis.

Adding the financial constraint dummy for the focal companies increases the CCC variable (H1b), leading to an optimum of minus six days for the focal company's CCC. This optimum has been calculated by differentiating the model with respect to the CCC variables:

$$\frac{-(\beta_1+\theta_1)}{2(\beta_2+\theta_2)}$$

As assumed, introducing financial constraint shifts the optimum CCC to the left and therefore lowers it, proving H1b. The same effect was also observed by Baños-Caballero et al. (2014) and Altaf and Shah (2017). The negative CCC value in the optimum indicates that DPO should be higher than DSO and DIH together. This is likely a result from the lower initial optimum for focal companies.

4.2. Upstream oriented perspective

For the upstream suppliers' side, the optimal CCC is 71 days—eight days higher than for the focal company. Unfortunately, the NWC variables are not significant in the first supplier model (H2a rejected). Thus, this result could be random and needs further data for validation. Analysing financially constrained firms leads to an optimum of 119 days for the CCC. Reversely than for the focal companies, the influence of financial constraint shifts the concave regression function to the right and therefore to a higher optimum NWC level (H2b accepted).

4.3. Downstream oriented perspective

As one can see in the regression results for downstream customers, the relation between the CCC and the profitability is still a concave graph. Calculating the maximal profitability leads to a CCC value of 86 days. This is a 23 day higher optimum CCC than for focal companies (H3a accepted). Calculating the maximal profitability for financially constrained customers leads to the expected CCC level of eleven days. As for focal companies, financial constraint shifts the CCC that corresponds to a maximal profitability for the customers to the left and therefore to a lower CCC. The lowering effect of the financial constraint is 75 days and therefore closely the same as for the focal companies with a difference of 69 days (H3b accepted).

4.4. Discussion

The regression outcomes prove the existence of a concave function of the NWC to the profitability for any player of the supply chain. An overview of the found optimum CCCs for all the regression models is given by Table 3. The results for focal companies are similar to those from Altaf and Shah (2017) with an optimum CCC of 65 days and Baños-Caballero et al. (2014) with 66.95 days. Robustness and sensitivity checks that were conducted confirmed the paper's results.

	Focal companies		Suppliers		Customers	
	Not constrained	Constrained	Not constrained	Constrained	Not constrained	Constrained
Optimum	63	−6	71	119	86	11
ROA	3.45	2.87	3.89	4.00	3.97	3.79
	(6.53)	(7.58)	(3.23)	(3.63)	(2.61)	(2.50)
DSO	83.09	92.93	25.2	23.78	24.04	21.89
	(98.37)	(99.85)	(20.61)	(22.75)	(21.19)	(22.48)
DIH	81.49	92.14	58.28	58.51	58.22	61.18
	(189.73)	(148.53)	(42.17)	(49.08)	(43.17)	(52.17)
DPO	70.25	78.17	46.78	46.94	50.57	50.99
	(91.55)	(122.63)	(38.57)	(40.87)	(36.05)	(44.93)
CCC	97.65	138.39	61.79	57.07	70.69	64.38
	(90.28)	(182.94)	(47.78)	(55.44)	(55.33)	(58.98)

Standard deviation in parentheses

Table 3: Overview over resulting optimum CCC levels

The higher optimum CCC for suppliers could be due to the effect of larger inventories to lower supply costs and to achieve a better handling of price fluctuations, or to strengthen long-term relationships with the customers, which reduces asymmetric information between the counterparts (Baños-Caballero et al., 2014). At the same time, a higher CCC bears the risk of bankruptcy due to high amounts of non-liquid capital. Taking into account the effects of financial constraint, one can observe that the financial constraint dummy has a decreasing effect on the CCC corresponding to an optimum ROA for focal companies and customers while it bears an increasing effect for suppliers. Recent studies showed an overall decreasing effect (Altaf & Shah, 2017; Baños-Caballero et al., 2014), which is why the increasing effect for suppliers is unexpected. Possible reasons could be that financially constrained suppliers see opportunities by investing into long-term relationships with their customers as an answer to higher external financing costs. This assumption supports the results from Minetti, Murro, Rotondi, and Zhu (2018), who indicate that financially constrained firms with difficult access to bank credits have to participate more in the supply chains and therefore equip their business with long-term relationships. Another explanation by Hoberg, Protopappa-Sieke, and Steinker (2017) considers the higher demand of inventories for financially constrained firms, especially for firms in the supplier- customers dyads. To conclude, the overall results partly approve previous literature findings while also opening up new discussions with regard to considering the supply chain as a whole.

5. Conclusion

Research in the topic of NWC management has gained traction since the past financial crisis. The aim of this paper is to approve the findings of recent studies on this topic and to broaden the current perspective of the topic by integrating the up- and downstream counterparts of the supply chain. This was done with panel data from Bloomberg considering industrial companies, their suppliers, and their customers throughout the years 2013 to 2017. Six models were created, two for every actor in the supply chain, with and without financial constraint. Finally, using the OLS method, the regressions were analysed.

The majority of hypotheses were confirmed: for focal companies, suppliers, and customers this paper found a concave relationship between NWC and profitability. As supposed, financial constraint decreased the level of NWC corresponding to an optimum profitability for focal companies and customers, as also shown by recent studies. Unexpectedly, the financial constraint dummy shifted the optimum NWC for suppliers to the right and thus to a higher level. Two arguments were mentioned that explain this anomaly. First, according to Minetti et al. (2018), financially constrained firms have to build on long term relationships, which increases the CCC and are especially relevant for suppliers. Second, as found by Hoberg et al. (2017), financially constrained firms have a higher demand of inventory, which increases DIH and thus CCC as a proxy for NWC.

The novelty of this paper was to find the optimum NWC for each actor in the supply chain. Considering the findings, firms can obtain a competitive advantage by increasing their profitability through a well- balanced NWC. Nevertheless, one has to be aware of certain limitations inherent in this paper, specifically among others is a strict industry focus on industrials and the consideration of supply chain actors in isolation. Further research is necessary to determine interdependencies of NWC levels between suppliers, focal companies, and customers. Finally, this paper recommends considering the concave influence of the NWC for the business community and the influence of financial constraint not only for the own company but also for the suppliers and customers in the supply chain.

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Benefits of supply chain finance-oriented working capital approaches in three-tier supply chains

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Abstract

Purpose – This paper examines the functional form of the relationship between working capital assets and corporate performance, beyond the traditional single company perspective. In particular, it explores how collaborative practices in working capital management (WCM) influence a focal company's performance in triadic supply chain sections. Further, the performance impact of supply chain finance (SCF)-oriented WCM approaches is investigated. Propositions regarding the relationship between working capital and corporate performance from prior WCM research are presented, and in so doing, raising awareness of factors yet to be tested.

Research approach – A COMPUSTAT database is used for the analysis. Proxy variables for collaborative WCM are derived from extant contributions to the understanding of WCM in an inter- organizational context, which are then applied in regression models to estimate various performance metrics.

Findings and originality – The results indicate that a relationship between collaborative WCM and supply chain performance exists, but the direction and power of this relationship vary among the various proxies used for collaborative WCM and the estimated performance metrics.

Research impact – The paper at hand contributes to SCF-related research by validating several proxy variables for collaborative working capital approaches. Responding to the call in previous research, we examine the performance impacts of collaborative WCM approaches in the context of an inter- organizational supply chain network.

Practical impact – Several practical implications are derived, demonstrating how companies can increase the efficiency and effectiveness of the financial supply chain network in which they operate. In that regard, our paper guides practitioners in allocating working capital adequately in a supply chain network.

Keywords – Collaborative working capital management, Corporate performance, Financial supply chain management, Supply chain finance

Introduction

The relationship of working capital management (WCM) and corporate performance has received attention from researchers who have reported their findings in a multitude of publications. Evidence has emerged supporting various shapes and directions of this relationship between WCM and firm performance: Jose, Lancaster and Stevens (1996) support the notion of a negative relationship between the amount of net working capital (NWC) and performance, Padachi (2006) found evidence of a positive relationship, while Singhania and Mehta (2017) assert that this relationship is of a non-linear nature. Those researchers looked at WCM from a single-firm perspective, and thus their findings only concern single-firm performance. Hofmann and Kotzab (2010) were among the first authors to take a different approach to WCM by considering the effect of a focal firm's working capital decisions on its suppliers and customers. From a conceptual standpoint they argue that, in contrast to the classic paradigm, decision making in WCM should not be undertaken by one firm alone but rather aligned with partner firms in their respective supply chains. In the long run, such supply chain-oriented, collaborative WCM practices would be more performance enhancing than a myopic approach concerned with achieving maximal liquidity within the focal company. Other authors subsequently took up this notion and identified leverages affecting how collaborative WCM contributes to supply chain and firm performance (e.g., Viskari & Kärri, 2012; Randall & Farris, 2009). In this research paper the claim that collaborative WCM is beneficial for performance is put to the test. The paper is structured as follows: After a review of extant literature, proxies for collaborative WCM are developed and then applied in regression models to assess whether supply chains that exhibit a higher degree of collaboration in their working capital practices also demonstrate superior performance. Attention is given to the performance of the partner firms within the supply chains, by testing whether the degree of WCM collaboration in a supply chain has an influence on the performance of its member firms. The method used to identify and measure supply chains was first introduced by Lanier, Wempe and Zacharia (2010) and has been adapted to the context of this research.

Theoretical background

Single company perspective on working capital and performance

The cash conversion cycle (CCC) is a key WCM indicator for assessing the performance of individual companies or industries. According to Shin and Soenen (1998), CCC is calculated as: CCC = (accounts receivable/sales) × 365 + (inventories/sales) × 365 - (accounts payable/sales) × 365. In the existing literature on the relationship between working capital levels and profitability of a firm, extant evidence allows for multiple explanations of the nature of this relationship. Shin and Soenen (1998) propose a linear negative relationship using a sample of 58,985 firms and investigating a time span from 1975 to 1994. They demonstrate a significant negative relationship between CCC length and firm profitability, which is supported by numerous studies, such as Deloof (2003), Wang (2002), and Lazaridis and Tryfonidis (2006). There are several theoretical explanations for these results. For example, lower working capital implies lower financing and interest costs and thus, improved shareholder value (Kieschnick, Laplante & Moussawi, 2013; Kim & Chung, 1990). In addition, firms may be forced to draw capital away from alternative value-enhancing projects, if they have too much capital tied up in working capital positions (Deloof, 2003; Baños Caballero et al., 2014). Alternatively, other studies propose a positive linear relationship. Higher investment in working capital is thought to increase a firm's profitability (Tauringana & Afrifa, 2013; Afrifa & Padachi, 2016). By extending payment, firms may differentiate themselves from competitors by offering a unique selling proposition when there is low differentiation in the market, translating into better profitability measures (Shipley & Davies, 1991; Deloof & Jegers, 1996). Such extensions of payment periods may be perceived as a price cut (Petersen & Rajan, 1997; Emery, 1984) and reduce the risk for the buyer by using payment period to inspect the quality of the purchase (Biais & Gollier, 1997). In the long run, the practice of granting high DSO (days sales outstanding) can further contribute to improved profitability, as it may serve as an instrument to strengthen ties to customers, increasing loyalty and the firm's sales at times of low demand (Deloof & Jegers, 1996; Shah, 2009; Long, Mailitz & Ravid, 1993). According to Blinder and Maccini (1991) and to Schiff and Lieber (1974), larger inventories reduce the risk of price fluctuations, distortions in the production process, and costly out-of-stock situations that limit a firm's sales opportunities. In addition, Carpenter et al. (1994) demonstrated that adjustment costs for fixed assets are in general higher than those for working capital. Working capital may also serve as a stock of precautionary liquidity, since it is less expensive for high-working-capital firms to counterbalance a potential short-term liquidity shock (Fazzari & Petersen, 1993). Recently, research papers have tried to conciliate the two aforementioned theories of a negative or a positive relationship between working capital and performance. According to these studies, the relationship between levels of working capital and firms' performance is a non-linear inverted u-shape, which implies that an optimal level of working capital exists. As previously proposed by Rafuse (1996), working capital is an investment to keep a business running, so that each firm has to manage a trade-off between too much capital tied up and too little working capital available for its daily business operations. This theory is supported by various research papers (Afrifa & Padachi, 2016; Baños-Caballero et al., 2014; Mun & Jang, 2015; Altaf & Shah, 2017; Pais & Gama, 2015). According to Baños-Caballero et al. (2014), the optimal level of working capital can differ among firms, noting that financially constrained firms have lower optimal working capital levels. However, it becomes apparent from a review of extant studies that there is no consensus at this time on the relationship between working capital and firm profitability.

Supply chain-oriented view of working capital and performance

The supply chain finance (SCF) orientation takes into account that management of working capital directly influences affiliated supply chain partners through accounts payable, inventories, and accounts receivable along the supply chain. In particular, self-centred working capital improvements are made at the expense of affiliated supply chain partners. Hofmann and Kotzab (2010) used model calculations to show that the optimization of working capital by a single firm in a supply chain does not add value to other supply chain members. An illustrative example is that a reduction in DPO (days payable outstanding) by one supply chain member results in an increase of another member's DSO (zero-sum game). Grosse-Ruyken et al. (2011) studied CCCs of different industry sectors and detected a strong negative correlation between average industry CCC and average industry ROCE (return on capital employed). They thus argue that industries that collaborate in their WCM activities, signified by a lower average industry CCC, are rewarded with a higher average industry ROCE.

Implications and proposition building

The aforementioned research outputs conclude that the application of a supply chain-oriented perspective on WCM will be beneficial for the performance of the supply chain. In their scenario, Viskari and Kärri (2012) found that the shift of inventory to upstream partners in a supply chain can reduce overall costs for the supply chain due to the increasing value of a product as it passes through the value chain (Porter, 1985). In addition, after a supply chain transaction is undertaken, shifting the associated financial burden towards the supply chain partner with the lowest WACC (weighted average cost of capital) affords an opportunity to lower total supply chain incurred costs and helps generate higher profits (Randall & Farris, 2009).

Proposition 1: Supply chains that shift working capital components among their members, with a goal of minimizing the cost associated with these components, exhibit superior performance.

Grosse-Ruyken et al. (2011) illustrate how the CCC is linked to profitability and provide evidence that industries with a shorter average CCC exhibit higher profitability on average. However, intense collaboration of all supply chain members, involving upstream and downstream partners, is necessary to achieve a sustainable reduction of the CCC. Hofmann and Kotzab (2010) showed that an isolated reduction of a CCC by a firm within a supply chain does not affect the collaborative CCC length at all. Such practices might even be detrimental to a supply chain in the long run. Weaker members will incur higher financing costs, if their CCC is stretched by stronger supply chain members (Protopappa-Sieke & Seifert, 2017). This can lead to downstream delays, quality issues, and

ultimately higher costs of goods sold for the affected supply chain members, diminishing the competitive advantage of that supply chain (Hofmann & Kotzab, 2010).

Proposition 2: Supply chains that manage their chain CCC collaboratively will exhibit superior performance.

According to Rafuse (1996), working capital is an investment and comes with associated costs and benefits; thus, a reduction of working capital will enable the use of capital in a more productive way. Consequently, Hofmann and Kotzab identify the optimal collaborative CCC as being 'the one that minimizes the cost of tied up capital […] across all collaboration members' (2010, p. 324). Furthermore, simulations showed that a shared pool of working capital in a supply chain is less costly overall than if members each keep their separate working capital stock, partly due to the reduced overall requirement of working capital in the case of a joint pool (Protopappa-Sieke & Seifert, 2017).

Proposition 3: Supply chains which harmonize their members' activities to reduce the overall amount of net working capital in a supply chain exhibit superior performance.

Research methodology

The approach introduced by Lanier et al. (2010) is used to investigate financial performance of three-firm supply chains adapted for the investigation of WCM. The Statements of Financial Accounting Standard No. 14 (1976) and No. 131 (1997), which require firms to disclose major customers, that is, customers that account for 10% or more of a firm's sales in one year, are used for the construction of supply chains. If, in the same year, a firm reports a major customer and also appears as a major customer in the disclosures, then that firm is a focal company of a concentrated supply chain (CSC) (Lanier et al., 2010). The three-firm CSCs were chosen as the subject of this study because the building of three-firm CSCs allows the creation of a larger sample as compared to larger CSCs. This will result in increased robustness and validity of the results.

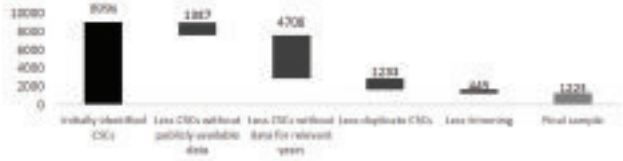


Figure 1: Illustration of the sampling process

The COMPUSTAT database delivered 137,063 major customer disclosures covering a span from 1978 to 2018. This database was reduced to an initial dataset of 8,996 possible CSCs for the study (Figure 1) by identifying focal companies that reported a major customer and were likewise named as a major customer. In the next step, identifiers were applied to screen the information that was needed for the calculation of the proxies, resulting in a sample size of 7,609 CSCs. Subsequently, as not all data necessary for the calculation were available, the number of CSCs was reduced to 2,901. Then, duplicate CSCs were removed in a screening within the reduced dataset, resulting in 1,668 CSCs. Finally, to limit the effects of statistical outliers and to improve robustness of the results, the dataset was trimmed using the 1.5 × interquartile step fence, applied for all proxy variables used (Wilcox, 2001). This step delivered the final dataset, consisting of 1,223 CSCs, aggregated of 704 suppliers, 188 focal companies and 162 customers. As the database consists of an international sample of companies that do not all necessarily calculate their income statement using the cost-of-sales method (some may use the full-cost method), the inventory and payables turns are based on a company's sales.

The CSC performance metrics (dependent variables) EBITDA margin, EVA, profit margin, asset turnover, and ROA are used to measure CSC performance. To diminish the risk of a regression outcome being biased by other influencing factors, the regression models are controlled using the following variables, adapted from the study of Baños-Caballero et al. (2014): size (natural logarithm of sales), leverage (ratio of total debt to total assets), and growth opportunities (ratio of book value of intangible assets to total assets), representing the control variables. The calculation of metrics and variables at the chain level follows the procedure outlined by Lanier et al. (2010). The five performance metrics (ROA, EBITDA margin, profit margin, EVA, and asset turnover) are calculated on a chain level, interpreting the CSC as a quasi-entity. For the measurement of chain level-oriented Propositions 1 to 3, proxy variables (formulas (1)–(5)) are calculated for the supply chain in the form of a supply chain as a quasi-entity (Lanier et al., 2010; Blois, 1972). This procedure allows the formulation of regression models, which are then used to assess the propositions for significance and power.

In order to evaluate Proposition 1, proxy variable Inv_{shift} is used to measure the degree to which inventory is stored upstream within the supply chain, as the associated costs for inventory are lower in the earlier stage of a good's production cycle (Viskari & Kärri, 2012). Inv_{shift} is calculated as follows:

(1) $$Inv_{shift} = \frac{\left(Inv_{Supplier} + Inv_{Focal\ Company}\right)}{\left(Inv_{Supplier} + Inv_{Focal\ Company} + Inv_{Customer}\right) * \left(S_{Supplier} + S_{Focal\ Company}\right)}$$

where Inv_x is inventory held by the position within the supply chain (Supplier, Focal Company, Customer) which is defined in the index. S_x represents the relative number of chain sales by the position within the supply chain (Supplier, Focal Company, Customer) which is defined in the index.

The second proxy variable, NWC_{Costs} to assess Proposition 1, builds on the contributions of Randall and Farris (2009) as well as Hofmann and Kotzab (2010), who recognize that firms within a supply chain may be exposed to different costs of capital. They argue that supply chains as a whole may benefit from such differences. The NWC_{Costs} variable, used to calculate to what degree supply chain members with a lower WACC undertake financing activities for chain members with a higher WACC, is calculated as:

(2) $$NWC_{costs} = \frac{\sum_{i=1}^{3}\left(NWC_i * WACC_i\right)}{\sum_{i=1}^{3}\left(NWC_i\right) * WACC_{chain}}$$

where $WACC_{chain}$ is calculated as the sum of $WACC_{chain}$ multiplied by S_x.

The first proxy variable, CCC_{chain} to assess Proposition 2, builds on the contribution of Hofmann and Kotzab (2010), who showed that harmonized WCM within the supply chain leads to a shorter CCC. This is further supported by Grosse-Ruyken et al. (2011), who provided evidence of the negative relationship between CCC_{chain} and ROCE on the industry level. Thus, CCC_{chain} is calculated as:

(3) $CCC_{chain} = CCC_{supplier} + CCC_{focal\ company} + CCC_{customer}$

The second proxy variable, $CCC_{balance}$ to assess Proposition 2, builds on the contribution of Grosse-Ruyken et al. (2011) who state that CSCs can increase their performance if they aim for a collaborative CCC balanced across member firms. An increasing $CCC_{balance}$ is perceived as a decreasing balance within the CCC. Thus, the proxy variable $CCC_{balance}$, attempting to measure the degree to which a CSC achieves an equal distribution of the collaborative CCC, is calculated as:

(4) $ccc_{balance} = \ln\left(\left(\frac{CCC_{chain}}{3}\right) - ccc_{supplier}\right)^2 + \left(\left(\frac{CCC_{chain}}{3}\right) - ccc_{focal\ company}\right)^2 + \left(\left(\frac{CCC_{chain}}{3}\right) - ccc_{customer}\right)^2$

The proxy variable $CCC_{difference}$ to assess Proposition 3 builds on the contribution of Protopappa-Sieke and Seifert (2017), who showed that a joint point of working capital in supply chains may reduce the overall need for working capital in supply chains. Thus, adapted from Vazquez, Sartal and Lozano-Lozano (2016), the proxy variable $CCC_{difference}$, attempting to measure the degree to which invested capital could have been deployed in a more productive way (Rafuse, 1996), is calculated as follows:

(5) $NWC_{difference} = \frac{NWC}{Sales} - \frac{NWC}{Sales}$

where *NWC* and *Sales* express the particular means.

The following models are used to estimate effects of the proxy variables on the CSC performance metrics described above. Support for Proposition 1 is expressed if regression (6) results deliver a positive value for β1 of Inv_{Shift}. Support for Proposition 1 is expressed if regression (7) results deliver a negative value for β1 of NWC_{costs}.

(6) $CSC_{metric} = \beta_1 Inv_{shift} + \beta_2 size + \beta_3 leverage + \beta_4 growth$

(7) $CSC_{metric} = \beta_1 NWC_{costs} + \beta_2 size + \beta_3 leverage + \beta_4 growth$

Support for Proposition 2 is expressed if regression (8) results deliver a negative value for β1 of CCC_{chain}.

Support for Proposition 2 is expressed if regression (9) results deliver a negative value for β1 of $CCC_{balance}$.

(8) $CSC_{metric} = \beta_1 CCC_{chain} + \beta_2 size + \beta_3 leverage + \beta_4 growth$

(9) $CSC_{metric} = \beta_1 CCC_{balance} + \beta_2 size + \beta_3 leverage + \beta_4 growth$

Support for Proposition 3 is expressed if regression (10) results deliver a negative value for β1 of $CCC_{difference}$.

(10) $CSC_{metric} = \beta_1 NWC_{difference} + \beta_2 size + \beta_3 leverage + \beta_4 growth$

Each of the introduced models is used to estimate performance metrics ROA, EBITDA margin, profit margin, EVA, and asset turnover. Having five models and five performance metrics to be estimated results in a total of 25 regressions.

Results

Table 1 shows the descriptive statistics for the independent and dependent variables, giving insights into the distribution of variables. For example, two variables can be proven with the corresponding literature. The mean CCC_{chain} is slightly higher than results of corresponding studies at the firm level (Jose, Lancaster & Stevens, 1996; Afrifa & Padachi, 2016), due to the created CSC with an increasing CCC along the upstream partners. The mean ROA of 0.050 corresponds to the values found in similar studies (Baños-Caballero et al., 2014). Table 2 shows the estimation results of the derived models and assesses to what extent the proxies for collaborative WCM may explain CSC performance metrics.

Inv_{shift}: The results indicate a significant influence of Inv_{shift} on ROA and asset turnover on the 1% significance level as well as on profit margin and EVA on the 5% significance level. No significant influence of Inv_{shift} was found on the EBITDA margin. In performance metrics where a significant influence was found, the direction is positive for all metrics and thus support Proposition 1.

	Mean	S. D.	25%	50%	75%
Inv_{shift}	0.983	0.408	0.783	0.956	1.233
NWC_{costs}	1.068	0.357	0.871	1.010	1.240
CCC_{chain}	466.003	131.939	372.722	448.153	545.225
$CCC_{balance}$	4.956	0.732	4.444	5.057	5.506
$NWC_{difference}$	0.002	0.079	-0.051	-0.016	0.056

Table 1: Descriptive statistics; N=1,223 for all coefficients

	ROA		EBITDA margin		Asset turnover		EVA		Profit margin	
	0.110	***	-0.024		0.098	***	0.064	**	0.061	**
	(3.968)		-(.853)		(3.424)		(2.596)		(2.113)	
NWC_{costs}	0.102	***	0.234	***	-0.221	***	0.170	***	0.171	***
	(3.703)		(8.513)		-(7.941)		(7.121)		(6.094)	
CCC_{chain}	0.028		0.279	***	-0.333	***	0.046	*	0.121	***
	(1.023)		(10.495)		-(12.645)		(1.914)		(4.321)	
$CCC_{balance}$	0.102	***	0.070	**	-0.026		-0.047	*	0.103	***
	(3.744)		(2.512)		-(.905)		-(1.932)		(3.641)	
$NWC_{difference}$	0.019		0.226	***	-0.473	***	0.182	***	0.071	**
	(.589)		(7.034)		-(15.744)		(6.554)		(2.138)	

*Table 2: Standardized coefficient output and standard error in parenthesis; *, **, *** represent significance below the 10%, 5% and 1% significance levels, respectively*

NWC_{costs}: The results indicate a significant influence of CCC_{chain} on all performance metrics of CSCs on the 1% significance level. However, the directions of the relationships differ among the metrics. While the performance metrics ROA, EBITDA margin, EVA, and profit margin are positively influenced by CCC_{chain}, asset turnover is negatively influenced by CCC_{chain}. Thus, one out of five models supports Proposition 1.

$CCC_{balance}$: The results indicate a significant influence of $CCC_{balance}$ on EBITDA margin, asset turnover, and profit margin on the 1% significance level, and for EVA on the 10% significance level. However, the directions of the relationships differ among the metrics. While the performance metrics EBITDA margin, EVA, and profit margin are positively influenced by $CCC_{balance}$, asset turnover is negatively influenced by $CCC_{balance}$. Thus, one out of five models supports Proposition 2.

$NWC_{difference}$: The results indicate a significant influence of $NWC_{difference}$ on ROA and profit margin on the 1% significance level and for EBITDA margin and EVA on the 5% significance level. However, the directions of the relationships differ among the metrics. While the performance metrics ROA, EBITDA margin, and profit margin are positively influenced by $NWC_{difference}$, EVA is negatively influenced by $NWC_{difference}$. Therefore, one out of five models supports Proposition 2.

$NWC_{difference}$: The results indicate a significant influence of $NWC_{difference}$ on EBITDA margin, asset turnover, EVA, and profit margin on the 1% significance level. However, the directions of the relationships differ among the metrics. While the performance metrics EBITDA margin, EVA, and profit margin are positively influenced by $NWC_{difference}$, asset turnover is negatively influenced by $NWC_{difference}$. Thus, one out of five models supports Proposition 3.

Discussion

Regarding Proposition 1, the results strongly indicate a relationship of shifting working capital components among the members of a supply chain and the chain's performance, as the regression models that test the influence of Inv_{shift} and NWC_{costs} on the performance metrics exhibit significant results. The effect on the performance metrics of shifts of inventory towards upstream supply chain partners was investigated with models employing proxy Inv_{shift}. The models that predict influence of Inv_{shift} on chain performance metrics strongly support Proposition 1. The analysis therefore complements previous research on WCM in the interorganizational context (Viskari & Kärri, 2012). It is also in line with previous work showing that by storing inventory upstream, when product value and associated inventory costs are lower, a supply chain may reduce its overall inventory costs (Randall & Farris, 2009). According to Hofmann and Kotzab (2010), the synchronization of the goods/material and financial flows within the supply chain is a key to improving CSC performance. The effect on the performance metrics of shifting net working capital within CSCs was investigated with models that employ proxy NWC_{costs}. Most performance metrics seem to be affected in the opposite direction, as postulated by proxy NWC_{costs}. A lower level of NWC_{costs} is related to a lower ROA, EBITDA margin, profit margin, as well as EVA, and is related to a higher asset turnover. Those different directions may either be caused by non-measured special effects which have an impact on the results, or by long-term influences which did not yet materialise in the performance metrics (Hofmann & Kotzab, 2010). Thus, Proposition 1 is supported regarding five of the assessed performance metrics and is not supported by the other five performance metrics. Regarding Proposition 2, the results do not indicate a strong relationship between a collaborative CCC and chain performance, as the regression models that test the influence of CCC_{chain} and $CCC_{balance}$ on the performance metrics exhibit mixed results. The effect of the length of the collaborative CCC cycle on the performance metrics was investigated with models employing proxy CCC_{chain}. Most performance metrics seem to be affected in the opposite direction, as postulated by proxy CCC_{chain}. A higher level of CCC_{chain} is related to a higher EBITDA margin, EVA, and profit margin, and is related to a lower asset turnover. The effect on the performance metrics of supply chains that strive to balance their collaborative CCC was investigated with models that employ proxy $CCC_{balance}$: $CCC_{balance}$ is related to a higher ROA, EBITDA margin, and profit margin, and is related to a lower EVA. Thus, Proposition 2 is supported regarding two of the assessed performance metrics and is not supported by the other eight performance metrics. The results reflect the current state of research as shown in Chapter 2. Regarding Proposition 3, the results do not indicate a clear relationship between a collaborative CCC and chain performance, as the regression models that test the influence of $NWC_{difference}$ on the performance metrics exhibit results for both supporting and rejecting Proposition 3. The effect of collaboration in WCM on the overall working capital level was investigated with models that employ proxy $NWC_{difference}$. Proposition 3 is supported regarding asset turnover and not supported by the other four assessed performance metrics. Asset turnover compares sales to total assets, thereby revealing to the analyst how efficiently a business has used its assets to generate sales revenue. Since asset turnover is a coefficient to measure the efficiency of a business entity, one might assume that a business that uses working capital more collaboratively is using its assets more efficiently to generate sales revenue. However, there is no clear evidence of the effect on ROA. Thus, the root cause might be in the profit margin, since there is no clear evidence for profit margin either, as shown in Table 1. Profit margin is an indicator of the overall profitability of an entity, as it shows net income relative to sales, reflecting the percentage of sales that remained in the company as net profit (Metha, 2016).

Conclusion and outlook

This study makes several theoretical contributions to SCF-related literature. First, it has proven the existence of a relationship between collaborative WCM practices and the performance of supply chains and their member firms. Second, there is strong evidence that collaborative WCM influences the efficiency of asset usage in a positive direction. Third, the measured contradicting direction of the relationships between WCM and chain performance mirrors the current state of knowledge on the relationship of WCM and chain performance. The exploratory character of the paper leads to certain limitations. Using COMPUSTAT as a secondary source to retrieve the necessary data affords no certainty that data used are fully accurate and that the companies worked collaboratively for the purpose of increasing chain performance. The proxies used to measure the degree of collaboration have been, with the exception of $NWC_{difference}$, untested constructs derived based on extant literature. Hence, the proxies may contain errors, as the analysis gives partially indistinct results. In future studies, researchers who take on the challenge of improving the database should gather primary data. According to Lanier et al. (2010), the receipt of survey-based measures could add greater validity to any deductions made. Additionally, future SCF research should aim to validate or improve the proxies used for collaborative WCM.

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Food

Identifying temperature breaks in the initial stages of the cold chain for navel oranges and clementines: A Western Cape case

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Abstract

Purpose – Agricultural exports play an important role in the South African economy and generate a significant amount of foreign income for the country each year. Citrus fruits are among the most exported agricultural products from South Africa. There is a growing concern that exporters suffer significant financial losses because of temperature breaks in the cold chain. These temperature breaks lead to rejected consignments, accelerated decay and a decline in the market value of the citrus.

Research approach – The researcher conducted two phases of research: firstly, in the form of exploratory secondary research and secondly, in the form of primary research. A literature review provided background on the South African citrus industry, cold chain logistics, the citrus cold chain and international best practice. Primary data collection allowed for the identification of temperature breaks as well as possible causes and recommended solutions.

Findings and originality – The collected temperature data clearly shows that temperature breaks are occurring along the initial stages of the citrus cold chain from farms in Citrusdal to the Port of Cape Town. Furthermore, temperatures surpassed the chilling injury threshold on a number of occasions, which poses another potential risk.

Research impact – Reducing unavoidable temperature breaks and eliminating avoidable temperature breaks will allow the South African citrus industry to be more competitive when compared to other large-scale citrus exporting countries like Brazil, China and the United States. Reducing the amount of produce that is lost will save costs and increase exporters' profit margins.

Practical impact – The study identifies various temperature breaks along the cold chain as well as their specific location and duration. This enables the industry to understand the reasons behind temperature breaks and allows them to formulate possible solutions.

Keywords – The Port of Cape Town; Cold chain logistics; Citrus; Cold storage; Refrigerated transport; Temperature break; Citrus quality.

Introduction

Cold chain logistics, which includes citrus export chains, faces challenges that manufacturing supply chains do not, with temperature stabilization being one of the most prominent of these challenges. Efficiently maintaining a stable post-harvest cold chain is critical to ensure high quality export citrus and there is a concern that a substantial amount South African citrus produce is lost each year as a result of improper cold chain maintenance (Freiboth, Goedhals-Gerber, Van Dyk & Dodd, 2013).

This study investigated the prominence, frequency and causes of temperature breaks in the export cold chains of Navel oranges and Clementines from Citrusdal to the Port of Cape Town. Company J is a citrus exporting company and approached the researcher to conduct the study.

Citrus from South Africa that are bound for the USA undergoes a mandatory cold sterilization protocol known as Steri. This protocol requires the citrus to be force-cooled to -0.6°C for at least 72 hours prior to loading. Steri starts in the cold sterilization chambers at Company B, situated in the Port of Cape Town.

Farmers and exporters utilise conventional vessels to export citrus to the USA. Mainly because it is cheaper and, until recently, these vessels could carry larger loads than container vessels. This mode of transport causes complications because the fruit moves between different temperature-controlled environments frequently, which often leads to temperature breaks. In addition, mismanaging the temperatures in cold storage facilities often leads to further temperature breaks.

This study attempted to identify the occurrence, frequency, position and severity of these temperature breaks to help Farm A, Farm B, Company J and Company K to help solve the problems surrounding temperature stabilization during citrus exports, while in the process, aiding similar companies and farms with solutions regarding breaks in the cold chain.

Literature Review

Citrus Supply Chains

Fruit supply chains (SC's) can be complicated, as they have long lead times, unstable supply and demand figures and, often, small profit margins (Soto-Silva, Nadal-Roig, González-Araya & Pla- Aragones, 2016). Citrus supply chains consist of various phases, starting at the growing phase. In each phase the fruit and trees require special treatments to ensure proper production and prevent damage (Ortmann, 2005).

After the growing phase, harvesting starts. The farmer determines the harvest time and a technique called selective picking is utilized (Ortmann, 2005). Citrus is consumable while the peel is still green, but it is unfavourable from a cosmetic viewpoint, which is why the next phase – degreening – found its origin (Erasmus, Lennox, Njombolwana, Lesar & Fourie, 2015). This phase involves placing the fruit in a room with temperatures ranging between 20-25°C and filling it with Carbon dioxide (CO_2) to enhance the colour of the peel.

After degreening, the packing phase begins. Workers use machinery to pack the citrus into boxes inside specialized pack houses after which tautliner trucks transport the fruit to Company K (cold storage facility) at the Port of Cape Town who store the citrus in cold rooms (Khumalo, 2018). At least 72 hours prior to loading, Company K moves the pallets to Steri chambers and initialise the Steri phase. When the compulsory 72 hours of forced-cooling finishes, the loading process may start. Loading lasts approximately four days, after which the vessel transports the fruit to its final destination (Khumalo, 2018). This study only covered the phases prior to loading. In other words, the study stops after the Steri protocol.

South African Fruit and Citrus Industries

Citrus accounts for approximately 55% of South Africa's fresh fruit production, making it an important industry for the economy (Liphadzi, 2015). South Africa (SA) has a wide range of suitable fruit producing climates, enabling farmers to produce a significant number of fruit varieties. This includes deciduous fruit, citrus fruit and sub-tropical fruit (Ortmann, 2005).

Limpopo, the Eastern Cape, the Western Cape, and Mpumalanga are SA's main citrus producing regions. Citrus exporting figures in SA have been stagnant over the last five years and declined in 2016 because of an ongoing drought. The situation improved in 2017 when exports showed a significant growth figure compared to 2016 and 2015 (Citrus Growers Association, 2018). The country's main citrus exports are in the form oranges, for which it is ranked second in the world (Mogala, 2016). Valencias and Navels are the two main export orange varieties. Lemons & limes are third on the list and grapefruits are fourth. In the fifth place is soft citrus, which is a growing industry worldwide (Citrus Growers Association, 2018).

Citrus and Temperature

Many experts regard temperature as the most influential factor concerning quality in the post-harvest stage of fresh fruit exports (Lafuente, Zacarías, Sala, Sánchez-Ballesta, Gosalbes, Marcos, González- Candelas, Lluch & Granell, 2005). The main reasons for controlling citrus' temperature are to minimise moisture loss and respiration and inhibit the growth of harmful microorganisms. This process significantly prolongs the fruits' shelf life (Lafuente et al., 2005).

There are various force-cooling techniques being utilised across the globe, for example, room cooling, forced-air cooling, hydro-cooling, evaporative cooling and vacuum cooling (Ngcobo, 2008). South African farmers predominantly use forced-air cooling and hydro-cooling. Hydro-cooling usually occurs in the form of drenching, where the citrus are drenched in a chemical solution that removes field heat and inhibits the growth of microorganisms that cause green mould.

South African citrus exports that are destined for the USA must undergo a special cold sterilization protocol known as Steri. The purpose of the protocol is to kill any insect larvae contained within the fruit. The protocol involves force cooling the citrus to -0.6°C for at least 72 hours before shipping them. This sub-zero temperature must then be maintained for 22 days (Hordijk, 2013).

Citrus Quality

The respiratory nature of fruit classify them as living objects, which means that they decay over time. Citrus fruits are normally stored before they reach their fresh consumption markets, which makes them vulnerable to fungal diseases (Duan, OuYang & Tao, 2018). This lead to the development of various techniques that aim to prevent post-harvest losses during the storage phase, including cold chain management. Respiration has a significant influence on fruit quality, as fruits respire quicker at higher temperatures (Duan et al., 2018).

When evaluating the quality of citrus fruits, inspectors will look at a couple of criteria. This includes juice content, which refers to the ratio of juice compared to the weight of the fruit (Citrus Australia, 2011). Brix content refers to the sugar level of the citrus and has a significant effect on the sweetness. The acid content, on the other hand, counteracts the effect of the Brix content and should not be too high or too low (Citrus Australia, 2011). Therefore, inspectors always calculate the Brix: acid ratio to determine if the citrus are suitable for the market.

Pests, Diseases and Defects

Citrus fruits are susceptible to a number of pests and diseases. If not managed properly they may also suffer from certain defects. The following section elaborates on the abovementioned.

False Codling Moth (FCM) – FCM is a South African indigenous insect that lay their eggs in the rind of citrus fruits. This pest is a considerable problem in Citrusdal. It is one of the main targets of the Steri protocol (De Jager, 2013).

Mediterranean fruit fly (Medfly) – The Medfly is another significant threat in SA and can cause severe damage to citrus crops. It is highly invasive and another major target of the Steri protocol (Karsten, 2011).

Citrus Black Spot (CBS) – This fungal disease is unique to citrus fruit. It is harmless to humans and does not affect the internal quality of the fruit. However, it causes an undesired appearance and, therefore, only citrus from CBS free regions are allowed in the USA (Carstens, Le Roux, Holtzhausen, Van Rooyen, Coetzee, Wentzel, Laubscher, Dawood, Venter, Schutte, Fourie & Hattingh, 2012).

Green mould – Green mould is a fungal disease that significantly affects citrus. Caused by Penicillium Digitatum,

it can lead to substantial post-harvest losses. The drenching process and cold chain are aimed at preventing diseases like green mould (Duan et al., 2018).

Chilling injury (CI) – CI has led to a lot of scrutiny against the Steri protocol. It occurs when citrus' pulp temperature drops below -1.5°C and can cause internal and external damage (Hordijk, 2013).

Previous Studies

This study originated in the "recommendations" section of a similar study that Khumalo (2018) conducted. Her study covered the entire export cold chain until the port of destination. However, a significant number of devices disappeared, because of negligence by external parties from the USA. Khumalo (2018) recommended a similar study that covers additional cultivars and farms. She also recommended removing the devices at the Port of Cape Town to ensure a higher rate of retrieval. Her study identified that temperature breaks occurred after the drenching process, during transportation to the pack house and during transportation to the cold store. The study also detected prominent temperature breaks during inspection and loading.

Freiboth et al. (2013) and Haasbroek (2013) discovered that temperature breaks occur along the cold chain of South African summer fruit exports and that companies neglect proper cold chain practices in order to maximise the through flow during export periods. Goedhals-Gerber et al. (2015) detected various temperature breaks along the South African table grape export cold chain, especially during the port section. Valentine & Goedhals-Gerber (2017) discovered that the time of harvest and time of cooling played a significant role in the temperature profile of apples during the first 48 hours of the cold chain.

Methodology

This study utilised primary and secondary research. The literature review consists of qualitative secondary research, aiming to provide an understanding of citrus cold chains and related topics and includes articles, books, reports, conference proceedings, presentations and theses. The goal of the literature review is to inform readers about previous research and broaden the researcher's understanding of the topic.

Primary research mainly occurred in the form of quantitative research. The researcher collected quantitative temperature data after conducting a three-way ANOVA test with the assistance of an expert from the Centre for Statistical Consultation (CSC) at Stellenbosch University. The researcher utilised stratified sampling and the ANOVA test determined a sample size of 216 temperature- monitoring devices as having substantial power. Initially, the study would utilise three cultivars with two consignments from each cultivar. Each consignment would have contained 36 devices – 18 pulp monitors and 18 ambient monitors, amounting to 216 devices in total. Unfortunately, due to unforeseen circumstances, the season ended earlier than usual and Company J cancelled the four final vessels. This lead to the exclusion of the third cultivar – Valencia oranges. Consequently, the researcher only collected 144 devices. Fortunately, this reduced the scope of the study by a third, meaning the smaller sample size did not have a significant influence on the results obtained.

The study incorporated the same definition of a temperature break as Khumalo's (2018): anytime the temperature rises by 2°C or more for 90 minutes or longer. A temperature spike occurs any time there is a rise in temperature along the export cold chain. iButtons® recorded both the pulp and ambient temperatures from Citrusdal to the Port of Cape Town. The researcher utilised Microsoft Excel to draw tables and sort the data into its final form and Tableau® and Statistica® to draw the figures contained within the document.

Results

Four consignments were analysed during this study, each one utilising 36 iButtons®. The first two were a load of Clementines from Farm A and another load of Clementines from farm B. The loads were degreened in the same chamber, on Farm A, but the second iButton® placement occurred at Farm B. The third and fourth consignments were Navel oranges from Farm A. This article contains the time- series line graph and table of dispersion from the second consignment of Navels, because it displays the most abnormalities. The vertical orange lines on Figure 1 indicate the end of the outside stage, degreening stage, pack house/transportation stage and Steri stage. Figure 1 illustrates a significant temperature spike during the degreening stage (16/06/2018) as well as a spike during the cold storage stage (06/07/2018). It shows another prominent rise in temperature during Steri (09/07/2018 – 10/07/2018). This article only discusses breaks in pulp temperature, not breaks in ambient temperature.

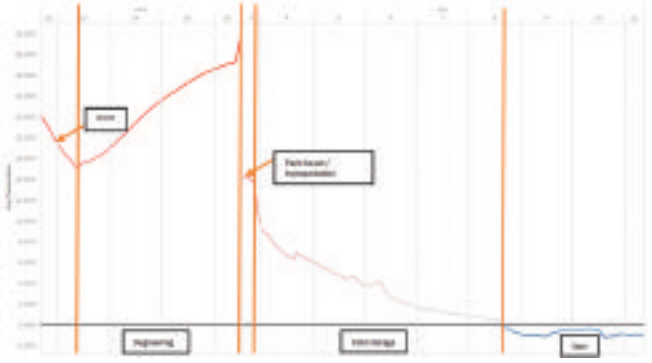


Figure 1 – Time series line graph of Navels load 2 (pulp temperature)

Table 1 – Temperature dispersion per stage of Navels load two

Clementines load one

On 18/06/2018, the temperature increased slightly during the pack house/transportation stage, but no temperature breaks occurred. All the monitors showed an increase in temperature on 19/06/2018, during the cold storage stage, where PULP TOP 3 qualified as a temperature break, as it increased by more than 2°C for longer than 90 minutes. Movement between cold stores or exposure to atmospheric temperatures during the inspection phase are the most probable causes of the temperature break. On 23/06/2018, there was another temperature increase, but no pulp devices qualified as temperature breaks. A temperature spike occurred during the switchover from the cold store to the Steri chamber. On 25/06/2018, during the Steri protocol, the temperature of numerous devices increased, but no devices increased enough to qualify as temperature breaks.

Clementines load two

During the pack house/transportation stage on 19/06/2018, the temperature of all the monitors increased. Two pulp monitors increased by more than 2°C, but neither of them qualified as temperature breaks, because the increase in temperature did not last for 90 minutes or longer. On 22/06/2018, during the cold storage stage, there was a prominent temperature increase, which resulted in a significant number of temperature breaks. Of the pulp monitors, 13 devices indicated temperature breaks, increasing by as much as 7.5°C. The most probable cause of the temperature break is that Company K removed the citrus from the cold store for inspection, which occurs at room temperature. The switchover from the cold store to the Steri chamber caused an increase in temperature, but none of the monitors indicated temperature breaks.

Navels load one

Concerning temperature, this was the most stable consignment. There was a slight temperature increase during the pack house/transportation segment, but no temperature breaks occurred. During the initialization of the Steri stage on 13/08/2018, the monitors indicated a temperature increase. Two pulp devices increased by more than 2°C for longer than 90 minutes and qualified as temperature breaks. The most probable cause of the temperature breaks is that Company K initialized the Steri protocol and then re-opened the chamber to stow fruit that arrived after the initialization.

Navels load two

Like the previous three consignments, the temperature spiked slightly during the pack house/transportation stage, with no temperature breaks occurring. As seen on Figure 2, there was a substantial temperature increase during the degreening phase, with the highest pulp temperature recorded being 35.11°C. A severe spike like this one has profoundly negative effects on fruit quality. Stacking the bins too close to the ceiling lights is the suspected cause of the temperature spike. Degreening occurred during the month of June, which is winter in SA. Therefore, it is highly unlikely that the temperature spike was a result of exposure to sunlight. A temperature spike occurred on 04/07/2018, during the cold storage stage, but no pulp devices qualified as temperature breaks. There was another increase in temperature on 06/07/2018, however, no monitors qualified as temperature breaks. During the Steri stage, the temperature increased for a prolonged period, but never breached 0°C, and would therefore still pass inspection.

Interpretation

This study identified numerous problem areas during the initial stages of the South African citrus export cold chain from Citrusdal to the Port of Newark. Irregularities occurred during each part of the cold chain, except when the fruit stood outside while awaiting degreening (outside stage).

No temperature breaks occurred during the pack house/transportation stages, but there were temperature spikes during this segment for each consignment. These spikes were most likely because of airflow in the tautliner trailers during the transportation stage, as pack house temperatures at Farm

A and Farm B are regulated efficiently. Refrigerated trailers can remedy this problem, but are a more expensive alternative.

Numerous temperature breaks occurred during the cold storage stage, mostly because of cold store switching or removal of fruit for inspection. Citrus fruits can only maintain their temperature for a limited time and extended exposure to atmospheric temperatures may lead to temperature breaks. Inspection occurs at room temperature, which also leads to temperature increases.

For each consignment, there were prominent temperature spikes and breaks during the switchover from cold storage to the Steri chambers. When Company K moves the fruit from Cold Storage to Steri, it exposes the fruit to atmospheric temperatures, which leads to temperature increases and in the worst case, temperature breaks. There were also prominent temperature spikes and breaks during the Steri stage, because of poor cold chain management and improper stowage processes.

Conclusion

Temperature breaks are a concerning problem in the citrus industry and still occur regularly. This study could not declare one of the analysed consignments as temperature break free. Temperature breaks in the cold chain incur financial losses for farmers and exporters, because buying entities reduce the market price of the citrus when they occur.

For SA to be competitive amongst other citrus producing countries, it is imperative that the industry makes a conscious effort to eliminate avoidable temperature breaks and minimise the effect of unavoidable temperature breaks. Continuous cold chain development and optimisation is the only way SA can remain competitive in a market with increasingly high standards.

Recommendations

When stowing the bins in the degreening rooms, the manager should always check to see whether the bins are not stacked too close to the ceiling lights. Using probes to monitor the temperature of fruit inside the degreening rooms may assist Farm A with detecting when fruit temperatures are too high inside the rooms.

The only solution for temperature spikes during the pack house/ transportation stage is to utilise refrigerated trucks. However, none of the spikes in this study led to temperature breaks during the pack house/transportation stage and refrigerated transportation is more expensive than tautliners.

Keeping cold store switches at a minimum by implementing a thoroughly planned stowing process may help reduce the time and frequency that the citrus spends outside after stowage. Inspections should take place in rooms with low temperatures. This will help the citrus to maintain their cold storage temperature for longer periods. It will also reduce the occurrence of temperature breaks.

The switchover from cold storage to Steri should run as smoothly as possible, without any hold-ups and bottlenecks. Where possible, this process should occur under shaded areas with minimum exposure to sunlight. Company J is experimenting with a new stowing process where the citrus will be stored at a central cold storage facility and transported onto the quayside by refrigerated trucks. If implemented properly, this should significantly reduce the number of temperature breaks that occur.

The Steri chamber should remain closed after initiating the Steri protocol. The lower a room's temperature is, the quicker it adapts to atmospheric temperatures. Opening a Steri chamber must only occur in the case of an emergency. It is important that the Steri chambers be stowed efficiently from the start, which will eliminate the need to open them after stowage. Monitoring the temperature of the Steri chambers in real-time will ensure that technicians can react quickly to prevent the occurrence of avoidable temperature breaks.

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Identifying temperature breaks in pome fruit and table grape export cold chains from South Africa to the Netherlands and the United Kingdom: A Western Cape case

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Abstract

Purpose – South Africa is the third largest deciduous fruit exporter in the southern hemisphere. There is a growing concern in the South African fruit industry of increasing losses, both financial and of the produce itself. As temperature is the most significant factor that results in the acceleration of the fruits senescence as well as a deterioration in its quality, an investigation into the origin of temperature breaks within the export cold chain of apples, pears and table grapes was conducted.

Research approach – The research was conducted in two main phases which were firstly, a secondary research phase and a primary data collection phase. The secondary research phase consisted of a literature review that provided a foundational knowledge of the fruit exporting industry in both a South African and international context. The primary phase consisted of temperature trials conducted from as close to the farm as possible and concluded as close to the end consumer as possible. The trials consisted of both pulp and ambient temperature probes being inserted into and around the fruit to monitor their export temperature profiles.

Findings and originality – The study confirmed suspected areas prone to temperature breaks as well as identified new, unsuspected areas. In addition, areas where palletized fruit gained heat unknowingly were identified and their impacts were shown to have far reaching and long-lasting, detrimental effects.

Research impact – The results of the trials show that a larger number of temperature breaks occurred along the export cold chain than were initially anticipated. Secondly, the position within the pallet where the temperature breaks occurred highlighted an issue of heat retention as a result of unintentional oversights during the initial stages of the cold chain.

Practical impact – The study identified areas of possible improvements, due to the initial unintentional oversights, where management could mitigate senescence factors. Secondly, it highlighted possible areas for further investigation into container handling on the importing side.

Keywords – Cold chain, Fresh fruit exports, South Africa, Temperature, Temperature breaks

Introduction

South Africa is ranked as the third largest deciduous fruit producer in the southern hemisphere with Chile and Argentina claiming the top two positions (Hortgro, 2017). The South African fruit industry is largely an export-orientated industry due to demand and premium prices created by inverse seasonality in the northern hemisphere. The industry prioritizes exports as approximately one third of all of South Africa's agricultural exports comprise of fresh fruit. This equates to around 2.7 million tons exported to more than 90 countries worldwide (Fresh Produce Exporters Forum. [n.d.]).

The deciduous fruit sub-sector is the largest within the South African fruit industry with approximately 44% of all deciduous fruit produced bound for international markets (Hortgro, 2017). The facilitation of the exporting journey of fresh produce has many strict protocols and regulations set by various bodies and other invested parties. These protocols and regulations stipulate specific requirements from the start of the chain to the end and throughout. As deciduous fruits are temperature sensitive commodities (Aung & Chang, 2014), a specialized, temperature managed supply chain, known as a cold chain, is used to facilitate the export trade of fresh produce.

There is a growing concern that the South African fruit export industry is losing a significant amount of money each year as a result of breaks in the cold chain. These temperature breaks within the cold chain could result in possible load rejections at importing customs and large financial losses. This concern prompted Company X, an international fruit exporting firm, to investigate its own cold chains.

This paper focuses on firstly, mapping the temperature profiles of apples, pears and table grapes from their point of origin on farms and pack houses in the Western Cape, South Africa to the distribution centre where the container was destuffed in London, the United Kingdom or Rotterdam, The Netherlands. Secondly, the stages where temperature breaks occurred are identified and lastly, reasons for the breaks and possible solutions are proposed.

Literature review

The South African growing seasons for apples and pears start in January and run through until August, while table grapes start around October and conclude in May (DAFF. 2017). The cold chains for pome fruit and table grapes are very similar, but have some important differences. Figure 1.1 illustrates a generic pome fruit supply chain. The highlighted green block indicates controlled atmosphere long term storage, which is not always a part of the pome fruit cold chain. Pome fruits are transported through the pack house by means of water. The water serves a dual purpose of firstly, washing the fruit as it enters the pack house and secondly, moving large quantities of fruit throughout the pack house with minimal damage, such as bruising. The table grape supply chain is similar to that of pome fruit, but differs during the initial stages. Firstly, after the first step of harvesting, table grapes undergo what is known as field heat removal, essentially pre-cooling. Hereafter, the table grapes are handled, cleaned and sorted by hand, instead of transported by water, through the pack house. In addition, table grapes cannot undergo controlled atmosphere long term storage.



Figure 1.1 Generic pome fruit cold chain
Source: Authors own interpretation and adapted from Fresh Produce Exporters' Forum, 2016:107

An effective cold chain starts at the farms where the produce is harvested and ends once that produce is in the consumers' refrigerator. As a cold chain refers to a supply chain in which the temperature is controlled, effective and efficient temperature monitoring and management is crucial to ensure an unbroken chain. This not only includes monitoring the temperature of the fruit itself throughout the cold chain, but also the temperature management of the facilities and their processes in addition to the technology and regulatory protocols of the information systems (Aung & Chang, 2013:199).

Temperature protocols dictate that once the temperature in the cold chain has started to decrease, it must not rise again. The Perishable Products Export Control Board (PPECB), (HP28 & 2013), stipulates that the optimal storage temperature for apples, pears and table grapes is -0.55°C. Therefore, scientifically speaking, a temperature break would immediately occur if the temperature varied even slightly above or below -0.55°C. In reality, it is not practical, nor realistic for industry to maintain that exact optimal temperature and thus, a compromise was reached that included both scientific criteria and industry limitations. The generally accepted definition of a cold chain temperature break is therefore, "every instance in which the temperature readings are 2°C higher or lower than the required

carrying temperature for longer than 90 minutes" (Fresh Produce Exporters' Forum, 2016:105, Freiboth, Goedals-Gerber, Van Dyk & Dodd, 2013 & Goedhals-Gerber, Haasbroek, Freiboth & Van Dyk, 2015). The precise definition used in this paper, however, is each instance where the temperature is 2°C or higher or -1.5°C or colder for longer the 90 minutes. This definition was chosen, because research has shown that fruit exposed to temperatures colder than -1.5°C results in chilling injury. As per request from Company X, the lower bound for temperature breaks in the pear supply chain is measured at -1°C instead of -1.5°C. Aspects such as the fruits ripening category, which will influence its respiration rate and ethylene production, as well as temperature related sensitivities including transpiration and relative humidity cannot be overlooked.

Fruits temperature sensitivity can be ascribed to simple postharvest physiology. Fruits are living things and thus, respire to produce energy. Pome fruits use starch as fuel, while table grapes use organic acids and sugars (PPECB HP02, n.d.). During respiration, these energy reserves are gradually depleted and hasten the senescence process, among other things, which ultimately results in the deterioration of the fruits' quality. Effective temperature control management can assist in extending the life span of the fruit as lower temperatures reduce the fruits' respiration rate as well as reducing the occurrence of other quality weakening aspects such as pathogen viability and moisture loss. According to the PPECB, "temperature abuse is the prime reason for loss of product quality" (PPECB HP02, n.d.). Furthermore, temperature control management is not only limited to the time the fruit is on-board a vessel or inside a container, but rather starts from the moment the fruit is harvested and continues until it is consumed by the end consumer.

Temperature is consequently, the most important aspect that must be managed in a sensitive fruit cold chain. Good temperature control can slow fruits' senescence by minimising the occurrences of temperature breaks. This will in turn impact the speed at which textural, colour and other changes occur within the fruit (PPECB HP02, n.d.), ultimately prolonging its shelf life, marketability and revenue generating potential.

Problem

There is a growing concern in the South African fruit industry of increasing losses, both financial and of the produce itself as a result of breaks in the cold chain. As temperature is the most significant factor that results in the acceleration of the fruits senescence as well as a deterioration in its quality, an investigation was prompted by Company X into the origin of temperature breaks within the export cold chain of apples, pears and table grapes from the Western Cape, South Africa to The Netherlands and the United Kingdom.

Methodology

The research made use of both primary and secondary data with a deductive, mixed methods approach. Secondary data was initially gathered through a review of current available literature on pertinent topics. This provided context and a foundation for the research.

Primary qualitative data was gathered in different ways. Firstly, through observations of the fruit export cold chains. These observations took place on farms, at pack houses and cold stores as well as at the ports and distribution centres.

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Secondly, additional primary qualitative data was gathered through informal interviews between the researcher and staff of the aforementioned facilities and Company X.

Primary quantitative data was gathered through the use of temperature monitoring devices/loggers, namely, iButtons® and TempTales®, during 24 temperature trials. The devices recorded the temperatures experienced every 30 minutes from the point of insertion at the pack houses to the conclusion at the final distribution centre in Europe and the UK. A power analysis was done to determine the minimum sample size of 216 temperature devices. For practical purposes, the 216 temperature monitoring devices were divided between twelve containers per trial. The temperature monitoring devices were inserted invasively, to measure the pulp temperatures and non-invasively, to measure the ambient temperatures of the fruits. These probed fruits were placed in the top, middle and bottom cartons of six pallets, which were then placed in the front, middle and back, on both the left and right sides of the container. In addition, the twelve containers per trial were also spread across more than four vessels.

The table grape trials incorporated twelve containers with 216 temperature monitoring devices. The pome fruit trials were separated into six pear and six apple containers with 144 temperature monitoring devices respectively. The principal difference between the table grape and pome fruit trials was the ratio of pulp to ambient temperature monitoring devices inserted. Individual grape berries are too small to house a pulp iButton® temperature monitoring device and thus, a TempTale® 4 steel probe was used to skewer several berries for a more accurate pulp temperature reading. Due to limited devices, only two middle, table grape cartons per container, were probed. Therefore, of the 216 temperature monitoring devices inserted, 24 were pulp temperature monitoring devices and 192 were ambient temperature monitoring devices. The pome fruit trials, however, had a pulp iButton® temperature monitoring device in every probed carton, but only had one ambient TempTale® temperature monitoring device in the top carton of each probed pallet. Therefore, of the 288 temperature monitoring devices inserted, 216 were pulp temperature monitoring devices and 72 were ambient temperature monitoring devices.

Once the probed containers reached the European and UK distribution centres and were destuffed, the temperature monitoring devices were collected by hand while the pallets were still staged for inspection and before intake into the distribution centre. The devices were then collected and data extracted or posted back to South Africa for data extraction and analysis.

Results

At the conclusion of the 24 temperature trials, 414 of the 504 initially inserted devices' data were retrieved. The 90 missing devices were either lost or unable to be read out. Despite this, there was still a total of 27 108 viable data points remaining.

After the initial data was captured in Excel spreadsheets, initial graphs and analysis was done using a statistical programme called Statisitca. Further graphs and analysis was done using data visualisation software called Tableau. Tableau enabled the temperature breaks to be analysed on an individual device level. It should be noted that temperature breaks were grouped into container breaks, which were instances of two or more device temperature breaks occurring simultaneously. It was important to distinguish the difference between a device and a container temperature break, for interpretation purposes, as a single container break could be registered, per device level, up to 24 times. In addition, both the apples and pears used in the trials came out of long-term storage where they were cooled.

After initial analysis and with the use of time series line graphs drawn per container, a few anomalies were found. These included examples such as ambient temperature readings that spiked and remained at high temperatures, but with little to no effect on pulp temperature readings within the same container. This was particularly prevalent in the pear temperature trials. An industry expert was consulted with the findings where after it was concluded to be a device malfunction. Furthermore, the high prevalence in the pear trials was due to the devices being sequential and thus, all experienced similar problems in and around the same time. The graphs in Figure 1.2 illustrate this problem as four ambient devices' temperatures spiked during the sea leg, but the effects of this drastic increase in temperature did not transpire in the pulp temperature readings.

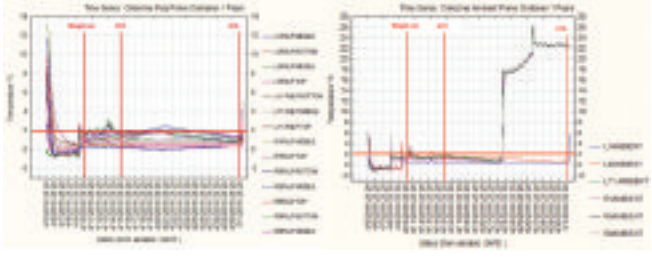


Figure 1.2 Time series line graphs of pulp & ambient temperature profiles of pears container one

Pears: The pear temperature trials were conducted from 5 April – 25 April 2018 with the Abate Fetel pear variety. Figure 1.3 illustrates the temperature profile of the pear containers. A total of 111 of the 144 temperature monitoring devices inserted data was retrieved and analysed. As explained earlier, the pear trials were the worst effected by devices that malfunctioned during the later stages of the trials. These ambient outliers can be seen in the bottom half of Figure 1.3 as the deep orange to red circles within the red box from the 'sea leg' stage through to the end at the 'destuffing and cold store intake' stage. The median ambient temperatures of the 'barged' & 'port of import post barge' stage without the device malfunctions are 1.65°C and 3.33°C respectively and not 14.8°C and 15.5°C as indicated.

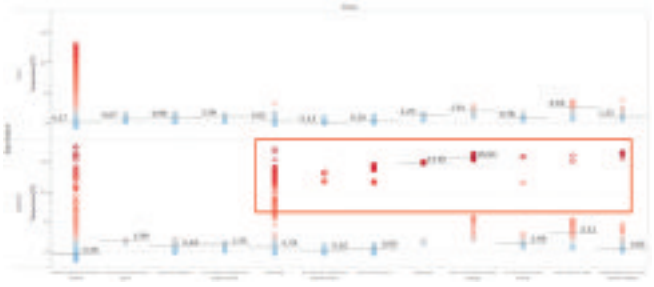


Figure 1.2 Pears trials collective temperature profiles

The pear trials resulted in 69 container temperature breaks, with 47 being above 2°C for 90 minutes or longer and 22 being below -1°C for 90 minutes or longer. The majority of the temperature breaks across all pear containers occurred in the first stage, the 'pack house and cold store' stage. The pears had been under long term storage and were already at protocol temperature when they were removed from cold storage. Therefore, this initial rise in temperature is consequently considered a temperature break. The maximum and minimum pulp temperatures experienced were 13.22°C and -0.67°C and the maximum and minimum ambient temperatures were 17.46°C and -1.44°C during the first stage.

Apples: The apple temperature trials were conducted from 03 May – 4 July 2018 on the Granny Smith and Pink Lady varieties. Figure 1.4 illustrates the temperature profile of the apple containers. A total of 111 of the 144 temperature monitoring devices inserted data was retrieved and analysed. The apple trials resulted in 57 container temperature breaks with 46 being above 2°C for 90 minutes or longer and 11 being below -1.5°C for 90 minutes or longer. The majority of the temperature breaks across the trials were found in the first stage and as with the pear trials, the apples were also kept under long term storage and thus, the initial rise in temperature is consequently considered a temperature break.

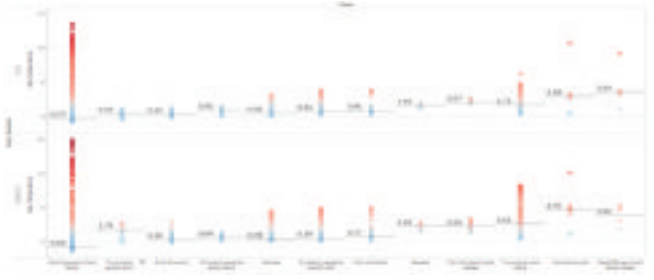


Figure 1.3 Apples trials collective temperature profiles

Furthermore, a trend was noticed in both the apple and pear trials. The bottom cartons of the pallets had the tendency of firstly, being the warmest layer in the pallet and secondly, experiencing the most radicle fluctuations during temperature changes. These cartons would be the first to rise when temperature breaks were experienced and would also rise to the highest temperatures recorded during those temperature breaks. The top cartons were the second warmest layer as they almost exactly mimicked the bottom cartons, but at lower temperatures. The middle cartons did not tend to have as distinct rapid spikes and fluctuations, but instead had a more gradual temperature increase. Moreover, the middle layer also had the longest after effect of a temperature break as once the heat was gained, it took much longer to dissipate when compared to the top and bottom layers. The maximum and minimum pulp temperature experienced were 13.54°C and -0.8°C and the maximum and minimum ambient temperature were 14.88°C and -1.32°C during the first stage.

Table grapes: The table grape temperature trials were conducted from 12 February 2018 - 14 March 2018 on three red seedless varieties, namely, Sweet Celebration®, Crimson Seedless® and Sugranineteen® also more commonly known as Scarlotta. Figure 1.5 illustrates the temperature profile of the table grape containers. A total of 192 of the 216 temperature monitoring devices data was retrieved and analysed. The table grape trials resulted in 53 temperature breaks of which 50 were above 2°C for 90 minutes or longer and 3 were below -1.5°C for 90 minutes or longer. The majority of the temperature breaks occurred in two main clusters. Firstly, during the first two stages namely, the 'pack house' and 'cold store' stages followed by the second cluster, during the 'trucking to export port' and 'port of import' stages. The maximum and minimum pulp temperatures experienced were 29.03°C and -1.06°C and the maximum and minimum ambient temperatures were 28.09°C and -1.09°C during the first and second stages.

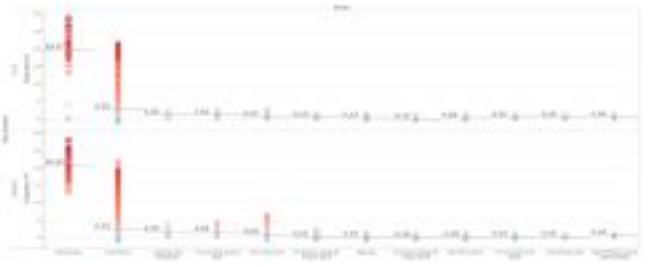


Figure 1.4 Table grapes trials collective temperature profiles

Interpretation

The majority of temperature breaks occurred in the initial 'pack house' and 'cold store' stages of all the cold chains. Regarding table grapes, this is to be expected as it is the hottest time of year during February and March with daily average temperatures consistently above 30°C. In addition, pack houses are cooled to approximately 22°C to assist in field heat removal while keeping the table grapes temperature on a downward trend.

Regarding the pome fruit cold chain, it is concerning that the temperature breaks occurred during the initial stages as the fruits were already cooled to protocol temperatures due to being in long term storage. This rise in temperature is suspected to be as a result of heat gained during the water bath. The temperature of the water may be cold to the touch, but it is still warmer than the -0.55°C core temperature of the fruit. It is recommended to monitor and cool the water baths temperature regularly to circumvent this avoidable temperature rise. Furthermore, the peculiar trend of the bottom layers being the warmest in the pallet is explained in two parts. Firstly, when pallets are staged for container loading, they are removed from cold storage and placed onto a concrete floor. Despite the area being under roof, but without side walls, the morning and late afternoon sun rays

still penetrate the space, heating the concrete floor. The concrete floor retains this heat and transfers part of it to the bottom cartons during the staging process. Containers do not have the capabilities to cool down warm or hot contents, but instead maintain already cooled products at specified temperatures (Fresh Produce Exporters' Forum, 2016:115). Due to container restrictions and the physiological nature of fruit, once loaded, the bottom cartons can never fully lower their temperatures back to protocol temperatures. This warm container issue is further exacerbated when the container is barged at the port of import. The containers are not connected to a power supply during this stage and the fruits' temperatures begin to rise with this effect continuing into the next stages.

The pome fruits' initial heat gained, due to the unintentional concrete oversight, resulted in the pome fruits' temperature profiles being warmer and more volatile throughout in comparison to the table grapes'. This occurred despite the table grapes having higher initial temperatures.

Conclusion

The results of this study illustrate that there are no faultless cold chains and that there is always room for improvement with existing issues needing to be addressed. There are preventable temperature breaks occurring, which cause significant fluctuations within the temperature profiles of the fruit that should, ideally, be relatively constant. The fluctuations in turn, influence the speed of senescence

factors, diminishing the fruits quality and thus, negatively impact on shelf life, marketability and revenue generating potential.

Recommendations

Recommendations for the table grape sector would be to improve farming practices and education among farm workers as well as farmers regarding the importance of temperature management and good cold chain practices. These could include minor habit changes for farm workers such as not leaving the plastic harvest crates in the sun on the ground while harvesting or not tossing the grape bunches into the crates, but rather gently placing them in. For farmers, keeping updated with technological improvements and other developments within industry is crucial to assist with continuous improvement and remaining competitive.

Concerning the pome fruit sector, recommendations would be to look at facilities and make changes to correct the concrete oversight through facility upgrades or re-routing. Moreover, the feasibility of implementing a water bath temperature monitoring and management system within pack house and cold store facilities should be explored. Additional investigation into the viability of electrical points at the cold store during waiting periods could be conducted. Furthermore, possibly investigating the ability and viability to expedite temperature sensitive commodities container barges as to decrease the time spent without power within port and in turn lower the risk of temperature breaks.

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A comment on access to digital data for food supply chain decision making and competitiveness in Australia

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Introduction

This paper discusses the changing structural nature of food supply chains in Australia and the impact this has had on the availability of high-quality data for decision making in an environment of unpredictable change. We stress the importance of reliable and accessible data to support agribusiness sustainability in the changes agri-food supply chains are undergoing from production, processing and consumer perspectives. Data are credited as being "the new oil" (van t'Spijker, 2014) and the key driver of the fourth industrial revolution (Schwab, 2017). They are necessary to support change in response to the demands of a constantly evolving global market.

Like much of the post-World War II Western world, Australia enjoyed government support in the form of agricultural policy development to structure its food supply chains to ensure food production was seamless and protected from disruptive competition. While Australians were not incentivised onto the land via generous government subsidies, as was the case in Europe and North America, government support for agri-food production, distribution and marketing was provided in the forms of statutory transport, warehousing and marketing authorities. These created fully-integrated, low-cost commodity supply chains that not only provided Australian citizens with reliable quantities of safe, nutritious food but great surpluses were exported to our colonial masters and nearby neighbours. We also enjoyed excellent government-funded data collection initiatives that monitored production, imports and exports. A series of policy failures, such as the government's wool reserve price scheme, eventuated in the industry-wide deregulation of most agricultural sectors. While the advent of free markets and competition has had the desired effect on stream-lining agricultural supply chains and minimising waste, the privatisation of many sectors and the rationalisation of government services has resulted in high-quality, reliable industry data being transformed from being a readily-available public good to a private good. In the absence of government support, high-quality data are now mostly generated by wealthy agribusinesses with the intellectual and financial capital to recognise their value.

Literature review

Australia has long-enjoyed a highly efficient supply chain for its bulk agricultural commodities; particularly in the grains sector. Up until the past 10-15 years, statutory regulations ensured exclusive logistics, storage, handling, marketing and outloading (i.e. exporting ports) rights to particular organisations. For example, the situation in Western Australia was that Westrail had exclusive rights to transport grain from country elevators to ports, Co-operative Bulk Handling had exclusive rights to store and handle grain up-country and at ports, the Australian Wheat Board had exclusive marketing rights over wheat production, the Grain Pool of WA had exclusive marketing rights over other bulk commodity grains (e.g. barley, oats, canola, lupins, etc.) and the state's four port authorities had exclusive rights to export bulk grain to overseas customers for value adding. The Wheat Marketing Act of 2008 marked a watershed moment in the structure of Australia's protected supply chain sectors. After 70 years of protection, this new act removed power from the Australian Wheat Board thereby creating competition in the market for accumulation and selling of Australian grains. The situation now is that anyone can buy and market Australian grain into the global market (Heard, 2018). The deregulation of other grain supply chain sectors followed; as did deregulation of the wool industry.

Increased competition, among other factors, has imposed a prolonged cost squeeze on the Australian grain supply chain but White, Carter and Kingwell (2018) found that Australia's supply chain costs remain higher than most of its competitors' costs resulting in high market grain prices. Competitors around the Black Sea and Argentina are low-cost grain suppliers and are investing in technology and infrastructure to make costs even lower. As such Australia must follow-suit and ensure its supply chain costs are low so it remains competitive in the international grain market. This is particularly important for Western Australia as 95% of its grain is produced for the export market (White, Carter & Kingwell, 2018). In their investigation of Australia's grain supply chain, White, Carter and Kingwell (2018) concluded that better business transparency is required to improve the current situation. This is directly linked to the provision of safe, reliable data that can be used for business performance reporting and the building of trust between key players; particularly when it comes to reducing costs.

Australia's bulk commodity supply chain has changed because of agri-political directives. Outside Australia, changes are occurring as a result of the invisible hand that guides market behaviours and these changes are influencing quantities of data being collected. Mooney (2017) suggests that mergers between already sizable global agribusinesses is creating a small yet powerful concentration of companies that put food production at risk. Mooney (2017, p. 13) cites "the $130 billion merger between US agro-chemical giants Dow and DuPont, Bayer's $66 billion buyout of Monsanto,

ChemChina's acquisition of Syngenta for $44 billion and its planned merger with Sinochem in 2018" as examples of increased concentration in global agribusiness. The research covered major farm inputs (seed, agrochemicals, genetics, pharmaceuticals and machinery), service providers (commodity traders) and downstream players (food processors and retailers). From this, eight impacts of concentration where identified; one of these impacts relates to the control of information. It is suggested that big data, generated from big agribusinesses, is one of the main drivers of concentration and the possession of big data sets could limit smaller firms from entering markets. A further issue to emerge, also considered by Bronson and Knezevic (2016), is the quantity of data that are being generated from the value-adding brand extension services that agribusiness firms are implementing. Cases in point include yield monitors fitted in modern combine harvesters and Monsanto Corporation's Weed I.D. "app" for identifying weeds in-paddock. While such data collection devices provide information for farmers, the question that arises surrounds data ownership. Does the farmer own the data or is it owned by the technology provider? If ownership lies with the technology provider then big data sets about farm production and productivity are being collected at alarmingly fast rates and being held within private enterprise. Further questions arise about the decisions that are being made and strategies that are being developed from these data. Is unlicensed third-party data being used for the improvement of big agribusiness?

This argument provides insight into data generation from traditional farms that are characterised as micro-businesses operating in an environment of perfect competition however farms have changed in nature since the 1960s when the first "corporate farms" emerged in the USA. These types of farms, also known as "mega farms", are characterised as being larger than 500,000 hectares and, as Plunkett et al. (2017) suggest, require scale to compete with the lower overhead costs of smaller, traditional farms. Scale of production is not limited to land mass. Mega farms are also livestock production units with Smithfield Foods Inc. in the USA cited as producing around 18 million pigs per annum (Hermans et al., 2017) and Penhros Farms is one of the UK's 800 mega farms and has the capacity to produce over a million birds per annum (Wasley and Davies, 2017). Animal welfare and retail quality standards demand that vast quantities of data are collected in the production of these animals. Data on growth rates, weights, nutrition, feed consumption, feed conversion, fluid consumption, pharmaceuticals consumption, housing temperature, production costs, among others, are kept in abundance for traceability, quality assurance and risk management purposes. The amount of data collection required, combined with the quantity of livestock being produced means that, once again, data sources are increasing at unprecedented rates. At this point, it must be noted that the mega farms described herein are holding these data and in no way are they supported by government interventions.

The vertical integration of farming systems (where a single entity owns and operates through a supply chain of farm, logistics, processing, distribution, etc), is another phenomenon facilitating the generation of mass quantities of data. An example of this is the ASX-listed AACo; an Australian beef producer which farms, feedlots and processes from nearly 430,000 cattle over 7 million hectares (AACo, 2019). Research by Carillo, Caracciolo and Cembalo (2016) suggests that vertical integration increases supply chain competitiveness so it is likely that this farming model will become more popular as improvements in competitiveness and profits are realised. As with other mega farms, vertically integrated agribusinesses will be generating significant quantities of data without government intervention.

Government intervention has been mentioned herein several times. This is to highlight the independence of farming systems from the type of government support that was discussed at the beginning of this paper. In the Australian context, both the grain and wool industries have had government regulation removed in the past 15 years. The result is that the relationship between government and farmers is decoupling. While this separation has not hindered productivity, the responsibility of governments to collect data and support agri-food supply chain decision making has certainly diminished. Herein lies the problem.

The problem

The nature of Australia's agri-food supply chain governance and infrastructure appears to have shifted power and scale so dominance now lies with siloed private enterprise whereas, in years gone by, the power lay with cross-sector governments; data that was in the public domain are now appropriated in the private domain. Grain and livestock sectors in Australia are particular cases in point here. Productivity is not the problem, in fact productivity in these sectors has increased despite the challenges of diminishing rural populations, increasing input costs and climate change (Boult and Chancellor, 2019). The problem is public accessibility to data.

Discussion

The advent of precision agriculture in the 1990s resulted in the widely-researched implementation of technology-supported farming. The research was conducted in expectation of change but by and large, precision agriculture has failed to deliver. It was expected to enable better management of field operations to achieve greater efficiencies of input or operations, or to yield product of higher quality. As described by Lamb et al. (2008), a lot of the research failed to translate fully from an academic to an operational reality because the technology providers failed to link to users. There were also some important lessons about the true nature of change; this was overlooked because specialists focussed on technological details, instead of the process it enabled (Cook et al., 1998).

Blackburn, Freeland and Gärtner (2017) reports on McKinsey's Australian Industry Digitisation Index, a measure of digital penetration across sectors and the gap between the digital frontier and the rest of the economy. The index shows that agriculture rates as the lowest of all industries considered in understanding digitisation. The news is not all bad, though. Of the 14 factors rated as very low to low digitisation, digital supply chains where ranked as medium digitisation. So, there is some hope of improved performance. Conversely, probably as a result of the nature of change in agriculture, much of the technology in agriculture is embedded within machinery, agrochemicals and genetic material, all of which are protected by private enterprise; so the scope for disruption is limited.

So far in this paper, several points have been argued: 1) there has been a shift away from government power to private enterprise power in Australian agri-food systems thereby isolating data to the private sector, 2) the world is experiencing a rise in the scale and output of individual agri-food suppliers (i.e. the concentration of agribusinesses and the advent of mega farms), 3) expectations of quality have increased in global agri-food supply chains (particularly in livestock systems) so more data are being collected than ever before, 4) efforts have been made in the past to improve agri-food technology but have experienced limited success due to an emphasis on the technology rather than its enabling features, 5) agriculture is the poorest-performing sector in McKinsey's Australian Industry Digitisation Index and 6) Australian grain supply chains need to improve in their competitiveness.

It is suggested that, while there is a rise in the quantity of data being generated, Australia may be behind in the use of data and digitalisation because the data that are being generated are not accessible to those who make recommendations for competitiveness in the global market for food. We question if the keepers of this data are aware of the asset that they are holding? Private enterprise that is aware of the cost and value of the data that it owns keep it close to their metaphorical chests as good-quality data are an inimitable source of competitive advantage. Private enterprise that is unaware of the cost and value of its data risks wasting resources as the collection and storage of data is an overhead cost, rather than an asset that generates value for the business. Whatever the case, the theoretical research that needs to be conducted across sectors to improve supply chain competitiveness and sustainability is being thwarted by the inaccessible nature of data. Australia exports enough food to feed more than 61.5 million people (Keogh, 2014) so there is a substantial reliance on the safety and security of its global food supply. Data sources are available for this type of work but they are unlinked and inaccessible to people who take a systems view of the agri-food supply chain.

It is therefore proposed that an inverse relationship exists between government power in the agriculture sector for generating data as a public good and the private sector locking vast quantities of data for its isolated decision making. It is acknowledged that the total quantity of data is increasing. But, while the total quantity of data is increasing, the relative fraction of common intellectual property available for analysis is unidentified so application decreases. The result of which is illustrated in Figure 1.

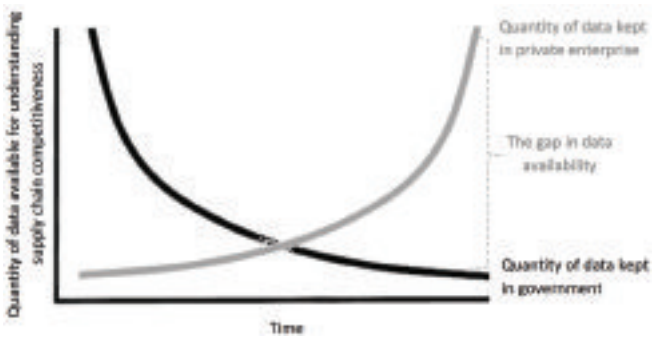


Figure 1: The proposed inverse relationship of data available for understanding agri-food competitiveness

Vertically integrated agribusinesses have gone someway to addressing the problem of unintegrated data systems but several problems still remain. We need to understand how to change the availability of unappropriated data and also encourage the entrepreneurship necessary to develop business models that create and share value from data. We may be able to seek understanding from the knowledge-based view of the firm proposed by Grant (1996) who suggested that organisations are units of knowledge generation and application which facilitates competitive advantage. This was in contrast to previous thinking that organisations are pools of resources that can achieve competitive advantage if those resources are organised better and more efficiently than other industry players. This is known as the resource-based view of the firm (Barney, 1991). Little research has been conducted on the knowledge or resource views of agribusiness firms. We therefore suggest that there may be an under-appreciation of data for supply chain decision making within the sector. There is no doubt that agribusinesses value data, but making it accessible to external parties to promote supply chain competitiveness remains a mystery.

It is well known that trust is an important factor in successful supply chain collaborations; agribusiness supply chains are no exception (Fritz and Fischer, 2007). Similarly, as supply chains become increasingly long and complex, they become inherently riskier in which to operate (Christopher and Peck, 2004). A genuine risk of making private data accessible as a public good is the threat of cyber security breach. Governments have an important role to play in helping to reduce the risk of sharing supply chain data and encouraging trust by supporting reasonable protection and sharing of data. An example of this is the European Union's General Data Protection Regulation which came into effect in May, 2018. This regulation was designed to harmonise the data protection rules of European states but, most importantly, it is a pan-European strategy for instilling trust in online services. Australia has a position on this Regulation but it largely remains aligned with its Privacy Act of 1988.

Despite all the current knowledge on data sharing and collaborative supply chains, there remains a struggle to inspire big agribusiness to share their data for addressing cross-sectoral questions. An example of a cross-sectoral question that has failed to be addressed and is becoming increasingly important to understand is resilience of Australia's major export commodities. The agricultural sector is vulnerable to numerous biotic and abiotic risks. Hence the sector needs robust, resilient systems to manage its vulnerabilities appropriately and efficiently. Estimating resilience has been discussed in many fora (e.g. humanitarian aid, natural disaster management, psychology, ecology, epidemiology and sociology) but a system-wide approach based on digital data to understand and benchmark resilience is lacking, especially in the agricultural sector. The Western Australian economy is heavily reliant on food production, manufacturing and associated services (food retail sales value was $13.8 billion in 2015/16). Furthermore, Australia exports enough food to feed more than 61.5 million people (Keogh, 2014) so there is a substantial reliance on the safety and security of Australia's global food supply. While considerable advances have been made to digitise the agricultural sector, these advances are yet to incorporate resilience measures for informing decision makers and helping them respond to major stresses. Cases in point include The CBH Group's trial of blockchain to improve

productivity, DPIRD's Agrifood and Fisheries Export Services Portal that provides market information for export business development, the MLA's National Livestock Identification System for identification and traceability of cattle, sheep and goats to promote competitive advantage through biosecurity and food safety. In terms of Western Australia's ability to meet global food demands in an environment that is vulnerable to uncertain, random climate conditions, current knowledge encompasses issues on wheat yields and quality. Nuttall et al. (2017) found that climate change will negatively impact wheat quality by decreasing protein concentration which translates into reduced functional properties. Hughes, Lawson and Valle (2017) suggest that climate conditions have lowered total factor productivity in Western Australia by an average of 7.7% between 2000–01 and 2014–15. They also present evidence to suggest that, despite this, farmers are using technologies and management practices to adapt to these changes. Similarly, Huai (2017) found Western Australian wheat production to be "sensitive" in terms of biophysical resilience to drought in 2006-2010 but other constructs of the study (on-site adaptive capacity, off-site adaptive capacity, adaptive capacity and synthesised resilience) achieved his definition of "resilience". Huai's (2017) study is significant as it has developed a framework for measuring both climate and social resilience.

Against this background of efforts to digitise the agricultural sector and build supply chains that will provide safe and secure food to meet global demands, a data-driven, system-wide model was proposed to the agri-food sector that would use existing digital business intelligence data to 1) develop resilience benchmarks of the Western Australian grain value chain and 2) provide digital feedback and strategic intelligence on resilience to value chain members. The project failed due to lack of accessible data and the "closed" nature of its businesses.

Conclusion

The purpose of this paper was to discuss the conundrum agri-food supply chain enthusiasts face when attempting to address cross-sectoral problems that require data to join-up individual members of fragmented chains; the type that dominate Australian agri-food supply chains. It is suggested that the decoupling of food production from being the responsibility of the government to the responsibility of private enterprise is one of the barriers to having problems properly addressed, principally because data are no longer in the public domain as they were in years gone by. It has also been suggested that the growth of farm business (in scale and supply chain dominance) and consumer demand for safe, nutritious food has facilitated the growth in quantity of data about agri-food enterprises. The role of data to create value is increasingly being recognised as essential for enabling business innovation and has created a paradigm shift in the way businesses compete (van t'Spijker, 2014). Furthermore, technology and data are at the heart of what Schwab (2017) describes as the latest industrial revolution. Australian agriculture is behind (Blackburn, Freeland and Gärtner, 2017), but is catching up fast.

Our argument increases in complexity because as the volume of data increases, appropriation is uneven. If data are appropriated by enterprises within closed business models, the ability of organisations around those enterprises to adjust is compromised, hence the adaptation of the entire supply chain. Agribusinesses operate in a systems environment. As they are faced with increased unpredictable change from climate variability and erratic consumer preferences, there is an increasing reliance on service organisations for support e.g. banks, insurance providers, consultancies, research institutions etc. In order to make good, cross-sectoral decisions, robust data must be accessible throughout the agri-food supply chain.

The position of these closed models within the value chain is important. With agri-food supply chains becoming increasingly dominated by mega farms and vertically integrated enterprises (Mooney, 2017), opportunities for change may be limited as these enterprises view themselves as too big to fail. This contrasts markedly with the picture of digital disruption portrayed as indicative of open systems that are driving the Fourth Industrial Revolution.

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Determinants of blockchain adoption and perceived benefits in food supply chains

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Introduction

Concerns about food safety have grown over the past decade due to several food safety scandals such as the horse meat scandal in 2013 where foods advertised as containing beef were found to contain horse meat in retailers such as Tesco and Aldi. In response to growing food safety incidents, companies in the food supply chain are using certain technologies such as RFID. However, information that is taken from these technologies is not always trusted; thus, companies cannot achieve their full potential in terms of supply chain traceability and visibility (Tian, 2018). Decentralized and immutable storage of verified data can be accessed through the Blockchain technology.

According to Treiblmaier (2018, p.547) Blockchain can be defined "as a digital, decentralized and distributed ledger in which transactions are logged and added in chronological order with the goal of creating permanent and tamper-proof records". Blockchain can be used to ease paperwork processing, identify counterfeit products, facilitate origin of tracking and connect and manage IoT devices reliably (Hackius and Petersen, 2017). Despite the advantages Blockchain technology does come with a number of potential operational, organisational and technological challenges e.g. regarding security and latency (Wang et al., 2019). Moreover Blockchain technology has not widely been adopted as it is not mature yet; for example in the food supply chain has started been explored by large companies such as Walmart and Nestle. Consequently, decision makers have to address the advantages and risks associated with Blockchain, as well as the implications of this growing technology for their specific organisation.

Although there are a few studies in the food supply chain area that have focused on Blockchain (Pearson et al., 2019; Tian, 2018; Tse et al., 2018), there is limited empirical work which captures the determinants of Blockchain adoption and explores the perceived benefits from its adoption. No study has conducted a holistic evaluation of the direct effects and the indirect effects of the determinants on Blockchain in the field of supply chain management. Thus, this study aims to explore the factors influencing supply chain, operational and logistics managers' decision in the food industry to adopt Blockchain and to develop a framework that is based on the technology-organization-environment (TOE) perspectives.

The remaining sections of the paper are structured as follows: first the related theoretical framework and the methodology are presented. Then the results are presented and discussed. Finally, conclusions, limitations and directions of future research are provided.

Theoretical framework and Methodology

Several authors have explored the adoption of various technologies such as ERP and RFID by applying different theoretical models such as Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT) and the TOE framework. It is supported that the last two frameworks can explain better the technology adoption from the perspective of usage by firms

(Gangwar et al., 2014). IDT is taking into account technological and organizational factors on firms' technology adoption decision, however it does not incorporate any environmental factors such as pressure from competitors. In this study TOE framework was adopted; it is proposed by Tornatzky and Fleischer (1990) to analyse the adoption of new IT technologies at an organisational level. TOE framework considers three main factors of an enterprise that influence the adoption of innovation: technological factors, organizational factors, and environmental factors. Technological factors entail the characteristics of the technology in this study Blockchain that influence its adoption e.g. perceived benefit, complexity, security (Gangwar et al., 2014). Organisational factors include descriptive characteristics of a company e.g. firm size and managerial perspectives (Lian et al., 2014). Environmental factors comprise external characteristics in company's environment such as firm size, trading partner support or pressure (Leung et al., 2015). TOE framework is adopted as the foundation for exploring factors affecting the Blockchain adoption in food supply chain as it is more holistic and has robust empirical support in IS field more than other adoption frameworks e.g. IDT, TRA (Awa et al., 2016).

The findings derived firstly from conducting a literature review; particularly a keyword search was conducted (i.e. "Blockchain" AND "supply chain" OR "logistics", "Blockchain" AND "technology adoption" AND "food industry") on major databases such as EBSCO, Google Scholar and Emerald

Insight) and X articles were included in this review. Due to the limited knowledge about the Blockchain in the field of supply chain management, the second phase of this study utilised semi-structured interviews; a qualitative methodology is deemed more appropriate to ensure a holistic and in-depth understanding of factors affecting companies in the food supply chain in adopting and using Blockchain. Semi-structured interviews were conducted from May to June 2019 with supply chain managers (SCM) in the food industry in the UK who are responsible for the implementation decisions of Blockchain technology in the case companies (see table 1 below).

Code	Description of the company	Company size	Awareness of Blockchain technology
SCM1	Produces convenience food such as fresh sandwiches for a retailer and catering.	Number of employees: 11,300 Annual turnover: £1,498.5m	The company has good awareness of Blockchain and no implementation of Blockchain.
SCM2	Own-brand and branded ready meals manufacturer	Number of employees: 500 Annual turnover: £51.1m	Not much awareness and no implementation of Blockchain.
SCM3	Poultry meat producer	Number of employees: 10, 500 Annual turnover: £64.5 m	Some awareness of Blockchain and no implementation of Blockchain.

Table 1: Experts interviewed

Each interview lasted between 30 and 40 minutes. Interviewers were conducted through a variety of means i.e. telephone and online. An interview guide with open-ended questions was designed and interviews were recorded with the interviewees' permission and subsequently transcribed for data analysis. The following section provides the results of the literature review and the primary data organised by the key themes (i.e. technological factors, organisational factors and environmental factors and perceived benefits), followed by the presentation of a framework that takes both results into consideration.

Findings and discussion

The potential adoption determinants of Blockchain are discussed below around the three principle contexts - technological, organizational, and environmental. Moreover, the perceived benefits from Blockchain adoption and implementation are presented.

Technological factors

The main factors within the technological context that found are relative advantage, perceived challenges and compatibility. Relative advantage refers to the advantages that emerge from the adoption of specific technologies (Low et al., 2011). In this context, Blockchain technology adoption in supply chain is associated with increased trust, seamless connectivity and reliability, business ethics, social responsibility, public safety and security (Wang et al., 2018). Moreover, it is supported that Blockchain will play a crucial role in the implementation of other emerging technologies namely Internet of Things (IoT) (Hackius and Petersen, 2017; IBM, 2017).

However, new innovations come with several challenges that discourage companies from implementing those new systems (Arnold et al., 2018). The main challenges around the emerging technology of Blockchain are scalability issues (e.g. Blockchain can only process nearly 7 transactions per second), privacy leakage (e.g. hacking), selfish mining e.g. temporarily control from group of miners of the network's mining hash-rate (Zheng et al., 2017; Wang et al., 2018). Latency is another challenge as well as that if a mistake will happen in a transaction in supply chains it cannot be reversed (Wang et al., 2018). SCM1 argues that "No one has a well-established, working blockchain technology so this technology is not mature yet. Companies are not buying unproved systems that can have great impact

on food safety". "Like electric cars, if the infrastructure isn't there will have little application" (SCM3). SCM3 further adds another challenge "The quality of the blockchain system is only as good as the information used. If someone includes fraudulent information will that perpetuate the error? What if the identification of a container at the supplier is correct and someone replaces the content for something of less quality? How can I be sure that the physical product is the same identified by blockchain?". "Technology needs to ensure security against attacks/tampering… Some information might be confidential. How can we protect if the information is shared?" (SCM2). Another point that was highlighted by SCM1 was the need for scalability and more flexible Blockchain systems as companies tend to have high number of product mix/finished products and/or ingredients. Blockchain has been currently applied successfully to single products such as egg production, coffee or Mousline purée by Nestlé and Carrefour (Nestlé, 2019).

Last but not least, compatibility can be defined as the degree to which the new technology fits with the potential adopter's existing values, work application systems (Low et al., 2011). It is supported that if technology is considered incompatible, companies will likely to be unwilling to implement the innovation as it will not fit the existing processes (Arnold et al., 2018). Thus, it is supported that is it important Blockchain to be integrated smoothly with the existing IT systems (Wang et al., 2017). SCM3 supports that "Can a company develop its own system and this system is unable to 'talk' with another company that is on another blockchain system? Does it need to become standardised? Who does this?".

Organisational factors

Firm size, top management support, and existing technical skills are the factors that emerged under the organisational context. Firm size has been widely used to predict IT adoption in companies (Gutierrez et al., 2015). A few studies support that large firms have the resources and can take easier the risk of innovation adoptions whereas small firms face constraints and challenges thus the avoid to adopt emerging technologies (Gibbs and Kraemer, 2004). However, other studies support that small companies can be more flexible due to their lower levels of bureaucracy (Gutierrez et al., 2015). While large companies in several industries such as Maersk, Walmart are either already adopting Blockchain technology or are in the process of understanding how Blockchain can be used in their company small companies have a higher likelihood to adopt Blockchain technology than large companies (Schneider, 2019). The experts supported

that SMEs companies within the food industry will not take the risk to adopt this emerging technology at the moment as do not have the resources. “A small company would be reluctant to adopt a new system; SMEs would consider the additional cost of hardware/software/ training/equipment as a burden” (SCM1). Blockchain implementation will be feasible in the next 3- 5 years (SCM3).

Top management support is also crucial for supporting any initiative of new technology adoption; top managers will provide the needed resources for the adoption of new technologies (Wang et al., 2010). A study that has been conducted in Ireland found that top management support influences blockchain technology adoption in a positive way (NUI Galway, 2018). SCM1 supports that “Within the company, the initiative to adopt Blockchain would come from senior management but the successful implementation depends on each department for example operation, technical and financial department”. SCM2 highlighted that “Initially, it will be difficult to change the culture”.

Blockchain IT knowledge and skills within the company are considered as one of the Blockchain enablers (NUI Galway, 2018). This is also supported by SCM2 “It will require a very different level of skills in the business”. Well-trained and highly skilled employees are vital for a successful adoption of any technology (Wright, 2003). “There is a need for a dedicated person, probably that is an IT expert but has an expertise within the food industry. Moreover, there will be a need to train the staff in using this technology (SCM1).

Environmental factors

Within the environmental context, four factors emerged namely competitive pressure, trading partner pressure, regulatory environment and customer pressure. Regarding trading partner pressure, focal companies can use its size advantage to experiment with Blockchain and then transfer it to the suppliers, or focal companies may even require its suppliers to use certain type of technology in this case Blockchain (Premkumar and Roberts, 1999). For example, Walmart will require suppliers that provide fresh fruit and vegetables to use a digital ledger from September 2019 (Kharif, 2018). “To ensure traceability and prevent food fraud, all pieces of supply chain need to buy into the BC, otherwise you have a big investment but you have a partial traceability. What is the advantage of some of the suppliers using BC and others not? It won’t improve traceability unless the WHOLE supply chain joins…Some suppliers would not be interested on blockchain particularly the smaller ones (SCM3).

Apart from the pressures from trading partners, competition and high rivalry increases the likelihood of adoption of technologies so as to remain competitive (Thong, 1999). According to Deloitte (2018), companies that do not take any action to think how Blockchain can impact them are at risk of lacking critical functions that this technology can offer and thus not be able to capture any growth opportunities offered by Blockchain. It has been supported that the regulatory environment can influence the adoption of technologies in a positive or negative way (Baker, 2011). Companies are sceptical about adopting Blockchain as there are different regulations across different countries such as USA, Belarus; thus, it is likely the incontinences between direct (i.e. officially introduced by the government) and indirect regulations (i.e. general regulations imposed on tech companies) may hamper the adoption of Blockchain (Karatkevich, 2019; Mizrahi, 2018).

According to PwC (2018), Germany, Australia and the United Kingdom are facing the highest regulatory uncertainty. Codification of law and the development of a uniform global system for legal entity identification can act as enablers of Blockchain adoption (Ganne, 2018). Customer pressure is another important environmental factor that impacts new technology adoption (Al Rahbi, 2017). Consumers demand from companies to be able to trace the origin of products e.g. when consumers purchase fish they want to know that the company followed ethical and legal practices such as legal netting practices (Francisco and Swanson, 2018). “If a client (retailer) demanded adoption of this technology, the company will do the necessary investment” (SCM1). More specifically SCM1 believes that the “The main driver that might lead to adoption of Blockchain within the food industry is when it will be a client or a 3rd party audit requirement such as the BRC certification”.

Perceived benefits

For companies planning to implement, piloting or implementing Blockchain, many authors recognised the perceived benefits of its implementation in supply chains such as cost savings, minimisation of lead times, higher customer service, and increased flexibility (Korpela et al., 2017). Queiroz et al. (2019) supported that through Blockchain supply chains are more transparent and though traceability more trust and security can be achieved. “It would prevent people from extending the ‘best before date’ with potential quality issues.” (SCM1). In the food industry particularly, this technology will offer food traceability and the ability to fight counterfeiting (Hackius and Petersen, 2017; Queiroz et al., 2019). Blockchain can decrease communication or transfer data errors and fraud, minimize inventory losses, stock outs, delays from paperwork (Thornpike, 2019). It help manage traceability from raw materials to end product, prevent errors with documentation and it will enable fast and effective recalls to build consumer trust (SCM1, SCM2 and SCM3).

Based on the findings, this paper develops a framework based on the TOE framework (Figure1).

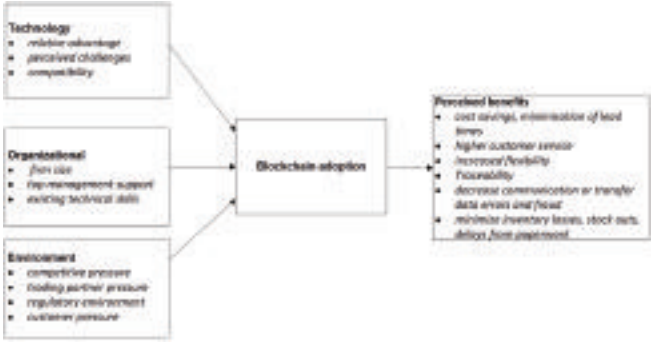


Figure 1: Blockchain adoption framework and its perceived benefits

Conclusions

This study aimed to determine the factors influencing supply chain managers' decisions to adopt Blockchain technology in the food supply chains, along with the potential benefits of its adoption. TOE adoption framework was adopted and adapted to identify the most important factors which were drawn from previous studies and primary data collected from companies in the food industry. Under the technological, organisational and environmental context the following factors were identified: relative advantage, perceived challenges, compatibility, firm size, top management support, existing technical skills, competitive pressure, trading partner pressure, regulatory environment and customer pressure. Regarding the benefits of the Blockchain implementation, these ranged from cost savings, minimisation of lead times, higher customer service, and increased flexibility, traceability and the ability to fight counterfeiting. Moreover, it has been found that currently it is very difficult to adopt Blockchain but in the future, when the technology is cheaper and less complex and proven to be more flexible it will become easier to adopt it. Despite this study's contributions, there are some limitations. The findings cannot be generalized to a wider population and the sample size within the food industry is small to provide a good representation of the population studied. Since Blockchain is also relevant for other industries such as logistics, future studies should consider respective companies. Our framework considers only three key areas within the boundaries of the TOE framework and these factors are the same for small and large companies, future research should differentiate the factors that determine Blockchain adoption in small and large companies and future studies should consider other factors.



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Humanitarian

The applicability of commercial supply chain models in humanitarian supply chain thinking

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Abstract

Purpose – This research argues that there are a number of potential pitfalls when using traditional commercial supply chain models for humanitarian supply chain issues and it examines the extent to which existing humanitarian supply chain thinking is based on commercial supply chain concepts. The issues and challenges faced by humanitarian supply chains are distinctive, with their own complexities and this paper examines the limitations of existing models and takes a new holistic approach.

Keywords – Commercial supply chain models, Holistic approach to humanitarian supply chains, Complexity, Systems thinking

1. Introduction

This year's conference theme of 'Building a Platform for International Success' is one of the building blocks which underpins disaster relief operations around the world. In comparison to Supply Chain Management in the commercial context, humanitarian supply chain management is a relatively new discipline which only became accepted as being distinct after the 2004 Boxing Day Tsunami, an era heralded by the establishment of the Journal of Humanitarian Logistics and Supply Chain Management. Individual elements of the humanitarian supply chain such as procurement, in-country logistics management and the delivery of humanitarian commodities can be studied and analysed using existing supply chain models and frameworks emanating from, for example established economic and management theory. However, the authors argue that there are few if any models that take a holistic view that can represent the humanitarian supply chain with all its complexities. Taking a holistic view is essential when attempting to study and analyse supply chain information flows, or understand how a disaster relief operation can derive increased effectiveness and efficiency through coordination, cooperation or collaboration. This is because it is necessary to understand what effect information and decision-making in one part of the supply chain has on the rest of the supply chain.

Existing models take a reductionist approach by looking at individual functions or processes of the humanitarian supply chain in relative isolation. However, by considering the humanitarian paradigm not as a chain, but as a network with inter-dependent stakeholder and decision-making elements, it is possible to make sense of the linkages and information flows between the constituent parts. This can be done by taking a Systems Thinking approach to deliver a holistic view of the humanitarian supply chain as an inherent complex network.

This paper forms part of an ongoing PhD which looks specifically at the flow of information in humanitarian supply chains, and in particular, the role of coordination, cooperation and collaboration.

2. Literature Review

When considering humanitarian supply chain issues, early contributors merely applied commercial practice and commercial supply chain thinking. For example, in defining humanitarian supply chain management, Thomas and Mizushima (2005) simply relabel the Council of Supply Chain Management Professionals definition as: 'the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, aswell as related information, from

point of origin to point of consumption for the purpose of meeting the end beneficiary's requirements'. The straight substitution of the term 'end beneficiary' for the existing word 'customer' demonstrates the reductionist thinking and lack of understanding of the complexities of the humanitarian paradigm at the time. Chandes and Paché (2010) are amongst the first to recognise the challenge of using commercial logic when attempting to describe the emerging discipline of humanitarian logistics using hitherto traditional models through their acknowledgement that the 'manufacturing perspective and service perspective is not necessarily relevant' (p.322). They explain that humanitarian logistics is a service because it provides assistance not just to the victims of a disaster, but also to those providing the relief; however, it also parallels the manufacturing sector because 'the delivery process requires a great deal of material and technological resources, notable in terms of transportation, handling and warehousing of products'.

The need for frameworks to be developed to assist logistic practitioners is acknowledged by Overstreet, et al (2011), D'Haene (2015) and Carroll and Neu (2009), but attention is

drawn to the issues of ownership and control by Kovacs and Spens (2009), MacLachlin and Larson (2011) and Christopher and Tatham (2011). For example, an aspect of inventory strategywhich has greater ramifications in the humanitarian supply chain than in the commercial world is the dynamics of Push and Pull logistics, where tight control must be exercised. Oloruntoba and Kovacs (2015) look at this in some detail and Chandes and Pache (2010) consider this in the wider context of NGO reactionand collective action. However, to recognise which of these strategies is applicable in a particular set of circumstances requires coordination throughout the supply chain. To actually switch from one to the other when the time is right not only requires coordination, but a level of cooperation.

Considerable literature exists which describes the design of humanitarian supply chains as being bespoke (Altay (2008); Besiou and Van Wassenhove (2011); Charles, et al (2011); Cozzolino (2012); Olorundoba and Kovacs (2015); and Pettit and Beresford (2009)), and by inference, it suggests that by attempting tomap a humanitarian supply chain, only a general description can be produced which can mainly be attributed to the high degree of complexity of such structures. In concurring that humanitarian supply chains are designed to meet the needs of eachindividual operation, others have mapped the design in terms of their qualities: agility, adaptability and alignment (Bhattacharaya, et al (2016); Dubey and Gunasekaran (2016) and L'Hermitte, et al (2016)).

Seven models and frameworks have been identified in the literature which have either been used to analyse specific areasof the humanitarian supply chain or have been adapted locally for use in analysing the humanitarian supply chain. All were initially developed for use in commercial supply chain management and no single frameworkcan be found that encompasses the humanitarian supply chain as a bespoke and separate entity, reflecting its own unique challenges and issues.

3. The Challenge

Even though they share critical elements such as procurement, transport and warehousing, there are significant differences between commercial and humanitarian supply chains. A wealthof knowledge and experience of commercial supply chains has developed since the term supply chain was coined in 1982 and several models have been developed to help understand the supply chain and elements of it in a commercial context. However, this is not the case for humanitarian supply chains. Two models which have been borrowed from the commercial world and applied tospecific elements of the humanitarian environment are the SCOR Model, and the model designed for the Global Supply Chain Forum as described by Cooper, et al (1997) for integrating and managing business processes across the supply chain. Whilst their application is appropriate in the management of transport assets or the procurement of storage facilities, they often fall short when applied to an entire supply chain operating in highly volatile political situations and in austere infrastructure conditions, staffed by a well-meaning, enthusiastic volunteer workforce that is not necessarily trained for the job they are undertaking.

Added to the challenge is the theoretical complication of the absence of supply chain theory which has been recognised for many years. Several contributors have applied Value Chain theory by Porter (1985) as their basis (Christopher (1992), Chopra and Meindl (2004), Lysons and Farrington (2006) and Grant, et al (2006)). Haberberg and Rieple (2001) developed value chain analysis to be applicable to service organisations while recognising that even this needed to be adapted if it were to be of use to non-competitive organisations such as in the public sector. Wikström and Normann (1994) considered the value contributions of stakeholders to public sector and third sector businesses in their Value Star, but all these models are of limited use to the humanitarian sector.

Overstreet, et al (2011) observe that humanitarian operations are complex and reiterate that the field of supply chain management has little specific theoretical basis. Instead, supply chain management relies on several models and frameworks which link into what Sweeney, et al (2015) describe as the Four Fundamentals Construct and theoretical foundations such as Porter's Value Theory, Commons' Transactional Cost Economics (TCE) Theory and Freeman's Stakeholder Theory, as shown below in Fig. 1. These three theories are applied consistently in commercial supply chain scenarios. However, with the developments in specific humanitarian supply chain management, other theoretical bases are now being considered including Macneil & Macauley's Channel Coordination Theory which is derived from Relational Contract Theory, Von Neumann & Morgenstern's Games Theory and Barney's Resource-Based Theory. Despite being grounded in industrial and commercial economics, these have contributed to the concept Bowersox, et al (1985) refer to as Materials Logistics Management (MLM).

4. The Research

This researchrecognises an interesting use of terminology. Tatham and Pettit (2010) cite several authors in their agreement that the phrase 'supply network management' rather than 'supply chain management' is a more accurate reflection of the reality found in humanitarian scenarios. Zhoa and Xia (2014) describe how network interoperability is an essential element of networks and that interoperability is best achieved through collaboration and the resulting interoperability of partner systems, as found in humanitarian operations. In their qualitative study, Jahre, et al (2016) identify demand characteristics, logistics and the policy and security situation as the factors which influence the design of what they refer to as a humanitarian supply network. This research also embraces this term for use in the humanitarian context. This paper seeks to identify the most appropriate conceptual approach to take when viewing the humanitarian supply network holistically. Specifically, it concentrates on the distinct issues and challenges that are characteristic of the humanitarian supply network which, if they feature in a commercial supply chain, only do so on a much smaller scale.

The Concept of The System

In describing the 'single system' of direct transaction between a commercial provider and the customer and the 'dual system' between a humanitarian donor and an NGO and then the NGO and the recipient, Carroll and Neu (2009) acknowledge

the complexity of the humanitarian supply network reflecting the funding, stakeholder relationships and the in-country context where infrastructure, resources and societal instability can severely impact on aid delivery. Meanwhile, Senge (1990) describes Systems Thinking as 'a discipline for seeing the structures that underlie complex situations'. In the literature, Li, et al (2010), Hearnshaw and Wilson (2013) and Bowersox, et al (1985) show that there is broad consensus that the humanitarian supply network is systemic in nature, but despite Nassimbeni and Sivadasari, et al suggesting a strong correlation between supply chains generally and Systems Thinking in New and Westbrook (2005), there is little evidence to suggest that Systems Thinking has been used as a theoretical base for studying supply chain management in either the commercial or humanitarian context. It therefore seems logical to look at existing concept models and frameworks through a Systems Theory lens. Checkland (1981) defines

'root definition' as 'the description of the set of purposeful human activitiesconceived as a transformation process' (p.169), and therefore determining a root definition for the humanitarian supply network will involve understanding these purposeful human activities by studying them subjectively using qualitative methodology. Within the Systems concept model, Checkland (1981) shows how the system transforms inputs into outputs: 'the concept model is what will accomplish that which is defined'. This root definition is an account of what the system is, the conceptual model is an account of the activitieswhich the system must do in order to be the system named in the definition (p.169) and together, they identify the actions required to improve the problem situation.



Figure 1. he contribution of theory, models and frameworks to the concept of the Humanitarian Supply Chain as a System.

5. Analysis

Current Thinking

Lindgreen, et al (2013) consider how humanitarian supply chains compare with commercial supply chains and recognise that NGOs are subject to challenges in terms of relationships and interaction which are not normally experienced in the business world. Even though they acknowledge that NGOs can be involved in both simple supply chains and complex supply networks, they do not identify any contemporary business models or frameworks that can assist the humanitarian logistician.

The models based on the five business processes of suppliers, manufacturers, distributors, retailers and customers, as introduced by Forrester (1958) and developed by Christopher (1992) and Chopra and Meindl (2010), have no relevance to the design of humanitarian supply network operations, not least because concentrating on just processes involves taking a reductionist view. However, despite the SCOR model being essentially based on these five process models, it introduces the notion of planning which implies that organisational hierarchy has a fundamental role to play in supply network activities. Firmly grounded in commerce, the SCOR model as translated by Van Wassenhove and Martinez (2012) introduces this extra dimension of decision-making, one which is articulated well by Blecken(2010) whose model comes closest to recognising the horizontal and vertical nature of the humanitarian supply network. Boththe model presented by Cooper, et al (1997) and the one developed from it by Chen and Paulraj (2004) take a fresh view of the commercial supply chain, providing a deeper understanding by taking a more holistic approach.

However, Akhtar, et al (2012) fail to take a holistic view. They concentrate on the flow of material rather than the flow of information and the coordination of activities. There is little recognition of stakeholder engagement, but their model can be read as a one-dimensional map of what they refer to as a humanitarianrelief chain. Duddy, et al (2017) make an early attempt in achieving a holistic view of the humanitarian supply network but recognition of the vertical flow of information is implied rather than specified.

Clearly, early modelling of supply chains concentrated on the business processes involved in forging raw materials into products and getting these products to the customer. As sharper definition was given to supply chain management and logistics (Howden (2009) and Chandes and Paché (2010)), the business processes were largely takenas read, and focus switched to the supply chain management functions such as those expressed by Cooper, et al (1997). This set the scene for an in-depth examination of supply chain enablers such as technology and the role of stakeholders and other actors. The importance of the flow of information is evident in these original models but not necessarily understood by later iterations of the original source model, but the multi-dimensional nature of information tends to typify the humanitarian supply chain more than its commercial counterpart. It is clear that the earlywork of Christopher (1992) is the genus of Blecken(2010)'s model, while the Van Wassenhove and Martinez (2010) model bears all the hallmarks of the SCOR model.

While eachof the models above contribute much to commercial supply chain thinking, none of them can be applied to the humanitarian environment without alterationor adaption. Therefore, in the absence of a bespoke humanitarian model and the limited applicability of commercial models, a theoretical gapexists.

Model	Relevance	Limitations	Humanitarian Applicability
Forrester (1958)	Reflects the management processes	Developed for commercial business	None; already developed by Van Wassenhove and Martinez (2012)
Christopher (1992)	Reflects the management processes	Developed for commercial business	None; already developed by Van Wassenhove and Martinez (2012)
SCOR Model (c. 1996)	Easily translated into an HSC form. Rich in process support detail	Only focuses on strategic processes	Some; requires translating by an experienced HSC manager
Cooper, et al (1997)	Takes depth of detail and acknowledges information flows	Commercially focused; significant relabelling required	Limited in its current form but a sound basis if relabelled
Chen and Paulraj (2004b) – External	Takes account of other stakeholders and could be developed to cover supply networks	Doesn't deal with vertical and horizontal information flows	Good starting point from which to develop a multi-dimensional model
Chopra and Meindl (2010)	Reflects the management processes	Developed from Christopher as a foundation for other detailed commercial processes	None
Beamon (2000)	Multi-dimensional and includes an enterprise consideration of information flow. Captures the three levels of operations	Lack of management process detail	Excellent basis from which to develop a model which covers the complexity of the management aspects of the supply chain
Van Wassenhove and Martinez (2012)	Effectively the HSC version of SCOR; evidence that it has been adopted by NGOs	Doesn't deal with vertical and horizontal information flows	Good starting point from which to develop a multi-dimensional model
Akhtar, et al (2013)	Recognises diversity in supply sources and the need for information flows	No recognition of coordination or stakeholder engagement	A basis for demonstrating material flows but little else
Duddy, et al (2017)	Captures complexity and the three levels of operations	Implies, but doesn't specifically address, information flows	Good starting point from which to develop a multi-dimensional model

Table 1. Existing Model Applicability to the Humanitarian Supply Chain: A Comparison.

6. Complexities and Conflicts

It is without question that some commercial supply chains can be exceedingly complex, as Sarpong (2014) describes in his research into the food supply chain at the heart of the UK horse meat scandal of 2013. However, even with their level of complexity, commercial supply chains are more controllable because of the business need to be transparent and accountable, where a loss of either can have a detrimental effect on a company's bottom line. The complexities both induced and inherent in a humanitarian supply network are more pronounced and nuanced. Ergun, et al (2014) note that the first level of complexity occurs when more than one relief organisation becomes involved in a single relief operation 'because many organizations operate according totheir own systems and objectives while at the same time working to contribute to the overall humanitarian cause' (p.1002). Eachorganisation may introduce a separate, distinct supply chain tailored to its own specific goals and needs.

With multiple supply chains supporting one operation, a supply network arises, and Ergun, et al (2014) make the connection between this additional complexity and the need for robust coordination. Van Wassenhove and Pedraza Martinez (2012) discern that the operating conditions faced by humanitarian logistics are distinctly complex and include supply and demand uncertainty and a high degree of decentralisation. Such is the level of complexity in the humanitarian supply network that they propose using operational research (OR) to find solutions to the complex problems faced by humanitarian aid agencies.

Olorundoba and Kovacs (2015) see environmental instability as a significant distinction between humanitarian and commercial supply chains while Bharosa, et al (2010) refer to the dynamic nature of the humanitarian environment and recognise that deciding and acting in an disaster response situation is a 'challenging process for eachindividual, because everyone is faced with severe time- pressure and a flood of information that may be inaccurate or out-dated by the time a decision or action takes place. Such a complex, intense and information-rich environment caneasily result in cognitive overload at an individual level' (p.51).

Altay and LaBonte (2014) associate complexity with the chaotic nature of damage, and in addition to discrimination, corruption and ethnic bias, suggest the factors below as being key to contributing to humanitarian supply network complexity:

Supply chain issues: uncertainty in demand and supply;

- Funding issues: donors with specific targets;
- Needs assessment and procurement: accuracy and timeliness;
- Management of information: information systems and connectivity;
- Coordination issues: supply chain ownership, control and management;
- Infrastructure and network design: enabling the supply network through available infrastructure;
- Standardisation issues: lack of conformity and modular solutions;
- Operational issues: resource availability and consignment-specific issues;
- Personnel issues: qualification, experience and turn-over.

Holistic Illumination

By taking a new theoretical perspective, a sustainable holistic humanitarian model may not necessarily need to be developed from first principles. The Viable System Model (VSM) and Soft Systems Methodology (SSM) are two Systems Thinking approaches described by Flood and Jackson (1991); others include Systems Dynamics (which places its emphasis on structures and processes, and how these shape behaviour) and Critical System Heuristics (which emphasises the importance and role of boundary judgements). Yolles (1999) takes the view that VSM is applicable for an organisation seeking to improve the control mechanisms proposed to be essential for that organisation to be viable, while Jackson (2000) views SSM as being more interpretivist, capable of tackling vague and unstructured problems. Preece, et al (2013) describe how there is a view that VSM is particularly applicable in functionalist research where SSM is more suited to researchof an interpretivist nature; however, they echo the thoughts of Jackson (2000) by recognising that VSM is actually not so rigid as not to be valuable in undertaking more interpretivist work.

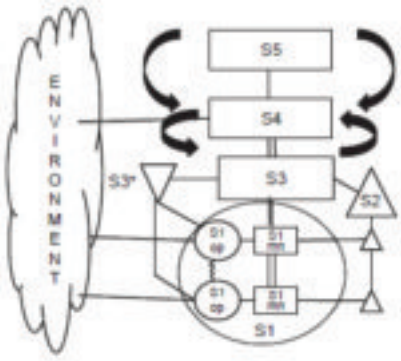


Figure 2. The Viable System Model adapted from Hildbrand and Bodhanya (2015).

Preece, et al (2013) argue that in the humanitarian context, the operations at S1 mimic the multi- facetedform of competing and complementing chains and stakeholder organisations which exist in the humanitarian supply network, with donors and outside support being represented by the Environment. It is also clear (Preece and Shaw (2019), Hildbrand and Bodhanya (2015) and Awuzie and McDermott (2016)) that VSM demonstrates the functions of coordination, cooperation and collaboration particularly well. Indeed, S2 of VSM is specifically the coordination function that occurs at the in-country level when projected onto the humanitarian paradigm. S3 controls the system and is concerned with forces inside the system, where S4, which sit above S3 and is often labelled 'Intelligence', is concerned with forces outside the system. S4 is intrinsically where cooperation would occur, where the system choses to cooperate with another organisation either inside or outside its system. Meanwhile, decisions to enter into collaboration are based on strategic aims, objectives and flexibility. Collaboration involves organisational dovetailing of governance and policy between partner stakeholders and therefore in VSM occurs at the S5 level.

7. Discussion

While VSM is able to take into consideration the relationships between stakeholders and the vertical structure of organisations within the humanitarian supply network and the environment they interact with, it lacks the flexibility to address the conflicts that exist in termsof complexities such as discrimination, corruption or ethnic and cultural bias: the problems of a human activity system as described by Checkland (1981). This is inherent to S1 in VSM and requires a bespoke system model for each operation, organic but based on a methodology capable of being easily derived from first principles.

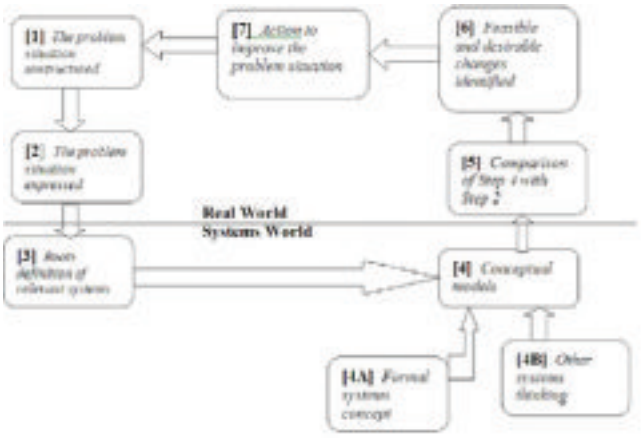


Figure 3. Soft Systems Methodology, Checkland (2000).

SSM can be adapted to deliver this flexibility because it is based on the principle of deriving a root definition for a problem using six established crucial characteristics, described by Checkland (1981) as CATWOE, but for the humanitarian paradigm, this mnemonic would have to be adapted. As a problem-solving tool, SSM comprises seven distinct steps; however, of the purposes of this research, it will only be necessary to follow the process to Step 4. This research considers the Real-World problem and express the problem situation, but the model development occurs within the Systems Thinking domain, culminating with the definition of domain specific knowledge guidelines. The development of a method to derive root definition for problems in the humanitarian supply network that represents a significant contributions to knowledge.

8. Conclusion

All research is underpinned by a conceptual basis but the researchcurrently being undertaken in the field of humanitarian supply network management suffers from a lack of applicable models and frameworks. The theories underpinning current work are drawn from commercial supply chain thinking and adapted to specific challenges and issues arising during humanitarian operations. This leads to a reductionist view of the challenges and issues because they are viewed in isolation, as either supply chain processes or functions; not holistically as part of a much greater and more complex paradigm.

Systems Thinking offers a robust conceptual model in the form of VSM because, in a similar way to Blecken (2010), it can be applied to a multi-layered supply chain organisation operating at strategic, operational and tactical levels but it can also handle the complexities of multiple supply chains coming together in a supply network. However, while VSM provides a sound conceptual base, it does not have the flexibility of coping with issues that have hitherto not be captured by commercial supply chain models. Should such issues arise, SSM becomes a valuable tool because by deriving a root definition of the system from the problem situation, a conceptual model can be developed using an arrayof other Systems Thinking tools, taking into consideration such factors as the customer, end beneficiary and donor; all the stakeholders; the owners of the system; environmental constraints; the desired transformation process to resolve the problem; and the world view (Weltanschauung) that makes this transformation meaningful within the context of the whole system.

By taking a systems approach to research and using VSM as the initial conceptual basis, issues within the humanitarian supply network can be identified, examined and analysed in a holistic manner with a full understanding of the impact that a localised solution would have on the greater system. Where problems become difficult to resolve within VSM, SSM offers a fully flexible, holistic solution by providing a CATWOE-type frameworkfrom which to derive a bespoke conceptual model through the determination of a problem situation specific root definition.

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A framework to measure performance in humanitarian supply chains

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Abstract

Purpose – The purpose of this paper is to establish a framework to use as a basis for developing performance indicators in humanitarian supply chains. This will allow humanitarian organisations to initially measure their performance in real time and subsequently to benchmark their performance with other organisations and situations. This performance monitoring will help to identify best practice and embed systems that can encourage continuous improvement during the operation as well as allow for learning after the event.

Research approach – This is an exploratory paper based on a literature review. Firstly, critical success factors were defined and then these were used to develop a range of indicators.

Findings and originality – Based on a literature review, the critical success factors were classed into seven categories, Beneficiaries, Financial, Partnerships, Processes, People, Performance, and Planning. It also became apparent that the requirements for the different stages of a disaster (Strategic, Tactical and Operational) varied in terms of speed, quality, flexibility, etc. Hence rather than develop a "flat" balanced scorecard, a 3 tier balanced scorecard was developed across the 3 stages of a disaster. Within each of those stages, seven categories of Key Performance Indicators were proposed from the seven categories of critical success factors above. Whilst literature reviews have been carried out looking at humanitarian supply chains, this is the first paper to focus on performance indicators in humanitarian supply chains, linking the indicators to the critical success factors and developing a 3 dimensional scorecard.

Research impact – Whilst many papers develop and discuss 2 dimensional scorecards, this research has designed a 3 dimensional scorecard to cope with different stages of a Humanitarian disaster.

This could be extrapolated to other scenarios where there are clear stages that require different performance metrics.

Practical impact – This research develops a framework that all humanitarian organisations can use to develop measures of their performance. The focus of this work is to provide a framework that can be used "in the field" rather than based on data collection and/ or analysis after the event.

Keywords – Humanitarian supply chains, Humanitarian organisations, Quality management, Performance management, Performance indicators, Performance measurement, Balanced score card

1. Introduction

"Humanitarian operations aim to preserve life and reduce suffering of members of communities in crises. They comprise the provision of material and technical aid as well as the delivery of essential services in response to situations of crises when a community's ability to cope has been severely impeded. It is given to people in need without distinction as to race, ethnicity, creed, nationality, sex, age, physical or mental disability or political affiliation. Humanitarian operations are not motivated by making profits; however, they are based on basic human rights as formulated in International Humanitarian Law and the Geneva Conventions. Humanitarian operations are temporary in nature and aim to re-establish self-sufficiency of the affected community." (Blecken, 2010, p52-53)

Over the past decade, humanitarian supply chains have become more complex, commercial organisations have become more involved, leading to increasing privatisation of humanitarian aid (Blecken, 2010) and there is greater interest from the academic community (e.g. the establishment of the Journal of Humanitarian Logistics and Supply Chain Management Journal in 2011, Journal of Humanitarian Assistance started in 1994 and stopped accepting articles in 2015, Journal of International Humanitarian Action started in March 2016). One of the reasons for this level of interest is that an estimated 80% of the costs of humanitarian aid (approximately $15billion per annum) can be associated with the logistics and supply chain element of the organisation (Blecken, 2010; Tatham and Pettit, 2010; Tomasini and Van Wassenhove, 2009). Another key factor is that according to the Centre for Research on the Epidemiology of Disasters (CRED) (2018) there is an anticipated increase in the number and extent of climate related disasters.

Over the years, many authors have highlighted deficiencies and gaps in performance measurement systems for HOs thus demonstrating the need for a way to evaluate the performance of humanitarian supply chains (Abidi et al, 2014; Khwaja et al, 2014; Fawcett and Fawcett, 2013; Kovac and Spens, 2011; Widera and Hellingrath, 2011; Blecken, 2010; Charles et al, 2010; Scholten et al, 2010; Pettit and Beresford, 2009; Oloruntoba and Gray, 2006; Thomas and Fritz, 2006; Van Wassenhove, 2006).

The purpose of this paper is to develop a framework that could be used by a range of Humanitarian Organisations (HO) to measure their own performance. This information would then be available for use internally for continuous improvement and externally for benchmarking.

2. Literature Review

According to Pettit and Beresford (2009) the significant differences between humanitarian and commercial supply chains is that they "generally operate(s) in a context of voluntary contributions of finance and labour, that the 'end consumers' are people who will not be party to any commercial transaction, that final delivery will be in countries without any established logistics community or infrastructure (conceivably no functioning transport infrastructure), that governments and the military may be involved at a significant level and the environment may be both politically and militarily unstable." (p451).

Blecken (2010) felt that the major difference is that, in commercial supply chains, the aim is to serve the customer so that they become repeat customers (and hence maximise profits). In contrast, in humanitarian supply chains, the aim is that the customers (beneficiaries) are given aid so that they do not need to return. Charles et al. (2010) further contributed to the debate as they felt the fundamental difference was that there was no clear definition of the customer.

There are a range of other areas where Humanitarian Supply Chains are different from other SCs in terms of:

- Uncertainty (of objectives, demand, supply, personnel, infrastructure, information);
- Funding (donors can stipulate how the funds are used, priority is on the supply of goods and services rather than developing systems/research);
- HR (staff are generally volunteers rather than professional logisticians, lack of standardised work processes, high turnover of staff (which Thomas and Fritz (2006) estimated could be as high as 80%));
- Politicized environment;
- Limited human and capital resources;
- Others (minimal focus on production more about mass movement of goods and people, temporary nature of the supply chain, focus is on setting up and maintaining supply chain rather than optimisation, potentially chaotic environment/poor infrastructure, poor communication) (Blecken, 2010; Charles et al., 2010; Tomasini and Van Wassenhove, 2009).

Abidi et al. (2014) summarised the factors that made measuring HSC performance difficult:

- "non-existence of centrally captured data from operations;
- Limited information technology capacity and infrastructure;
- Chaotic environment;
- Lack of motivation for measurement in the non-profit sector;
- Potentially negative media exposure;
- Human resource issues;
- General reluctance to implement performance measurement in the humanitarian sector;
- Long-term versus short-term goals of disaster response;
- Increasing complexity of performance measurement in this sector;
- The inability of field workers to capture accurate data while working under significant time pressure; and
- Limited recognition of the key role of logistics as an essential part of humanitarian relief operations" (p593).

Subsequently, they defined the key challenges as:

- Aligning metrics with satisfaction of the donor;
- Determining meaningful indicators;
- Fostering learning and training of employees; and
- Poor data accuracy and availability (Abidi et al., 2014).

Tatham (2012) stated that as the funding comes from the donors who are not the final customers, the different stakeholders would have potentially different aims and objectives which made it difficult to identify a clear goal.

These differences and challenges make it important to develop performance measurement systems that reflect the needs and characteristics of HSC. This research will initially look at existing work in order to identify why existing indicators are not providing the necessary information before proposing a new framework.

3. Frameworks

Previously, authors have used frameworks to help determine measurements. Abidi et al. (2014) recommended using Supply Chain Operations Reference (SCOR) as the basis for developing a framework although Charles et al (2010) felt existing models such as the Capability Maturity Model (CMMI), the European Foundation for Quality Management Quality Award (EFQM) and SCOR were not relevant for measuring either the context or the agility of HSC.

Gunasekaran et al (2001) carried out a literature review of performance indicators in the supply chain and separated them into different stages which were similar to the SCOR processes (Figure 1).

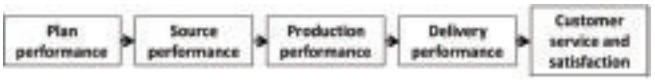


Figure 1 – Different Stages of the Supply Chain (Gunasekaran et al., 2001 pg. 85)

All of the above models had their advocates and their opponents but none of the frameworks have been universally adopted. Medori and Steeple (2000) proposed a 6-stage approach to developing a performance measurement framework and whilst they tested this out in medium to large manufacturing organisations, it was not sector specific. The six stages are:

1. Identify the company success factors

2. Map the competitive priorities with the company's success factors

3. Select measures

4. Audit

5. Implement measures

6. Carry out periodic maintenance.

Due to the range of indicators and scorecards already in existence for supply chains, this paper will use the above framework to provide a structured approach to developing a scorecard of measures for HSC. The reasons for using this approach are because it is a generic model and it resonates with continuous improvement and Six Sigma approaches of Plan Do Check Act and Define Measure Analyse Implement Check. This means that re-evaluating the indicators is part of the process. This paper will only cover the first three stages of the framework and future research will be carried out to implement and test the measures.

4. Critical Success Factors

Stage one of the process is to determine the critical success factors (CSFs). Over the years, a range of CSFs have been developed for humanitarian supply chains with varying focus, depending on the author(s). In order to make sense of the information, the CSFs from the extant literature were grouped into broad categories. This grouping took into account the number of authors who listed the factor as a CSF whilst reflecting the previous discussions (Table 1) (Celik and Gumos, 2015; Talib et al., 2014; Pettit and Beresford, 2009; Fryer et al., 2007; Lu et al., 2006; Pathranarakul, 2006). The broad categories were defined as Planning, Partnerships (donors, suppliers), People (staff), Processes, Performance, Beneficiaries and Financial.

Category	No. of authors	Authors	No. of CSFs
Planning: Organisation, coordination and collaboration; Transport Management; Inventory/ procurement Management including capacity planning; Strategic planning	7	Celik and Gumos, 2015;Abidi et al, 2013; Lu et al., 2006; Fryer et al., 2007; Pettit and Beresford, 2009; Talib et al., 2014; Pathranarakul, 2006	25
People: Sufficient Skilled, qualified and experienced staff including teamwork and trust; Management commitment	6	Abidi et al, 2013; Lu et al., 2006; Fryer et al., 2007; Pettit and Beresford, 2009; Talib et al., 2014; Pathranarakul, 2006	13
Performance/Quality: Performance measurement;	6	Abidi et al, 2013; Lu et al., 2006; Fryer et al., 2007; Pettit and Beresford,	10
Continuum of care Sustainability, service quality, availability of relief items, flexibility, speed, assurance and empathy, security and sufficient mobilisation and disbursement of resources		2009; Talib et al., 2014; Pathranarakul, 2006	
Processes: Information Management/ use of IT Process; Management Effective Communication mechanisms; Organisational structure; Quality culture/ Management with clearly defined goals and commitments by key stakeholders	4	Abidi et al, 2013; Fryer et al., 2007; Talib et al., 2014; Pathranarakul, 2006	9
Partnerships: Supplier relations/management, cooperation and consultation	5	Abidi et al, 2013; Fryer et al., 2007; Pettit and Beresford, 2009; Talib et al., 2014; Pathranarakul, 2006	6
Beneficiaries: Beneficiary involvement, consultation	4	Abidi et al, 2013; Fryer et al., 2007; Talib et al., 2014; Pathranarakul, 2006	4
Finance: Cost efficiency and minimisation	2	Abidi et al, 2013; Talib et al., 2014	2

Table 1 – Analysis of Critical Success Factors

From Table 2, it can be seen that there are significantly more CSFs for planning rather than performance, processes or the beneficiaries. This could be because the planning stage is easier to quantify and measure compared with some of the other aspects of HSCs.

From the preceding work, it is clear that any system for managing performance in HSC must cover a range of perspectives. In 1996, Kaplan and Norton proposed that organisations should use a Balanced Scorecard of indicators to represent fully the performance of the organisation. They initially proposed four dimensions – the customer, internal process, learning and growth and financial perspectives but subsequently, a number of authors adapted the Balanced Scorecard approach for HSC (Widera and Hellingrath, 2011; Shulz and Heigh, 2009; Charles et al, 2010 and Beamon and Balcik, 2008).

Gunasekaran et al (2001) identified the need for a "balanced scorecard" approach that also covered the different stages of response (strategic, tactical and operational). Due to the differences in requirements over time, disaster management is often split into three categories based on time from the original event:

- operational (< 6 months) which is responding to beneficiaries' needs;
- tactical (6 months – 2years) which includes the optimisation of the supply chain; and
- strategic level (2+ years) which are predominantly structural decisions (Becken, 2010; Abidi et al., 2014).

Each of these stages have different requirements which influences what information is required, available and appropriate.

Pathranarakul (2006) demonstrated similarities between the stages of disaster management and the management of public sector projects. Tomasini and Van Wassenhove (2009, p550) identified the different stages of a humanitarian supply chain ("preparedness, response and collaboration" and whilst Kovacs and Spens (2011) also identified 3 stages, their third stage was reconstruction rather than collaboration which is more aligned with the terminology used by Pathranarakul (2006) (Table 2).

Project Life Cycle Phases	Disaster Management Phases	Stages	Categories
Initiation	Prediction	Preparedness (Before)	
Planning			
Executing	Warning	Response (During)	
	Emergency Relief		Operational
	Rehabilitation (short-term)	Collaboration/ reconstruction (After)	Tactical
	Reconstruction (long-term)		Strategic
Completing			

Table 2 - Linkages between Project Management, Disaster Management, Stages and Categories of the operation (Adapted from Pathranarakul, 2006 p401)

Tomasini and Van Wassenhove (2009) discussed that during the response stage, the focus was about speed whereas the other two stages were more like commercial supply chains in that they were more cost conscious. Oloruntoba and Gray (2006) suggested that HSC needed to be lean and agile with a decoupling point to allow the organisations to be flexible and responsive to the beneficiaries needs (Table 3).

Disaster Management Phases	Stages	Focus	CSF category
Prediction	Before	Cost	Planning, Finance, People, Partnerships
Warning	During	Flexibility/agility, speed, performance	Beneficiaries, Processes, Performance, Partnerships
Emergency Relief			
Rehabilitation (short-term)	After	Flexibility, cost	Beneficiaries, performance, Finance
Reconstruction (long-term)			Beneficiaries, performance, Finance

Table 3 - Linkages between Disaster Management, Stages, focus and CSFs

There are a wide range of indicators already in use and the focus of this work is to develop a framework that HOs can use as the basis for their performance management systems. Each HO can then add in other indicators that reflect the nuances of the individual organisations. This will allow organisations to benchmark against each other and disseminate good practice in the core areas.

From Figures 2 and 3, it can be seen that the existing KPIs focus on performances and processes with financial measures and partnerships following behind. There are far fewer indicators relating to the beneficiaries or the people in the organisations. The existing indicators span the different stages of humanitarian aid delivery and, unlike the CSF's, the majority of indicators are focused on performance and processes.

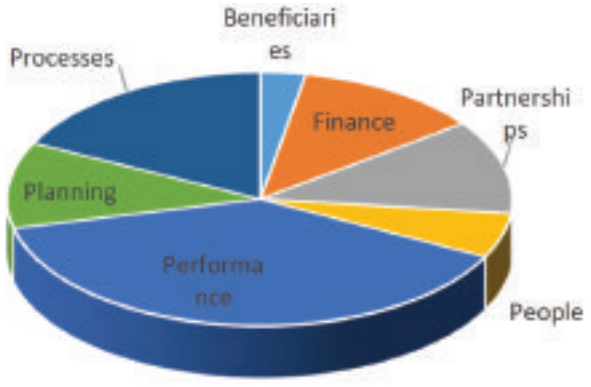


Figure 2 – Breakdown of existing KPIs

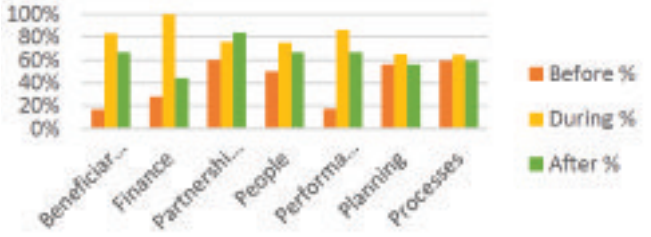


Figure 3 – KPIs by category and stage of operations

5. Discussion and conclusions

This initial exploration of the existing KPIs used in HSC has shown that there is a disconnect between the CSFs and the KPI's, the key priorities for the organisations. For example, in the 'during' stage, when organisations are focusing on speed and agility to respond to a disaster, many of the indicators are based on financial measures and whilst 'Performance' covers a range of topics that might be further broken down, it still demonstrates that, as in many sectors, the indicators do not reflect the aims of the organisation. However, Table 3 does indicate that the type of indicators varies by stage of the disaster.

Thomas and Fritz (2006) had criticised many of the indicators earlier:

"the sector measures itself with throughput indicators rather than output or outcome metrics…(e.g.) how much food they have distributed or how much shelter they have provided, not what outcomes these relief services have created in terms of lives saved or suffering alleviated. Thus, demonstrating the effectiveness, efficient or impact of an organisation is virtually impossible." (p117)

Kunz and Reiner (2012) found the majority of papers concentrated on sudden onset natural disasters and that "more attention be paid to the logistics of continuous aid operations, that more focus be put on slow onset man-made disasters and that the case study and survey methodologies be increasingly used to collect empirical knowledge. We also think that the reconstruction phase and its sustainability should be studied more" (p137).

However, before particular areas need greater research a clearer raft of indicators needs to be established reflecting the aims and objectives of HO. Figure 4 shows a proposed balanced scorecard that will allow HO to assess their performance during the different stages of a disaster and will allow benchmarking across organisations.

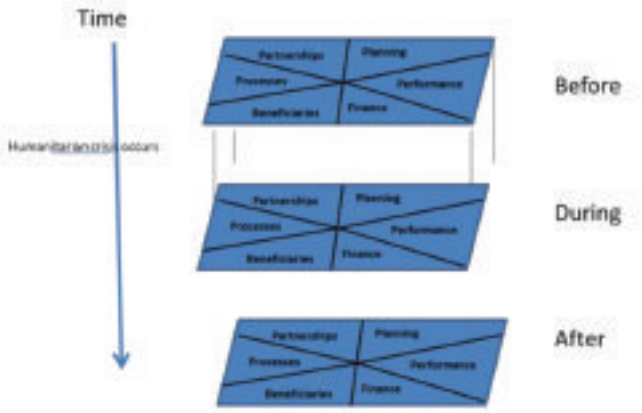


Figure 4 – Proposed 3 Tier Balanced Scorecard goes here

The next stage for this research is to work with HOs to clarify their existing KPIs, identify where they fit into the proposed framework, and test data collection methodologies to ensure that the information can be provided in a timely and useful manner.

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Emergency logistics response system to supply lightweight high performance walls

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1. Introduction

Emergency logistics is defined as the process of planning, managing and controlling the efficient flow of relief, information, and services to the points of destination to meet urgent needs of the affected people under emergency conditions (Sheu, 2007). Logistics is the bridge between preparedness and response, procurement and distribution the critical role being coordination of all activities required to minimize the response time and to maximize the relief in a disaster zone.

Natural disasters such as hurricanes not only bring devastation and danger to the population during the landfill of the hurricane due to the category of the hurricane (wind speed) but also create flooding condition. The United States Geological services define a flood as a relatively high streamflow overtopping natural or artificial banks in any reach of a stream (Holmes and Dinicola, 2010). Unfortunately, flood disasters in many countries are the natural disaster with more incidence. In fact, it is estimated that an average of more than 196 million people are affected by a natural disaster flooding every year worldwide (Pelling et al, 2004). However, flood disasters are more easily predicted once the hurricane category, projected path, and speed the hurricane moves are known.

The environmental, human, and residential and non-residential damages due to flooding have reached significantly high levels. The National Oceanic and Atmospheric Administration (U.S.) reports that the average loss due to flooding during the last 30 years is $7.96 U.S. billions and 82 fatalities per year. Furthermore, in the United States the house are built using dry walls, and consequently significant flooding can affect permanently the house since mold infested and water-damaged drywall make the household inhabitable to its owners. The bacteria will begin to grow exponentially on the drywall meaning all affected walls will need to be replaced.

Therefore, there is a need to develop a material that is as light as the drywall, can be handle and installed using the same structure that the dry walls, but it is not subject to mold under flooding conditions. The study of this project is twofold; to develop a fly ash activated mix design to produce a lightweight fly ash based concrete walls with a weight of 650 kg/m3 and with a better strength that drywall material, and to develop an emergency logistics system to efficiently and promptly produce and distribute the lightweight walls to the affected areas.

2. Literature Review

Research has been conducted to evaluate the logistic response during the preparedness and the response phases to efficiently and in a timely manner to distribute the most essential aid to the affected area: evacuation, medical assistance, prevention of diseases, water, food, shelter, and safety. Recent research on emergency preparedness for flooding (Chang. et al, 2007, Leiras et al, 2014, and Garrido et al, 2016) has focused on the location of relief distribution centers, allocation of resources, and optimization of inventory levels for emergency supplies. However, little research has focused on developing a sustainable solution to prevent and/or replace damaged infested dry walls. Diaz-Delgado (2014) researched flood risk assessment in humanitarian process that relates emergency events caused by flooding in which the process design uses a forecasting model. The model requires a hydrologic part that converts rainfall into runoff as a hydraulic component. Yang et. al (2018) formulate propose a solution to the inventory slack routing problem using a two-stage approach to tackle the vehicle routing and relief allocation sub-problem. They formulate the relief distribution problem as an optimization model that maximize the minimum slack among all dispensing sites.

Tovia (2007) developed an emergency logistics response system to analyze the resources required to evacuate the population on time in the event a hurricane landfall in the U.S. Atlantic coast. He

developed a simulation model based on historical data of the hurricanes that had hit the U.S. Atlantic coast. D'Uffizi's (2015) study is in many ways similar to that of Tovia's (2007). While Tovia's simulation evaluates the response capabilities in the case of natural, D'Uffizi took into account both manmade and natural disasters in an effort to efficiently predict where to allocate sufficient materials in the case of such an event. The simulation model created uses road network maps, facilities, request demand sources, and available vehicles and equipment.

Rostami (2003) introduces the use of Alkali Ash Material (AAM) that can be used to create concrete. The material is made up of 40-95% Class F fly ash, which is a byproduct of coal burning resulting in a more economical and environmental concrete that substitutes Portland cement with fly ash. Rostami (2009) developed a new lightweight material for construction applications that utilizes alkali activated fly ash along with a gassing agent and lightweight aggregates (e.g. vermiculite) . This Lightweight Alkali Ash Material (LW-AAM) does not require autoclaving, can produce materials with densities ranging from 1200 kg/m3 to 2200 kg/m3 and compressive strength from 2 MPa to 65 MPa, and it is highly

resistant to corrosive actions, is a highly durable material, and resists the action of freezing and thawing.

3. Operating Policies

Operational policies are set in place to determine all major decisions and actions executed throughout the process of developing and distributing Lightweight AAFA-HPC drywall sheets. This project is limited to the delivery of Lightweight AAFA-HPC drywall sheets to the affected area. The O.P. identifies all the stakeholders, processes in the operation, and assigns responsibilities to their respective partner/stakeholder. The stakeholders in this operation are FEMA, transportation companies, power plants, precasting facilities, local contractors and emergency relief centers. There are three phases in this process and each phase is triggered depending on the National Oceanic and Atmospheric Administration (NOAA) weather forecasts and FEMA approvals. These three phases are the preparation phase, response phase, and the reconstruction phase. These phases are triggered by Hub Statuses that are determined by different risk factors developed by Tovia (2007) in terms of the category of the hurricane and time to land. The logistics required for the reception, warehousing, and distribution of material at the affected areas are beyond this paper and are work in progress by the authors. The terminology used in this section is as follows:

τ = the time (hours) prior to the potential landfall τ ε {72, 60, 48, 36, 24, 18, 12, 6, 0}
s = slack time given time to landfall

φ(t) = category of the hurricane at time t

β(t) = the risk level that the hurricane represents to the affected zone at time t, determined as a function of φ(t) and s, which were developed by Tovia (2007) and presented in Table 1.

Γ(n) = hub status level (n)

The Hub Status Γ(n) given β(t), s and φ(t) which are presented in Table 2 are as follows: If β(t) = 1 or 2 for all φ(t), Γ(0) is assigned.

If β(t) = 3 for all φ(t), Γ (1) is assigned.

If β(t) = 4 for φ(t)= 1 or 2, Γ(1) is assigned.

If β(t) = 4 for φ(t) = 3, 4 or 5, Γ (2) is assigned. If β(t) = 5 for all φ(t), Γ(3) is assigned.

The Hub status triggers the following actions of the stakeholders:

- Hub Status Γ (0) (Evaluation): FEMA closely monitors weather forecast through NOAA.
- Hub Status Γ (1) (Hub-Alert): FEMA contacts all stakeholders to alert them of a possible strike.
- Hub Status Γ (2) (On-Call): All stakeholders are on-call ready to start production of lightweight HPC walls.
- Hub Status Γ (3) (The Response): Hurricane has made landfall, production begins according to the following operational policies (Figure 1 and Figure 2).

		τ							
φ(t)	s	72	60	48	36	24	18	12	6
1	>=0	1	2	2	2	3	4	4	5
	<=0	n/a	n/a	n/a	n/a	5	5	5	5
2	>=0	1	2	2	3	4	4	4	5
	<=0	n/a	n/a	n/a	n/a	5	5	5	5
3	>=0	1	2	3	3	4	4	4	5
	<=0	n/a	n/a	n/a	n/a	5	5	5	5
4	>=0	1	3	3	4	4	5	5	5
	<=0	n/a	n/a	n/a	5	5	5	5	5
5	>=0	1	3	3	4	5	5	5	5
	<=0	n/a	n/a	n/a	5	5	5	5	5

Table 1: β(t) risk values as a function of φ(t), s and τ

	τ							
	72	60	48	36	24	18	12	6
φ(t) = 1	1	2	2	2	3	4	4	5
Γ(n)	0	0	0	0	1	1	1	3
φ(t) = 2	1	2	2	3	4	4	4	5
Γ(n)	0	0	0	1	1	1	1	3
φ(t) = 3	1	2	3	3	4	4	4	5
Γ(n)	0	0	1	1	2	2	2	3
φ(t) = 4	1	3	3	4	4	5	5	5
Γ(n)	0	1	1	2	2	3	3	3
φ(t) = 5	1	3	3	4	5	5	5	5
Γ(n)	0	1	1	2	3	3	3	3

Table 2: Hub Statuses Γ(n)

As soon as hurricane represents a potential risk -Γ (1)- FEMA contacts stakeholders near the affected areas to alert them of the possibility of a natural disaster. This alert prepares those stakeholders for extra work that could be the result of FEMA confirming that a natural disaster will hit land. Once the risk is confirmed -Γ (2)-, all stakeholders must reach out to their suppliers to arrange for the delivery of extra materials to produce the required amount of Lightweight AAFA-HPC drywall sheets to support affected areas. When the landfall is imminent -Γ (3)-, FEMA approves the production of the walls, where the first batch should be ready to ship within six hours after the disaster strikes. The operating policies and responsibilities of each stakeholder depending on the Hub status are defined in the stake holder map (Figure 1) and the value stream map (Figure 2).



Figure 1: Stakeholder Map

4. Emergency Logistics Model

There are two parts to the emergency logistics portion of the project: a mixed integer programming (MIP) optimization model and a simulation model that incorporates operational policies (O.P.) and full supply chain of Lightweight AAFA-HPC drywall sheets. The MIP optimization model determines the most feasible centralized locations where precasting facilities (Hubs) will begin production in accordance with the O.P. when a hurricane strikes in its respective region. The objective of simulating the emergency logistics behind a hurricane is to incorporate and modify Tovia (2007) simulation model to include the logistics of producing and transporting the drywall panels to the affected areas. Included in the modification are: O.P. and the full supply chain of Lightweight AAFA-HPC drywall sheets.

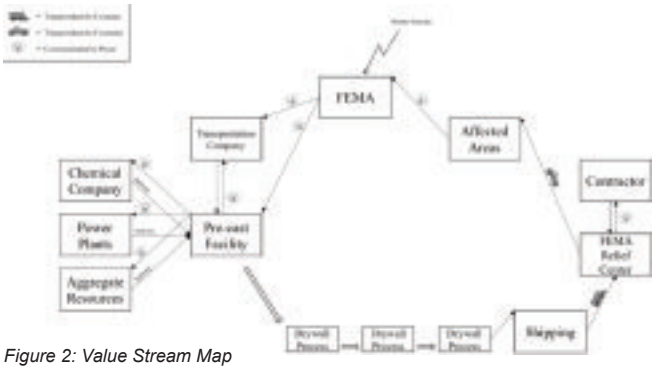


Figure 2: Value Stream Map

In order to properly model the emergency logistics, significant data collection is necessary to determine the input parameters to the MIP and simulation models, as well as to determine the probability distributions that truly represent the resources, production, transportation, and distribution of the lightweight walls. The extensive data collection was conducted by our students during their Senior Design 2017-18 Capstone project (Fixl et. al 2018). The data that they obtained through extensive research was used throughout each of the steps in simulating the logistics behind the response to a hurricane affecting an area along the Atlantic and Gulf coasts. The demand of dry walls was estimated for each of the 23 hurricanes regions in the U.S. Atlantic Coast defined by the NOAA. It was approximated by aggregating the total population in the region and divided by the average household size in that region. Then, based on the probability distribution of hurricane by region given the categories developed by Tovia (2007), the expected demand per hurricane region is given by:

E(demand per region) = # households in region * Pr(% population affected |φ = 3, 4 or 5 per region)

Mixed Integer Programming (MIP) Hub Locations Optimization Model

Given that the projected path of the hurricanes shift within a range, the Hub locations must be located to serve only neighbor regions (west, east, north and south). In addition, hurricane regions in the Gulf of Mexico and southeast are more prompt to hurricane landfalls than in the northeast. Therefore, the Hub location (precasting facilities location) must be optimal located to serve the neighbored hurricane landing location. A MIP model was develop to determine the optimal location of the Hub, but it was executed separately (different input parameters) for each of the sub-regions (Figure 3). The problem formulation for the MIP optimization model is as follows:

X_{jk}: Number of trucks to send from Hub j to affected region k

C_{jk}: Cost (in USD) to send a single truck from Hub j to affected region k MH: Number of hubs selected from the sub-model

F_k: Cost (in USD) to open up allocation hub (assumed to be 1)

Y_k: Decision to select region for production (1 = true, 0 = false)

$$\text{Min } Z = \sum_{j=1}^{} \sum_{k=1}^{} C_{jk} X_{jk} + F_k \sum_{k=1}^{} Y_k$$

$$\text{st.} \quad \sum_{k=1}^{} C_{1k} X_{1k} \le \text{Max}\,|D_{jk}| \cdot Y_k$$

$$\sum_{k=1}^{} C_{2k} X_{1k} \le \text{Max}\,|D_{jk}| \cdot Y_k$$

$$\sum_{k=1}^{} C_{mk} X_{1k} \le \text{Max}\,|D_{jk}| \cdot Y_k$$

$$\sum_{k=1}^{} Y_k \ge M_p$$

*Note: The D_{jk} in the constraints are the max aggregate demand that the hub would need to fulfill given the affected regions {*k-2, k-1, k, k+1, k+2*}.



Figure 3: MIP Sub-model regions

Region	#	Location
Texas South	2	Texas (south, north)
Texas Central	3	Texas (south, central, north)
Texas North	4	Texas (s, c, n) Mississippi
Florida N.W.	2	Florida (southwest, northeast)
Florida N.E	3	Florida (N.W., N.E., S,W)
Florida S.W	4	Florida (S.E, S.W, N.E, N.W)
Mid Atlantic	3	Maryland, Delaware, North Carolina
Northeast	2	Delaware, New Hampshire

Table 3: MIP sub-model optimal locations

The results for each of the sub-models per hurricane landing region (assumed hurricane landed on the center of the region) are presented in Table 3.

Emergency Logistics Simulation Model

The simulation model developed by Tovia (2007) was modified to include two sub-models that incorporate the operating policies and full supply chain of Lightweight AAFA-HPC drywall sheets. A pseudo code of the sub-models developed are as follows:

Step 1: Read data from Excel

Read from the Excel file the hurricanes probability distributions and generate the number of hurricanes per year. For each hurricane, generate the month of landfall, category, strike zone and population size. Then, schedule the arrival of each hurricane to the system.

Step 2: Track hurricane based on hours prior to landfall

Set τ = 72, which means 72 hours prior to the landfall of each hurricane to the predicted strike zone, and based on the historical data of the hurricanes that have hit that specific zone, randomly generate the path, current location and speed of the hurricane.

Step 3: Hub Status (Γ) determined based on Risk Factor Level (β)

Based on β, the precasting facilities will act based on its value in the nearby striking area will prepare according to Operational Policies.

Step 4: Incorporate delay to ensure production occurs after hurricane strikes.

The operating policies state that the production should occur only within 24 hours of the hurricane striking. Simply stating the production should occur after the hurricane strikes so the shipments should be signaled only when the hurricane is within 24 hours of landfall. This ensures that the production will occur directly after, or a few hours after the hurricane strikes.

Step 5: Calculate necessary materials needed per hurricane category

Calculate the number of drywall sheets needed, number of trucks filled with fly ash needed for transportation, the number of trucks filled with drywall sheets needed for transportation and time needed to complete all production and delivery to a given population.

Step 6: Determine number of precasting facilities to open

Determines the number of precasting facilities to operate given hurricane category.

Step 7: Write final statistics

Write the statistics to an output Excel file

Output Statistics and Sensitivity Analysis

The statistics were collected based on simulating 200 hurricane seasons (years), equivalent to 1426 hurricanes. Since this is a terminating simulation, no warm-up period and steady-state analyses are required. The confidence intervals of the output statistics are presented in Table 3. It is also important to note that the statistics in the chart given may not seem accurate due to the fast rebuilding time for hurricane category 5 in comparison to category 4. This only occurred because over the span of 200 hurricane seasons, only six category 5 hurricanes landed, and randomly in cities with small population. The results show that the proposed model is a robust model since in all the cases except for the upper confidence limit category 4, the delivery reconstruction time is less than 100 days.

	Population of Zone		# of Households Affected		Trucks of Fly Ash		Trucks of Drywall		Delivery Time of Reconstruction Materials (days)	
Category	Lower CI (95%)	Upper CI (95%)	Lower CI (95%)	Upper CI (95%)	Lower CI (95%)	Upper CI (95%)	Lower CI (95%)	Upper CI (95%)	Lower CI (95%)	Upper CI (95%)
1	279846	403794	196	281	0.398	0.284	1.809	1.450	0.2895	0.201
2	285753	318580	17181	20480	15	21	67	106	18	22
3	217357	351111	22023	36867	23	36	118	191	25	40
4	272148	515516	54289	120817	53	126	273	636	57	134
5	43214	341619	11408	98188	12	94	59	468	12	99

Table 4: 95% Confidence Interval of Output Simulation Results

5. Experimental Study of Lightweight Alkali Activated Fly Ash High Performance Concrete

The main objective of the experimental study is to produce a sample with lightweight qualities, subject to a required strength of 0.7-2.0 MPa (Rostami, 2009). Cement lightweight walls are usually produced using Autoclave Cellular Concrete (ACC) technology or by the replacement of lightweight aggregates for natural aggregates. However, the proposed lightweight walls will be produced combing alkali activation, silicate cement, lightweight and high performance concrete technology (Rostami 2009).

AAFA-HPC lightweight walls have six ingredients in the design mix. These include fly ash, vermiculite, coarse aggregates (sand, haydite, perlite or both), sodium hydroxide, sodium silicate, and water. The fly ash used will be Class F with a required make up of less than 2% carbon. Fly ash has superior qualities as Portland cement for its low cost, high strength, better chemical resistance and reduced alkali-silica reactivity. Vermiculite is used to make the wall material as light as it can be. The coarse materials act as filler material and support through its hardening properties. Sodium hydroxide mixed with sodium silicate react with fly ash to create cementitious characteristics. Water is used for the hydration process that assists in the hardening process. Initially, the fly ash and aggregates are mixed very thoroughly. The activating chemicals are then added and mixed until uniformity is reached. Finally, the mixture is poured into a mold and placed in the oven for 24 hours at 70oC.

An experimental design was created to vary the amount of ash, vermiculate (% by volume), and perlite (% by volume). The standard mix design, which was the base of the experimental study, was NaSi02 (105 grams), NaOH (95 grams), Fly ash, aggregates, and course. It is important to note that the entire experimental study and testing was conducted by our by our students during their Senior Design 2018- 19 Capstone project (Burkert et. al 2019).The first experimental results showed that the best results were obtained using as aggregates vermiculate and perlite. Varying the % by volume of this aggregates at three factor levels 25%, 50%, and 75% yield to reduce the weight of the samples (2" x 2" x 2" cubes) from 200 grams to 150.1, 147.7, and 147.78.

	Mix 22	Mix 23	Mix24
A(NASIO2) (Grams)	105	105	105
B(NAOH) (Grams)	95	95	95
Ash(AEP Mountaineer) (grams)	250	250	250
Vermiculite (% of volume of 300 ml	25%	50%	75%
Perlite (% of volume of 300 ml)	75%	50%	25%
Al Powder (% of volume from ash)	0.10%	0.10%	0.10%
Weight (Grams)	150.1, 151.9	147.7, 145.1	147.8, 155.5

Table 5: Experimental Results 3 factor levels Vermiculite and Perlite

Then, reducing the amount of ash by volume yield a sample with acceptable density that can be used to replace the commercial dry wall by the lightweight AAFA-HPC walls using the same frames and installation procedures. The road map of the experimental design is presented in Figure 4, which after a significant number of experiments, the best results were obtained using 50% of perlite (as % of 300ml) and 50% vermiculate (as % of 300ml), and 150 grams of fly ash, while maintain the other ingredients at the levels of the standard mix design. The weight of the 2" x 2" x 2" sample was 115.9 grams equivalent to a density of 787.92 (kg/cm3). The strength of the AAFA-HPC material was tested using the Instron compression tester, obtaining a compressive load of 273.35 psi, which is greater than the target compressive strength (Rostami 2009) of 250 psi.

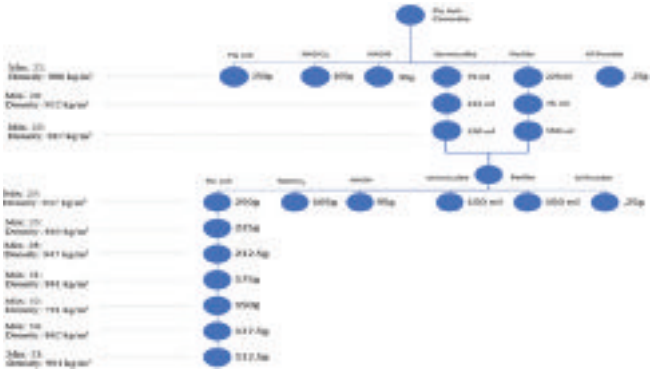


Figure 4: Experimental Mix Design Tree Diagram

Finally, it was critical to test that the material would not be subject to mold in case of flooding. The best mix designs were tested to evaluate their ability to resist mold. The 2" x 2" x 2" cubes were placed into a bowl filled with water until about half of the cube was submerged. The reason to leave about half of the cube exposed to air is that when mold grows in a dry wall, the point at which the mold begins to grow is where the water meets the air. The cubes were left to soak into the water for about two weeks. No mold grew in the cube, which was expected due to the high pH of the AAFA material that kills any bacteria.

6. Conclusion

The statistical analysis of the simulation model of 200 hurricane seasons proves that the proposed model; operating policies, MIP optimal hub location, and the simulation model, is a robust model. The confidence interval of the time response to supply AAFA-HPC light walls to the affected area in less than 100 days, and suggest that a pilot test should be implemented in collaboration with FEMA. Furthermore, the results of the AAFA-HPC light walls show that the material is superior to the dry walls with enhanced strength, easy to install, and not subject to mold during flooding. A full-scale pilot room should be build and tested to evaluate that it meets all safety-housing regulations.

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Information systems

The impact of cloud computing system on supply chain companies in Egypt

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Abstract

With the significant advances in Information and Communications Technology (ICT) over the last half century, there is an increasingly perceived vision that Cloud computing will one day be one of the most important systems of technology. This computing utility, will provide the basic level of computing service that is considered essential to meet the everyday needs of the general community and private business. To deliver this vision, a number of computing paradigms have been proposed, of which the latest one known as Cloud computing. Cloud Computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services. Cloud Computing can take the form of software as a service (SaaS), infrastructure as a service (IaaS) and/or platform as a service (PaaS). Cloud technologies are dynamically reconfigurable, which refers to being tailored to meet the specific needs of the organization using it. This research paper aims to investigate and discover the drawback against the benefits of applying Cloud Computing in Companies in Egypt through finding the difference between the current system used by the industry and the Cloud Computing system. It also aims to analyze the residing views regarding the weight of the benefits and drawbacks of Cloud Computing. The importance of this research lays in its contribution to literature centered on the application of up to date technology in supply chain management within Egypt. It concentrates on studying the country's variables and representing data to be considered in order to further help increase the efficiency and effectiveness of supply chain management systems in domestic companies and foreign companies residing in Egypt.

1. Introduction

In today's global supply chain, companies from different industries face a lot of challenges like increased selection, competition, uncertainty and information sharing. A lot of these challenges can be considered one of the primary performance setbacks of any company. Faced by ferocious competition and ever changing customer demands, organizations need systems capable of adapting and advancing its company through these tough waters.

One of the newest advances or systems to be used on supply chains, is Cloud Computing, with capabilities that include product innovation, strategic material sourcing, outsourced manufacturing, integrated logistics, Omni-channel fulfillment, and integrated demand and supply planning. The main idea behind Cloud Computing is to consolidate and manage computing resources in central locations, make them available to users anywhere and move maintenance and operational management burdens away from the enterprise to a third party. Nonetheless, despite the benefit of the SCM cloud companies tend to fear losing their information or having their information leaked to their competitors which can have a counter negative effect on their market status.

This paper investigates the benefit against risk of applying Cloud Computing in companies in Egypt using Carrefour Egypt, Coco Cola Egypt and Nestle Egypt as samples for data collection. A comparison between the current system used by the industries and the Cloud Computing system will be discussed to find out the different factors and barriers stopping organization in Egypt from applying the Cloud Computing application to manage their business processes and the supply chain process.

In this research, two companies from different sectors and a company whose U.S inhabiting branch uses Cloud Computing technology to manage their supply chain activities will be visited. The three companies are Carrefour Egypt- a retail company-, Coca Cola Egypt- an FMCG whose US counterpart applies Cloud Computing- and Nestle Egypt- an FMCG-. The research analysis will be focused on applied semi- structured interviews with the IT manager and Supply Chain or Operations Manager of each business while also handing out fifteen questionnaires to employees in different departments, to further research the state of the currently applied IT systems, their problems and performance barriers based on usage experiences and comparing them to the Cloud Computing system whilst allowing the participants to analyze the system's pros and cons and leaving their professional opinions and suggestion regarding the application of Cloud Computing.

2. Literature Review

2.1.1. New technologies in management information systems

Laudon (2013) explained the major new technologies in business uses of information system and their business impact as follows;

Cloud computing platforms, which comprise of a flexible collection of computers on the internet that perform tasks traditionally performed on corporate computers.

Growth in software as service (SaaS), which are major business application that are now delivered online rather than as boxed software.

Mobile digital platforms that compete with personal computers, or PCs, as a business system, where business users can download hundreds of application to support collaboration, location based service and communication with colleagues. For instance, YouTube, Facebook and smart phones are not just gadgets or entertainment outlets, they now represent new computing platform on an array of hardware and software technologies and business investments and those technologies are being adopted by enterprises as business tools to improve management and achieve competitive advantage.

2.1.2. Cloud Computing

Cloud Computing growth has taken the attention of various communities like researches, student, business, consumer and government organization. Big data is the main reason for the introduction of Cloud Computing. Cloud Computing can be defined as a model for enabling convenient, on- demand network access to a shared pool of customizable computing resources, such as networks, servers, storage, applications and services, that can be rapidly edited and released with minimal management effort or service provider interaction (Mell and Grance, 2018). In other words, a cloud can be considered to be a collection of hardware, software and other resources that can be accessed over the Internet, and used to assemble a solution on demand at the time of request to provide a set of services back to the requester.

Cloud Computing presented a vital shift in the way businesses pay for and access IT services as well as creating new opportunities for IT services providers and outsourcing vendors who now have to modify their strategy to take advantage of this new computing exemplar (Dhar, 2012). Cloud Computing is a new model of computing that is widely used in today's industry and society (Hartig, 2008). According to Hartig (2008), Cloud Computing is one of the latest computer industry trends. The concept is derived from the idea of an Internet cloud, in which the term "cloud" is traditionally used to represent the Internet or some large networked environment. The idea presented is that client data and applications are stored and accessed somewhere out there (Hosch, 2009). In Cloud Computing (Buyya et al., 2011), resources are located in virtualized and distributed environments geographically interspersed. One definition offered for Cloud Computing is the ''virtualization of

resources that maintains and manages itself (Hartig, 2008). Beal (2018) also stated that Cloud Computing can be described in an abundance of manners, of which that the phrase Cloud Computing means "'a type of Internet-based computing', where different services – such as servers, storage and applications – are delivered to an organization's computers and devices through the Internet". For simplification, Cloud Computing can be defined primarily as the use and sharing of applications and resources of a network environment to fulfill work without concern about ownership and management of the network's resources and applications.

2.1.3. Impact of Cloud computing on supply chain management in organizations

Organizations within a supply chain are increasingly using technology to aid them in collaboration. The biggest competitive contribution that an IT system could provide is the enablement of collaboration within an organization in itself and with its business partners and customers (Fawcett, et. al, 2011). Organizations that have joined their systems have increased and improved both collaboration and economic performance of each partner involved. The use of such suitable technology has helped firms differentiate from competitors by enhancing their relationships with suppliers and customers (Closs & Savitskie, 2003; Sareen et. Al, 2013).

Cloud computing as a new technology offers an opportunity to many firms to harness the tools, equipment, and expertise necessary to aid collaborative relationships. It offers a possible solution to some organizations to quickly increase their capacity without huge investments (Belalem, et al., 2011). As such, Cloud Computing provides faster implementation times and lower upfront investments in that organizations do not have to spend their resources acquiring infrastructure (Marston, et al., 2011).

Multiple business processes can be managed across businesses using cloud technology. A growing number of third party logistics providers, or 3PLs, are turning to Cloud Computing technology to successfully support customers enabling them to see further along both sides of the supply chain (Monkmeyer, 2011). Collaborative relationships are allowing shippers to improve decision making and the costs are spread across users. Cloud Computing also offers an opportunity that will enable small organizations to share the same services as larger companies, including the benefits from the ability to transparently interact and manage processes outside the organization, which reducing the cost of ownership for supply chain collaboration.

2.1.4. Cloud Computing benefit to SMEs

SMEs are defined as enterprises with an established volume of business of less than a hundred million Egyptian pounds with categories going down to less than one million Egyptian pounds- medium, small, very small and micro finance- (Central bank of Egypt, 2016). SMEs are amongst the most vital elements of any economy, generally. With a focus on the Egyptian economy, SMEs account for nearly seventy to eighty percent of the Gross Domestic Product, or GDP. They employ nearly sixty-six percent of the total workforce and seventy-five percent of non-agricultural man power. They contribute to nearly fifty-nine percent (thirteen for small enterprises and forty-six for medium ones) of total industrial production. As a result, SMEs contribution to the economy is quiet significant. The last official report for Central Agency for Public Mobilization and Statistics, or CAPMAS, in regards to SMEs was in 2006 stating that they reached 2.45 million enterprise accounting for more than ninety percent of total private enterprises in Egypt, then. In 2015 it is estimated that SMEs reached nearly 2.78 million enterprise where the annual increase in SMEs is nearly thirty-seven thousand enterprise (First equity, 2016). Cloud Computing promises to deliver many business benefits to SMEs, mainly in the form of much lower costs, as they would only need to pay for the resources need and at a much better ROI of their limited resources. As a result, these enterprises get to focus on their core competencies as such delivering better value to their customers and gaining competitive advantage (Alshamaila et. Al, 2013).

4. Research Problem

To identify the main barriers preventing companies in Egypt from applying the Cloud Computing system and whether system's benefits outweigh its risks and the risks.

5. Research Methodology

The data collection process will consist of the distribution of questionnaires to fifteen employees from different departments and face-to-face semi-structured interviews with the Supply Chain or Operations managers and IT managers. The questionnaire is consisted of eleven questions divided into two main sections starting with questions collecting demographics – the department and corporate title- and followed by Rating Scale questions, Yes/ No questions and open ended questions collecting input on how each individual would rate the current system in terms of functionality, such as whether it supports business' processes well enough, and compatibility, such as ease of access and transparency and questions to test individuals' familiarity with Cloud Computing, the system's benefits and drawbacks and their openness to using it. Semi-structured interviews were held with six current managers and operators from both supply chain and IT department at Carrefour Egypt, Coca Cola Egypt and Nestle Egypt. We have chosen them according to their positions that carry a lot of expertise and knowledge about their managerial and operational factors applying in both departments and also in order to help us understand the major barriers that affect the Cloud Computing.

6. Data Analysis

Data was collected in the form of semi-structured interviews conducted with the IT Managers and Supply Chain Managers of each of the three companies followed by questionnaires issued to 15 employees of different departments within the three companies. It was noted that awareness of the Cloud Computing system is in general low and that many respondents of managers were not familiar with the system due to the lack of focus on becoming better and advancing with technology. Furthermore, in terms of benefits, Cloud Computing's benefits were all rated very highly and during interviews the most highly rated benefit was that of cost reduction. On the other hand, in both the semi-structured interviews and questionnaire answers, the biggest drawbacks seemed to be that of data security followed by being hosted on a server with other companies. Most managers also noted that the need for an efficient internet service was also of concern due to the general nature of the internet services in Egypt not being very good. In terms of resolving drawbacks most managers focused on means of resolving the security issue by applying some form of authorization means to disallow unauthorized individuals and service provider personnel from accessing sensitive firm data. Respondents in the questionnaires also applied a similar idea regarding that drawback. Last but not least, although data security was regarded as a very sensitive drawback, most managers and respondents seemed to support changing the current IT system into a Cloud based system which supports the assumption that the system's benefits outweigh its risks.

The following is detailed description for the output and results of the questionnaire conducted to Nestle, Coca-Cola and Carrefour Egypt:

Regarding the Respondent Familiarity with Cloud Computing System, The results showed that most respondents were not in fact familiar with the system of Cloud Computing technology and its application on supply chain management.

Concerning the Ratings of Benefits of Cloud Computing System, This question helped achieve the second objective which is to establish an idea about the benefits and drawbacks of Cloud Computing in the minds of related professional. The benefits were rated as follows:

- Cost reduction (no capital cost but only operational, pay-per-use cost)

The results suggest that most respondents would view this benefit as very high, meaning it's a huge benefit of cloud computing which supports speculations regarding the high costs that arise with applying a desktop ERP system.

- No large capacity computers needed as software is run by service provider: The results suggest that most respondents would view this benefit as one that deserve a very high rating.
- Ability to use anywhere, at any time: As the most ratings were on very high, this suggests that most respondents would view this benefit as of a very high value.
- Easy start-up with minimal delay, as transferring to the cloud is a simple, quick process: The results show that most respondents rated this advantage as very high suggesting that most of them view it as a benefit of a very high value.
- Tailored to firm's needs: The results suggest that most respondents viewed this benefit as of very high rating.
- Elasticity in decreasing or increasing procession and work-load demands: This suggests that most respondents rated this criterion as very high of value as a benefit.
- Power saving and environmentally friendly (is only powered when needed for use and does not require full time operation): The results show that most respondents view this benefit as of very high of value supporting the strength of the benefits provided by the Cloud Computing system.

Rating of Drawbacks of Cloud Computing System

This question helped achieve objective two of understanding the views of professionals on the benefits and drawback of the system which are concluded as follow:

- Data can be accessed by service provider: The results show that all the respondents, with an exception of 1, would view the value of this drawback as very high which provided support to the literature stating that data security is a significant drawback of Cloud Computing systems.
- Multiple users are hosted on the same computer by service provider: Most respondents rated this drawback as very high of value supporting the idea that one of Cloud Computing's most prominent drawbacks is the data confidentiality in terms of the level of access that can be allowed to firm data to non-authorized users.
- The need to outsource computer services: The highest number of ratings was on Moderate, followed by low which is only 1 respondent less than moderate, suggesting people

viewed this drawback as moderate or low in risk. This supports the assumption that most of Cloud Computing's drawbacks are not very risky.

- Need for an efficient internet service: The results show that the highest number of rating was on very high showing that most respondents viewed this as a drawback with a very high value. This result puts weight on the assumption that due to internet service quality being low in Egypt, applying Cloud Computing may be risky and hard for companies in Egypt.
- Data bottlenecks must be considered and resolved to avoid cost buildups: The results show that most respondents viewed this drawback as high in value.

Results received from this question were 3 very high rating averages, 1 high and 1 moderate suggesting that the drawbacks of Cloud Computing carry a relatively high risk to the respondents especially in terms of data security, as supported by literature. The answers from this question acted as a means to address the problem statement regarding the risks and barriers preventing companies in Egypt from applying Cloud Computing in Supply Chain management.

Regarding the Respondent's Personal Opinions on Cloud Computing System's Drawbacks Minimization Only four of the respondents gave an answer to this question, while the rest did not have a suggestion to give but that data security was a vital issue to be addressed.

The four respondents were:

- The IT supervisor in Carrefour who said that a password protection could be added that does not allow any unauthorized access on sensitive data and requires permission for access
- The ERP Application Consultant in Coca Cola who said that the service provider could create a means for an IT employee within the firm to be the one systemizing the access and activities on the system so that the service provider would not need to access the firm's data thus maximizing security and decreasing need to outsource services.
- The IT specialist in Coco Cola who said that a passcode could be installed on sensitive data.
- The IT specialist in Nestle who said that data security could be increased if service provider could create walls to protect users on the system from accessing information of other users on the same server.

Regarding the Respondent's Support on the Application of Cloud Computing System, it was found that most participants were with the change to Cloud Computing.

These results provided highlighted that Cloud Computing benefits outweigh its risks and that it is considered better than the currently used IT systems. This result provides an answer to the first question of this research about whether the Cloud Computing system is better than the currently used IT system as respondent's support to changing to the Cloud Computing system shows that it must be better in some aspect than the existing IT system. Furthermore, this also provides an answer to the research's question of whether the system's benefits outweigh its drawbacks as the results state that although the system has several significant drawbacks, respondents are still supportive of applying the Cloud Computing system.

7. Conclusions

While analyzing the questionnaires and the answers gained from the semi-structured interviews, it was noted that the currently used IT systems are all desktop ERP systems supporting the researched literature. Additionally, it was also noted within the questionnaires that the lowest rated criteria of the currently used IT system is the cost friendliness, which is in contrast with Cloud Computing which offers cost friendliness as a benefit. Furthermore, it was discovered that for the larger part the Cloud Computing system is not a familiar concept within business around Egypt, particularly anyone outside the IT department. Following that, it was prominent that the benefits of Cloud Computing were mostly rated as a high or a very high by the most respondents of the questionnaire supporting the idea that Cloud Computing has major benefits. On the same note, the highest ranked benefit of cloud computing with most interviewees was the cost friendliness once again in contrast with currently used IT or ERP systems. On the other hand, the biggest drawbacks of the system in the eyes of respondents and managers were the service provider having access to the data, several hosts being on one computes and the reliance on an efficient internet service while the lowest ranked drawback was the need to outsource IT services which can be summarized as the risk of data security which was stated as the biggest drawback of the system by previous literature. Last but not the least, it was discovered that despite the benefits most respondents and managers said that they would support changing the current IT system into a Cloud Computing system supporting the theory that Cloud Computing's benefits outweigh its risks and that it is better than currently used IT systems.

8. Recommendations

Based on the analyzed data interpreted, some recommendations could be suggested regarding the application of Cloud Computing system in companies in Egypt:

- The awareness of new technology in Egypt is very low and this issue must be addressed as advancements in technology help companies achieve their maximum potential in the market and is vital to a firm's performance.
- The drawbacks of Cloud Computing for the most part and including the security matter, can be resolved following steps recommended and therefore the drawbacks as ranked by the respondents can be resolved from the biggest drawbacks as security requires some measures that minimize or even eliminate the risk completely.
- The Benefits of Cloud Computing benefits according to most respondents outweigh the drawbacks as they were supportive of switching the current IT system to a Cloud Computing system which means that the applicability of Cloud Computing to most respondents is positively viewed and therefore possible in Egypt.
- Before applying Cloud Computing in Egypt, further means to protect data security must be developed and research by the service providers and developers and protection against data loss during internet cuts must also be installed in order to ensure the system fits the Egyptian business environment in the most optimal manner keeping in mind the setbacks available in the environment.

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Knowledge management

Integrating social media and warranty data for fault identification: A Cloud-based collaborative framework

name

Details

Abstract

Fault identification during warranty is quite complex because of sophisticated product design and distributed manufacturing. Various supply chain facilities located at diverse geographical locations are usually utilised to manufacture a particular product. If a fault occurs in one component of a product, it may be linked with other components which are procured and manufactured by other segments of the globally distributed supply chain. Hence, in this multifaceted scenario, the information systems have to be integrated and responsive enough to respond proactively in sharing data from heterogeneous systems across the supply chain. To achieve this goal, in this paper, we integrate warranty data from multiple datasets. Initially social media dataset is used. Consumers increasingly engage in information sharing on weblogs, forums, Facebook and Twitter, among others. This valuable information is mostly untapped by the automotive manufacturers. In order to explore the large amount of hidden fault-related data we perform data analytics. Then, we develop a cloud based collaborative framework to manage the warranty data from other supply chain information systems viz. design, manufacture and service. The framework provides integration and access of warranty data from multiple datasets of supply chain. The 'autonomous smart agents' interaction in the framework assist to establish real time warranty data exchange across the supply chain. The combined data can then be used for detailed expert analysis by fault learning and rectification agent. The execution of the framework is demonstrated using an illustrative execution process. Our contributions are clearly detailed and some important managerial insights are provided for warranty management in globally distributed supply chain.

Keywords – Cloud computing technology (CCT); Product Life Cycle Management (PLM); Social Media; Content analysis; Sentiment analysis and warranty management.

1. Introduction

Vehicle faults are of major concern to consumers as well as automotive manufacturers. In the UK automobile industry, which is the focus of this paper, the Driver and Vehicle Standards Agency (DVSA), has issued over 8,400 recalls due to faults in the last decade, resulting in multimillion pound of expense to vehicle manufacturers (DVSA 2016). These faults usually relate to safety, performance, engine, security and quality. The identification of faults by automotive manufacturers is mostly done by their own diagnostics tests, vehicle road tests, inspection and customer feedback (Abrahams et al. 2012). Manufacturers also review warranty claims, dealer reported faults and customer filled complaints in agencies like DVSA. However, we believe that, because of the emergence of social media, a large amount of fault-related information is also hidden in social media. Consumers increasingly engage in information sharing on weblogs, forums, Facebook and Twitter, among others. This valuable information is mostly untapped by the automotive manufacturers.

In the existing literature, social media has been used for business intelligence to, for example, predict stock market volatility (Antweiler and Frank 2004), movie sales (Duan et al. 2008), and power tool equipment faults (Finch 1999). Researches have explored online forums using manual tagging for product quality information (Finch 1999). Vehicle defect discovery has been done by, for instance, (Abrahams et al. 2012). However, the use of social media for fault analysis in the context of distributed supply chain management has gained less attention. Even when social media is used, the existing literature usually applies a single dataset (e.g. twitter, Facebook, weblogs), neglecting the fault information which is scattered across the distributed supply chain.

Hence, data from social media can facilitate initial fault identification. This useful data should then be integrated with supply chain data for detailed and prompt fault analysis. Product Lifecycle Management (PLM) is a 'strategic business approach' which is normally used for managing and integrating the life cycle from design, manufacture, and service till disposal. It is an information and communication technology-driven method which integrates processes, people and business systems. This technological solution could be used to streamline the flow of information across the supply chain (Terzi et al. 2010; Park et et., 2016). PLM architecture is basically built on the philosophy of delivering the right information at the right time. Until now, PLM has played a 'holistic' role of integrating product knowledge because of non-standardized systems (Stark 2005). But recently, due to the emergence of standardized open business information systems, the sharing of information and collaboration across the supply chain has become easier. Srinivasan (2011) summarises some of the key IT developments that might aid data sharing:



1. Standardized product development engineering models such as Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), Computer-Aided Engineering (CAE) and Product Data Management (PDM);

2. Standardized business process systems such as Manufacturing Execution System (MES), Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and Enterprise Asset Management (EAM);

3. Standardized and mature product data and meta data models by STEP (Standard for the Exchange of Product model data);

4. Service-oriented architecture (SOA) i.e. principles of service for information sharing that are independent of any software and technology;

5. Open-source middleware to connect software components or enterprise level applications.

IT developments and standardized protocols paves a way for easy integration of various business information systems from manufacturing design, modelling and execution. Although the PLM concept provides a centralized access to product meta-data, it is still fragmented across the supply chain. Warranty data (which is important for fault identification in manufacturing) is dispersed across the supply chain. All models and techniques proposed in warranty data analysis (WDA) literature are mostly applied on a single database. Therefore, there is a need to integrate warranty data from multiple datasets across supply chain into fault identification system. This will enable the utilization of product knowledge to support internal decisions, as well as the improvement of fault identification across the supply chain. The availability of integrated models for fault identification in distributed manufacturing industry is very rare. In this study, we propose principles of PLM that can be used for the integration of warranty data across the supply chain.

In the past, Cloud Computing Technology (CCT) was used to integrate various segments of the supply chain with minimum resources (Bruque et al., 2016). CCT has shown remarkable results in industries such as banking, healthcare, IT, logistics and so on; (Al-Hudhaif and Alkubeyyer 2011). It is an emerging technology which is built on Service Oriented Architecture (SOA) with layers of open standards. CCT can be used to share information across complex networks. CCT's modular structure allows business functions and processes to be provided as services using pay-as-you-go concept. Several service delivery models of cloud such as Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) have led to easier and real-time information availability. Keeping these attributes of wider cooperation and collaboration in mind, this paper proposes a cloud-based framework.

In light of these preliminaries, the main aim of this paper is to integrate data from multiple datasets of distributed supply chain for detailed and quick fault identification. The proposed cloud-based framework focuses on integration of faults data from social media and manufacturing supply chain. Multi-agent system (MAS) is used for task accomplishment by mutual coordination of autonomous smart agents. The framework comprises of 21 autonomous software agents. These agents are capable of decision-making at various levels without or with minimum human interaction. Three of the agents i.e. supply chain facilitator agent (SCF), fault learning and rectification agent (FLR) and design agent (Di) play a key role in fault analysis. The cloud-based framework facilitates in quick fault identification in short life cycle of products. We evaluate the effectiveness of the cloud framework using faults data from multiple datasets.

In our analysis, we find that social media is very useful for production of faults information related to vehicles. The detailed fault analysis is done using sentiment and content analysis. But in our analysis, we also find that the results may not give a full representation of the population of faults and thus may be biased as per customer sentiments. In order to overcome this, a cloud-based framework is proposed to integrate the warranty data across supply chain for full representation. The warranty management process described here is to simplify the gathering of warranty data from multiple datasets. The combined data can then be used for detailed expert analysis by fault learning and rectification agent. Finally, the execution of the framework is demonstrated using an illustrative execution process.

The reminder of the paper is organized as follows. Section 2 briefly reviews the existing studies on fault identification. Section 3 contains the research questions and contributions while Section 4 explains the use of social media for initial fault identification. Section 5 discusses in detail cloud-based framework. Section 6 illustrates the execution of framework. Section 7 identifies a number of managerial implications which emanate from our study. Finally, Section 8 concludes.

2. Literature Review for fault identification

Over the last decade, extensive research has been done on fault identification in failed products during warranty (Abrahams et al. 2015; Khan et al. 2014). The traditional life cycle of failed products is illustrated in Fig. 1. Here, the manufacturer first procures various components of the product from multiple suppliers, and assembles them in assembly units. The products are then distributed to customers through various regional retailers and distributors. Often, it is only when the customer receives the product that the faults are identified and returned to service centres (Wu and Meeker 2002).

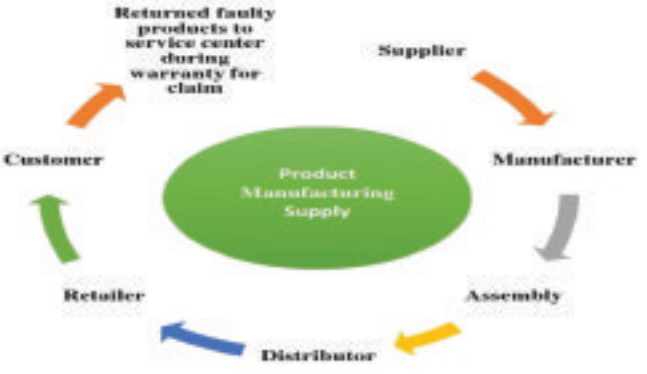


Figure 1: Life cycle of failed products

The returned faulty products are checked as per warranty for claims. Generally, the reliability literature assumes that warranty claims can be gauged using a single dataset. However, this assumption might not hold in today's distributed manufacturing where complex product data is stored in multiple datasets. In this distributed scenario, there is a need for extensive warranty data analysis from multiple datasets of distributed manufacturing in order to find the main cause of the fault.

2.1 Warranty Data Analysis (WDA)

Blischke et al. (2011) analyse warranty from the reliability viewpoint. They use warranty data and prediction methodologies to identify component failures. Thomas et al. (1999) develop a complete framework for analysing warranty cost and warranty policy. Wu and Meeker (2012) and Shafiee and Chukova (2013) have categorize WDA into five areas:

1. Early detection of faults. Here, several techniques and methods have been developed. Karim et al (2001) use nonparametric estimation for the mean number of failures in repairable and non-repairable products. Wu and Meeker (2002) apply statistics and statistical detection rules by Poisson distribution estimation. Honari and Donovan (2007) use control charts using artificially generated data and warranty claims data;

2. Design modification. This is very important for improving the reliability of products. Yang and Cekecek (2004) devise a design improvement method on the basis of warranty claims data and design susceptibility. Buddhakulsomsiri et al. (2006) and Buddhakulsomsiri and Zakarian (2009) use warranty databases. Both of these studies apply rule-based reasoning on warranty data to identify warranty problems;

3. Field reliability estimation. This is done on the basis of the manufacturer's warranty policy. Warranty policies are categorised as one-dimensional (1D) on the basis of age or usage only and two-dimensional (2D) on the basis of region in the 2D plane i.e. one dimension depicts age and the other, usage. Researchers have analysed one-dimensional approach for warranty policy using mixed distribution, Weibull distribution, mixed-Weibull regression, non-homogeneous Poisson process, parametric and non- parametric pseudo-likelihood, covariate and lifetime distribution (Majeske 2003; Ion et al. 2007; Wilson et al. 2009; Suzuki 1985; Oh and Bai 2005; Attardi et al. 2005). Methods used to analyse two-dimensional approach to consider failure models in 2D warranty policy include marginal, bivariate and composite scale (Baik and Murthy 2008; Chukova and Robinson 2005; Jung and Bai 2007);

4. Warranty claim prediction. This is used to analyse warranty claim cost during warranty coverage time. The techniques that have been developed to predict warranty claims are lifetime distribution, stochastic processes, artificial neural networks and time series models (Kleyner and Sandborn 2005; Majeske 2007; Kleyner and Sanborn 2008; Rai and Singh 2005);

5. Warranty claim estimation. Kalbfleisch et al. (1991) use a log-linear Poisson model, where the Poisson parameter is considered as a function of time in service; Lawless et al. (1992) use a Moment estimator for counting warranty claims in single product; Suzuki et al. (2001) and Karim et al. (2001) use non- homogeneous Poisson process (NHPP) to calculate warranty claims in repairable products; and Hu and Lawless (1996) use nonparametric analysis on warranty claims when observation period of a product is unknown.

The literature review shows that fault identification in complex products is difficult and complicated because of the distributed nature of warranty data. WDA techniques and the statistical methods mentioned above use single dataset which are not that much successful in distributed manufacturing. The complexity of today's products and inter-related components (subsystems) makes the identification of faults difficult (Khan et al. 2014).

Our central argument in this paper is that there is a great need of integrating data from multiple datasets of supply chain for quick fault identification. Combined knowledge/ data should be used by designers and engineers when using already developed warranty identification methods, engineering techniques and tools to identify and solve complex product design/technical faults. Cloud Computing Technology (CCT) is a relatively new technology that can be adopted to integrate the whole manufacturing supply chain data on a manufacturing company's own private cloud. Various deployment and service delivery models make the adoption easier for big as well as for small and medium sized enterprises (SME).

3. Research questions and contributions

In this paper, we tackle two main research questions:

1. Do social media contain substantial information related to faults during warranty?

2. Is the integration of warranty data from multiple datasets important for detailed fault analysis in a complex distributed manufacturing supply chain?

We make four main contributions in this paper. First, we extract large volume of social media data. Second, we evaluate these for fault identification using sentiments and content analyses (Section 4). Third, we design a cloud- based framework to integrate warranty data from multiple datasets of supply chain (Section 5). Finally, we elucidate the whole fault identification process using an illustrative step-by-step execution procedure (Section 6).

4. Use of Social Media Data

To identify faults during warranty, we explore social media data in the UK automobile industry. Our selection of the automobile industry for testing the framework is based on following criteria. First, we attempt to elucidate initial identification of faults during warranty. Second, we scrutinise the cost implications of faults during warranty period. Third, we explore customer perception about the fault rectification process during warranty. Fourth, we gauge the competence of dealers with respect to fault identification and rectification. It should be emphasised that this is currently not feasible in light of the fact that fault identification data tends to be scattered on different segments of the supply chain (Wiengarten et al. 2013, Thun & Hoenig 2011). We argue that this issue is important as it can have implications for both customer satisfaction in terms of prompt fault identification and manufacturer's profitability1. Unfortunately, attaining access



to warranty/ fault data is challenging. More specifically, vehicle dealers and manufacturers are not willing to provide access to their warranty data because of commercial sensitivities. In addition, there is the issue of the Data Protection Act 1998 (DPA) in the UK, which governs how personal information is handled by, among others, firms.

We sidestep the lack of availability of warranty data by utilising social media sources (Abrahams et al. 2013; Abrahams et al. 2012, Mostafa 2013). Social media is defined as a group of internet-based applications build on the ideological and technological foundations of Web 2.0 that allows the communication exchange of user- generated content (Kaplan and Haenlein 2010). Increasingly, social media such as Facebook, weblogs, microblogging and Twitter play a key role in shaping business analysis and decisions. Social media have shown a drastic growth in user counts, comments and tweets in scientific analysis (Stieglitz and Xuan 2013). As a result, huge volume of user-generated data is available for business analytics. However, navigating through these huge volumes of scattered and unstructured data requires various approaches including, filtering, sentiment and content analyses, tagging, text mining and so on (Stieglitz and Xuan 2013; Chae 2015; He et al. 2015).

4.1. Social media analytics framework for fault identification

Collecting data from Facebook requires application programming interface (API). The most frequently used API for Facebook is "Graph API". Secret API key is used as access token to extract Facebook data. It provides easy tracking of wall postings (i.e. comments). Weblogs do not have standardized method such as API for extracting data. However most of the blogs offer Rich Site Summary (RSS) for extracting metadata. If RSS is not available then manual web-crawling can be done, which requires HTML parsing (Stieglitz and Xuan 2013). The collected data could be unstructured (texts, expressions etc.) and enriched metadata with user profiles, URLs, or 'likes' (Daniel et al. 2010). In this study, Graph API and web-crawling is used to extract the data from: (i) the complaints department (CD) Weblogs website2 and (ii) vehicle companies' official UK Facebook (FB)3 pages. Using these two sources, we extract faults data during warranty for a period of one year, i.e. July 2015 – July 2016.

As highlighted above, navigating through this rich and unstructured social media data requires various research methods and intelligence techniques (Fan and Gordon 2014; Abrahams et al. 2015). With this in mind, we employ the following methods – business intelligence (BI), content analysis (CA) and sentiment analysis (SA). The results of the analyses help us to identify faults in vehicles. The framework is shown in Figure 2.

4.1.1. Business Intelligence

Business intelligence techniques are valuable to harness product or process information from multiple perspectives: customers, competitors, suppliers, markets, acquisitions and services to achieve success in competitive global business (Vedder et al. 1999). To gain understanding about products, firms gather intelligence from consumer complaints (Sampson 1996). The Internet or Web 2.0 is an online information technology that can enrich business intelligence (Chau and Xu 2012). Given the magnitude of available information and data, it is important to apply appropriate approaches (e.g. content analysis) to extract meaning (Stieglitz and Xuan 2013; Chae 2015).

4.1.2. Content Analysis (CA)

Social media data is "unstructured" which is composed of texts and expressions. Content Analysis can be adopted using various text mining techniques to extract intelligence from large volume of textual data of Web 2.0 (Chae 2015). Comments from Facebook and weblogs are composed of short list of words, URL, images and some other information. Text mining applications are mostly used for extraction, theme tracking, concept linkage, information visualization and content filtering (Abraham et al. 2012). Text mining is an important component of CA to analyse textual data and extract business intelligence (Abraham et al. 2012). Text mining transforms unstructured textual data into structured formatted data using text capturing techniques of tokenization, n-grams and the removal of unnecessary words (Chae 2015). The structured formatted data is then used for word frequency analysis, key word analysis using machine learning algorithms like association and clustering analysis (Chae 2015). Word analysis is the first step in CA. Word analysis includes term frequency analysis (TF), document summarization and clustering (Chae 2015). For information retrieval, TF is combined with n-grams to extract key phrases from the structured formatted data. The unsupervised machine learning algorithms such as clustering assists in analysing the topic of interest from the structured formatted data.

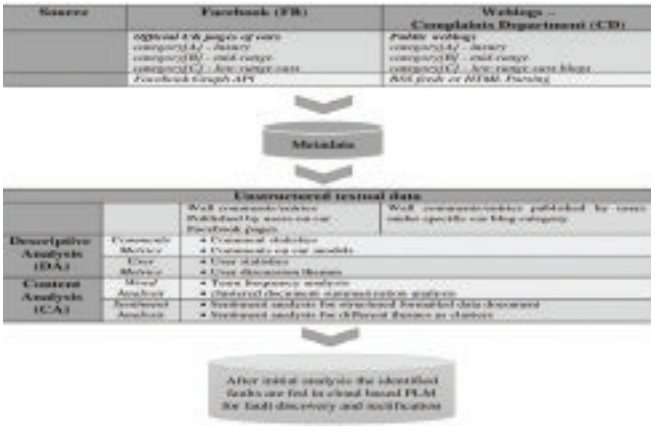


Figure 2: Analytics Framework for fault identification

4.1.3. Sentiment Analysis (SA)

Sentiment analysis is the detection and analysis of subjective information such as opinions, sentiments, emotions, products, problems, faults, complains and services (Pang and Lee 2004; Li and Wu 2010; Liu 2010). In sentiment analysis,

1 For example, there is evidence that Volkswagen's revenues and customer satisfaction dropped as a result of the recent emissions scandal (see Ewing 2016).
2 http://www.complaintsdepartment.com/companies/
3 As the data is unsolicited, it does not invoke ethical issues but nonetheless we have secured ethical clearance.

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polarity of positive, neutral and negative text is extracted from structured formatted data (Pang and Lee 2004). Dictionary such as WordNet is a powerful tool to analyse the strength of the sentiments expressed with synonyms and antonyms (Miller et al. 1990). Sentiment analysis can be performed either on the whole structured formatted data document or the document can be divided into different themes as clusters. Some small number of sentiment words are collected as seeds manually from the structured formatted data. Synonyms and antonyms of these words then are searched in the online WordNet dictionary. The words are combined as a word set with repeated iterations until no new words are found. Sentiment analysis is done by giving a score to the sentiment in a sentence (Hu and Liu 2004).

4.1.4. Summary

So far, very few studies have been done with particular focus on fault identification in vehicles for business intelligence using social media. Researches have explored online forums by manual tagging for product quality information (Finch and Luebbe 1997). Others, such as Abraham et al. (2012), examine vehicle defect discovery using text mining approach on online-forums. In particular, they use vehicle expert feedback for defect discovery and remedy planning. However, in today's distributed manufacturing, vehicle fault is not just fixed by analysing data from social media. It needs to be analysed in the context of integrated data from the whole vehicle manufacturing supply chain. Social media data, therefore, can help in initial fault identification process during the warranty period. This data can then be integrated with the supply chain data for detailed fault analysis.

4.2 Methodology

The ideal approach to better understand the reporting of vehicle faults is to undertake empirical study of social media (Flynn et al. 1990) i.e. Facebook and weblogs. In this study, we extract data pertaining to July 2015 – July 2016 from Facebook and weblogs (such as complaints department). The original raw dataset includes 51,467 comments and their metadata.

4.2.1. Data Sampling

In our sampling, we employ a range of criteria to classify the data. First, we classify the vehicles discussed in social media into three categories. Category [A] is luxury, category [B] is mid-range and category[C] is low-range vehicle. Next, we code the data under five themes as inclusion criteria:

- Types of faults during warranty: Vehicle is sold with particular warranty. The customer experiences some faults during the warranty period which they then report to the dealer or main manufacturer. An example of fault during warranty was:
- Comment: "the brake squeal issue on our last one had the brakes stripped, cleaned and bedded ok but didn't make a difference so further sound bytes were taken and it's been ruled new callipers are needed. This was after 2 months/900 miles"
- Faults and cost implications: Some faults during warranty are covered but some are charged as service, depending on the liability. An example of fault with cost implications was:
- Comment: "fuse box where it is prone to moisture and water penetration due to its position? The cost of a replacement can cost anything up to £600!"
- Customer perception about fault rectification: Customers express certain 'feelings' about their vehicle after having experienced faults and rectified during a specified period. An example of customer perception was:
- Comment: "like other German manufacturers, living on name and past reputation. Cars are too complex and costly when they go wrong and manufacturers ought to stand by their products if they fail prematurely. Not fit for purpose. Is there any recall issues on this Audi in question?"
- Customer's perception about dealer competence: Perception of customers depends largely on the service they get from the dealer. Proper and cost effective fault diagnosis plays a key role in shaping the customers' perceptions about dealer competence. An example of dealer competence was: Comment: "had disgraceful customer service experience at Audi Epsom. Complained to Audi UK who I thought would resolve the issue quickly as it was a new car however Audi UK's customer service is just as bad as the Dealership, I will never buy an Audi ever again and warn you not to use Audi Epsom"
- Junk (i.e. expressions with no faults reporting): It includes the expressions of vehicle enthusiast, joy, photos, requesting new vehicle model information, general vehicle service questions, vehicle customisation and modifications questions. An example of junk comment was: Comment: "myself and quite a few fellow Ford enthusiasts are looking into the availability of repair panels for the Ford Sierra (all variants)."

4.3. Results and evaluation

898 useful comments were filtered out of a total of 51,467 comments from the two sources (CD and FB), respectively. In what follows, we first elaborate on the data (Section 4.3.1). Following this, we conduct sentiment analysis (Section 4.3.3)

4.3.1. Descriptive Analysis

The selected comments discuss some 29 unique vehicle models. A total of 3,189 users mention vehicle faults and perceptions about their vehicle or dealer. The average comment contains 617 words expressed in 27 sentences. 179 (37%) of the words are unique and most of them contain, on average, 5 characters.

4.3.2. Content Analysis

In this study, we apply two types of CA: word analysis and sentiment analysis. Word analysis includes term frequency analysis (TF), document summarization and clustering (Chae, 2015).

Word analysis: Most popular words in CD comments are: change (3,306), active (2,560), instrument (2,543), going (2,523), take (1,866), events (1,759). On the other hand, popular words in FB comments are: change (30,943), act (19,577), get (17,795), move (16,443), make (15,673) and transport (12,587). The other common words in both datasets are shown in Figure 3.



Figure 3: Word analysis from CD and FB datasets

Types of faults during warranty

A close inspection of both data sources reveals that there are 233 faults which customers point out during the warranty period. The most common 25 faults mentioned are summarised in Table A1 in Appendix A. Across both data sources, category [A] vehicles (i.e. luxury) account for the bulk of reported faults (61.42%), followed by category [C] (21%) while category [B] vehicles have the lowest figures (17.42%). So in terms of engine design, complexity and reliability, category [A] vehicles are more prone to common faults (during warranty) as compared to the other two categories. This is consistent with our a priori expectation.

Fault and cost implications

The two data sources also capture the costs incurred by customers as a result of the faults. A total of 53 faults with costs reported during the warranty period. The combined average costs reported from both sources are as follows:

£1,534 (category [A]), £2,203 (category [B]), and £613 (category [C]). Thus, the data suggests that the repair costs of mid- range vehicles (i.e. category [B]) are, on average, higher than the two other categories. As expected, low- range vehicles (i.e. category [C]) are the cheapest to repair (See Table 1).

	Category [A]	Category [B]	Category [C]
Average Cost CD	£1685	£1675	£627
Average Cost FB	£1401	£2731	£600
Combined Average Cost	£1534	£2203	£613

Table 1: Fault vs average cost

4.3.3. Sentiment Analysis

In this section, we want to explore whether there is any link between (reported) faults and customer satisfaction. There are various tools and techniques of SA that could enable us to capture customer sentiment. For our purposes, we use the algorithm suggested by Thelwall et al. (2011) to cluster the sentiments on the basis of time period. Our broad objective is to solicit information regarding customer perception about fault rectification and customer perception about dealer competence.

Customer perception about fault rectification

The comments on customer perception about fault rectification during warranty are clustered on the basis of time period for fault rectification. The criteria for clustering are:

- Very good (+2) : Fault rectified within a week
- Good (+1) : Fault rectified within 1 month
- Average (0) : Fault rectified within 1-2 months
- Bad (-1) : Fault rectified within 2-3 months
- Very bad (-2) : Fault rectified in more than 3 months

After the clustering process, we use the sentiment words in WordNet (Section 4.1.3). Figure 4 shows customer sentiments about fault rectification at the (aggregated) dataset level (i.e. both sources)

Customer perception about dealer competence

The comments on customer perception about dealer competence during warranty are also clustered on the basis of time period. The criteria for clustering are:

Very good (+2) : Dealer was very competent

Good (+1) : Dealer was very competent

Average (0) : Dealer was ok

Bad (-1) : Dealer was bad

Very bad (-2) : Dealer was very bad

After the clustering process the sentiment words were used in WordNet (Section 4.1.3). Figure 4 shows the customer sentiments about dealer competence at the entire dataset level (CD and FB)

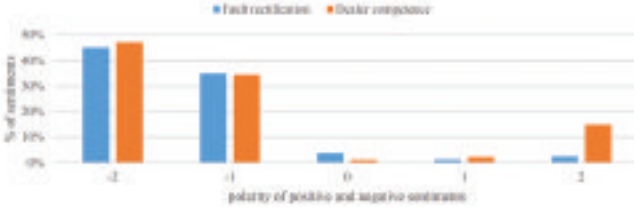


Figure 4: Sentiments of customers about fault rectification

5.3.4 Summary of key lessons and current practices

The above simple data exercise underlines some important issues in fault identification during warranty. First, faults do occur during warranty and these faults tend to affect all types of vehicle categories (Table A1 in Appendix A). Category [A] vehicles are more prone to faults while category [B] are least prone to faults. Second, both fault identification and rectification have cost implications for customers. In particular, category[C] vehicles are cheaper to repair as compared to other two categories (Table 2). Third, fault identification and rectification can be a tedious and lengthy process. The longer the time period it takes to rectify the faults, the more costumers become unhappy (Figure 4). Finally, the competence of the dealer in identifying and rectifying faults is crucially important. The least competent dealers tend to receive higher negative sentiments (Figure 4).

The key lesson emanating from the above data exercise is that a lot of vehicle fault data is hidden in social media. But the data fails to represent full population of faults. Also the customer sentiments for vehicles and faults stand biased. In order to overcome this issue, integration of warranty data from multiple datasets of supply chain data is important for full representation. The integrated data will enrich manufacturers in quick identification of faults. Integration of warranty data has been studied in detail by Gonzalez and Marquez (2012). They proposed a framework for industrial company after-sales services. Dai et al. (2012) have explored warranty management in the context of centralized and decentralized supply chain for maximizing profit.

However, to the best of our knowledge, there are very few integrated warranty data systems or frameworks that integrate data from distributed supply chain. High-tech industries are the hardest hit industries because of distributed manufacturing. The cost of warranty management is on the rise (Chakraborty 2015). Fault claims can consume a sizeable portion of their revenues. The main factor in the identification process is that, it is complex and time consuming to find the root cause of fault in distributed manufacturing. The fault which occurs in one component of a product may be linked with other components which are procured and manufactured in other segments of the distributed manufacturing supply chain. The non-availability of supply chain warranty data results in slow processing of fault claims. Recently, Madenas et al. (2016) have proposed a system architecture for automotive industry by integrating PLM systems. They designed the system using Unified Modelling Language (UML). The main aim of the system is to find the root cause of fault by integrating warranty data across the supply chain. But the system fails to have full representation of warranty data as semi-structured expert interview method was used as a data source.

In order to overcome these issues, we propose a cloud-based framework to manage the warranty data from supply chin systems viz. design, manufacture and service. We use a private cloud deployment model because of confidentiality and the need for greater control of data. Thus, within our framework, the infrastructure is hosted on manufacturer's own private cloud. SaaS delivery model is used to provide services to supply chain stakeholders across the distributed manufacturing. The stakeholders access and retrieve centrally available data from the private cloud. They also upload data through the usage of SaaS. This centrally stored data from multiple datasets is then used for fault identification and decision making.

5. Cloud-based Framework

The conceptual model is shown in Figure. 5. The manufacturer hosts the entire infrastructure over its cloud. Due to data confidentiality and security reasons, the manufacturer employs a private cloud deployment model. This framework comprises of two multi-agent based subsystems i.e. supply chain and manufacturing, which are integrated through interface agent. Both subsystems are explained in detail in Section 5.1 and 5.2, respectively. These two subsystems access product-related data, warranty data from cluster of cloud databases through discovery agent. SaaS delivery model is adopted. SaaS provides easier access to resources as it uses thin-client or a web-browser. All the needed software and subsystems are installed over the cloud. SaaS provides access to manufacturing private cloud for sharing, retrieving and updating product-related data.

The proposed framework provides supporting structure to the distributed manufacturing industry with sophisticated technological requirements and scattered standardized product data. It could help in WDA via integration of warranty data, field data, service data, and customer feedback, manufacturing measurements from supplier, manufacturer, assembly, distributor, retailer, field testing centre and service centre level. The subsystems are designed in general context so they could be applied to any industry e.g. aircraft, defence, automotive and high tech electronics.



Figure 5: Conceptual Cloud-based Framework

5.1. Multi-agent Based Supply Chain Subsystem

The multi-agent based supply chain subsystem provides access to supply chain stakeholders (service centre, field testing centre, customer, distributor and retailers) as show in Figure 6. The subsystem comprises of multiple software agents that can solve problems in a distributed and decentralized global manufacturing environment (Akkermans et al. 2003; Kamil et al. 2012; Zhou et al. 2013). These software agents are intelligent computers or machines that work autonomously to solve complex problems. In the supply chain subsystem, these software agents facilitate interaction among stakeholders i.e. service centre, field testing centre, customer, distributor and retailer. The main purpose of having cloud based multi-agent supply chain subsystem is to provide collaboration, interaction, exchange and sharing of product data among all stakeholders. The private cloud of the manufacturer provides access to stakeholders by using SaaS. Software agents and their respective functionalities as services are briefly summarised in Table A2 in Appendix A.



Figure 6: Data flow in multi-agent based supply chain subsystem

5.2. Multi-agent Based Manufacturing Subsystem

The multi-agent based manufacturing subsystem is shown in Figure 7. The multiple software agent concept (as in supply chain subsystem) is also applied in manufacturing subsystem. Agents with dynamic roles and responsibilities have been designed to do relevant jobs. The private cloud of manufacturer provides access to stakeholders using SaaS. Software agents and their respective functionalities as services are briefly summarised in Table A3 in Appendix A.

Design Agent (Di) and Fault Learning and Rectification Agent (FLR) are the key agents for fault identification in the proposed framework. These two agents will be discussed here in more detail.

Design Agent (Di)

Di agent holds product designs in various design formats i.e. CAD, CAM, CAE and so on. Di agent converts CAD, CAM and CAE into standardized format i.e. extensible mark-up language (XML).The XML-based design files are then stored in cluster of cloud databases. Di agent is shown in Figure 8. In step one, designers send design files in CAD, CAM or CAE format to data format definition databases. After getting the required data format definitions, the appropriate files with inferential definitions are forwarded to a software application (SA) bin in step 2. The software application bin comprises of databases of various software applications like CAD, CAM, CAE etc. The application engine, which is in software application (SA) bin, converts the design files as per rules laid down in engine. The converted files are then sent to cluster of cloud databases in step 3 through DA. If the designs or data formats for products/parts are required by stakeholders, then the XML files are compiled and formatted in sequence. The formatted files are then transmitted to supply chain stakeholders i.e. supplier, manufacturer, assembler, service centre and filed testing centre through DA.

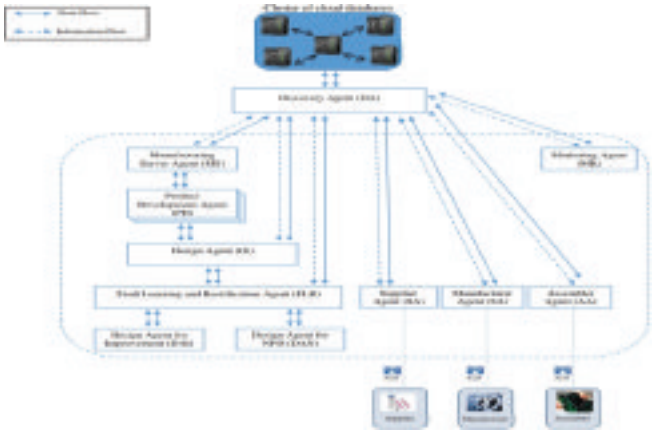


Figure 7: Data flow in multi-agent based manufacturing subsystem

Fault Learning and Rectification Agent (FLR)

FLR is the main agent for identification of faults in existing/ new products (Figure 9). FLR retrieves data from cluster of cloud databases such as warranty database, extended warranty database, filed performance database, service centre and customer feedback database, parameters database, manufacturing measurement database and knowledge database. It combines the gained knowledge, background knowledge, design and manufacturing engineer's expert knowledge to plan experiment by adopting 13-step approach of Coleman and Montgomery (1993). The problem can properly be defined by adopting 13-steps and relevant information is extracted from cluster of cloud databases. Various methods and algorithms could be adopted for fault solutions. Some of the salient ones in the literature are 0-1 mathematical traditional integer program solver, heuristic approaches such as genetic algorithms (GAs), tabu search

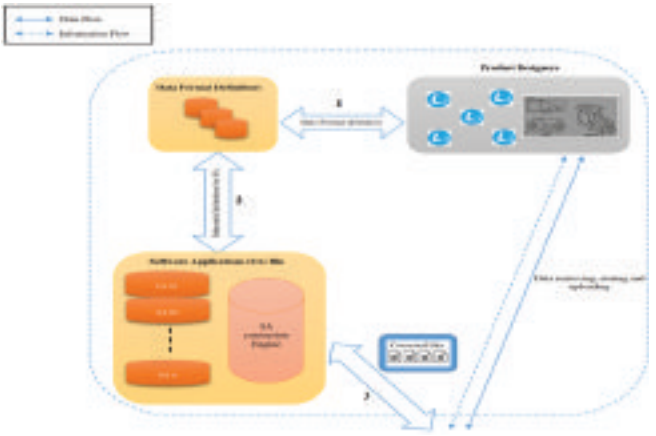


Figure 8: Design agent

(TS), bean search (BS) and hybridized genetic algorithm (HGAs). According to the literature, there is no specific search algorithm which can be regarded as best suited for a particular problem. The selection of a specific algorithm depends on the nature and type of the problem. Keeping this in mind, FLR uses a portfolio of algorithms (Gomes and Selman 2001). It is a collection of different algorithms or copies of them which run on different processors. The main point is to select the algorithm that meets most of the requirements. Portfolio of algorithm approach minimizes the computational cost and also increases fault solving capability (Kumar and Mishra 2011). New problem instance initiates the portfolio of algorithm system. Time limit is allocated to provide the solution to the fault with priority. As a first step, allocation agent assigns an experimentation time to various algorithm agents and accordingly decides priority order to algorithm agents (Kumar and Mishra 2011). The experimentation data collected by algorithm agent will be brought back to selector agent. Selector agent will decide about the algorithm in portfolio to solve the problem (Kumar and Mishra 2011). In the specified time limit, multiple iterations are made in order to make a decision about the final selection of an algorithm agent solution (Kumar and Mishra, 2011). The work flow of the portfolio algorithm, as shown in Fig. 6, is adopted from Gomes and Selmon (2001); Kumar and Mishra (2011); Mishra et al. (2012). The sorted list of recommendations for fault solution are then forwarded to design agent.

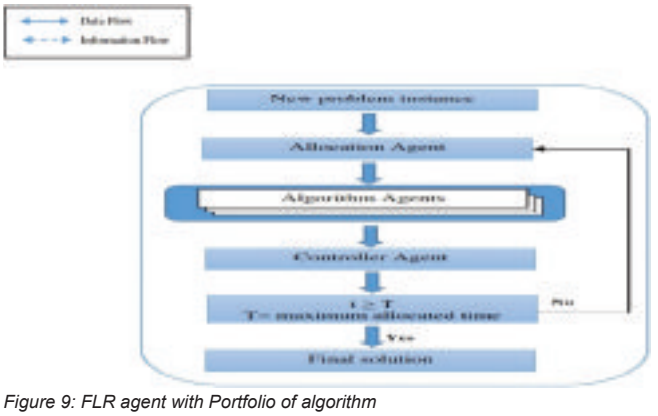


Figure 9: FLR agent with Portfolio of algorithm

There are two common agents between two subsystems i.e. discovery agent (DA) and interface agent (IA). Functionalities of these agents are as follows:

Discovery Agent (DA)

DA provides all agents access to cluster of databases over the cloud. DA holds detailed information about location of databases. It helps in updating and retrieving data from relevant databases.

Interface Agent (IA)

IA facilitates interaction of two subsystems i.e. manufacturing subsystem and supply chain subsystem. Both subsystems interact with each other using agent communication language (ACL).

The following section contains a step-by-step execution of our cloud based framework.

6. An illustrative Cloud-based Framework

In this section, we briefly illustrate the execution of the framework described in Section 6. The framework could be applied to any complex distributed manufacturing industry. We use an illustrative case study for fault identification in the automobile industry. We assume that the company has global service and field test centres for fault identification.

Steps of multi-agent interaction for fault identification in the framework are explained as follows:

Step 1: The customer agent (CA) reports a fault to the GS agent through social media.

Step 2: The GS agent forwards the fault to the regional service agent (SA) through DF agent

Step 3: The service agent (SA) contacts the customer and does initial identification of the fault and uploads the fault in framework through SaaS. The fault report is then forwarded from service agent (SA) to gateway service (GS) agent through directory facilitator (DF) agent.

Step 4: Gateway Service agent (GS) receives SA fault report and checks through warranty agent (WA) for validity of warranty. If warranty is valid then the request is forwarded to the supply chain facilitator agent (SCF), otherwise reported back to SA that the product/part is not under warranty.

Step 5: Supply chain facilitator agent (SCF), after receiving the request, extracts meta-data from cloud based STEP PDM database and forwards the same to service agent (SA) via SCF. The service centre repairs the faulty part as per recommendation in the meta-data. If the fault is not reported before then it is forwarded to manufacturing subsystem via SCF.

Fault identification in manufacturing subsystem involves a number of sub-steps as explained below:

Sub-step 5.1: Fault report for product/part in manufacturing subsystem is received by manufacturing server agent (MS) through interface agent (IA). MS agent then forwards the fault report of product/part to product development agent (PD)

Sub-step 5.2: PD agent creates a new PD agent for the fault received for specific product/part and then sends it to the design agent (Di)

Sub-step 5.3: Di agent receives the product/part fault report from PD agent. Di agent retrieves product/part details i.e. meta-data from STEP PDM database through discovery agent (DA). The product/part meta-data and fault report is then forwarded to design agent for improvement (DAI)

Sub-step 5.4: DAI forwards fault report to fault learning and recommendation agent (FLR). FLR agent extracts all data relating to fault from cluster of cloud databases. The gained knowledge, background knowledge, design and manufacturing engineers expert knowledge is combined together to plan experiment. On the basis of planned experiment portfolio of algorithms (See section 5.2) finds possible solution to the fault by running collection of different algorithms. On the basis of recommendations from FLR, DAI does improvement in product/part design and forwards the updated fault free designs to Di agent.

Sub-step 5.5: Di agent rechecks the improved design in coordination with MK and MU agent. Di agent also seeks recommendations on the basis of costing and manufacturing resource availability. If the costing is ok as per marketing and availability of resources then manufacturer forwards the updated designs to PD agent, otherwise it is sent back to DAI for further improvement in design on the basis of costing and manufacturer resource availability.

Sub-step 5.6: PD agent then updates the improved design of product/part in STEP PDM database, manufacturing process database, design and knowledge database. Finally, closes PD request for product/part and forwards the same to MS agent.

The procedure for fault identification in product/part by interaction in manufacturing subsystem ends here.

Step 6: SCF receives improved fault free design from manufacturing subsystem. The recommendations of product/part replacement / rectification is sent to GS agent.

Step 7: GS agent forwards fault solution or product/part to SA.

7. Managerial Implications

This paper proposes a framework that integrates data from multiple datasets for the identification of faults during warranty. The whole supply chain is integrated through the central platform of the manufacturer by utilizing services of CCT. The proposed framework can be very useful for managers of large as well as for small and medium sized enterprises who have limited resources, infrastructure, IT awareness and operational experience (Yeboah et al. 2014. This framework, not only saves money in implementation, but also provides easy and prompt real time access to any form of data by accessing SaaS from manufacturer's private cloud (Guo et al. 2014; Lin and Chen 2012). The manufacturer's private cloud maps all supply chain stakeholders. Stakeholders can use SaaS to upload customer feedback, service centre data, field test data, manufacturing data such as order details, production/manufacturing data, threshold limit checks data and quality control checks data. This can help in mitigating fault identification. In addition, it leads to a lesser dependency on requesting related data in distributed manufacturing. For example, the framework can help managers in tracing the relevant faulty component provided by specific stakeholder across the distributed supply chain. The integrated data facilitates detailed fault analysis. Our study can improve the



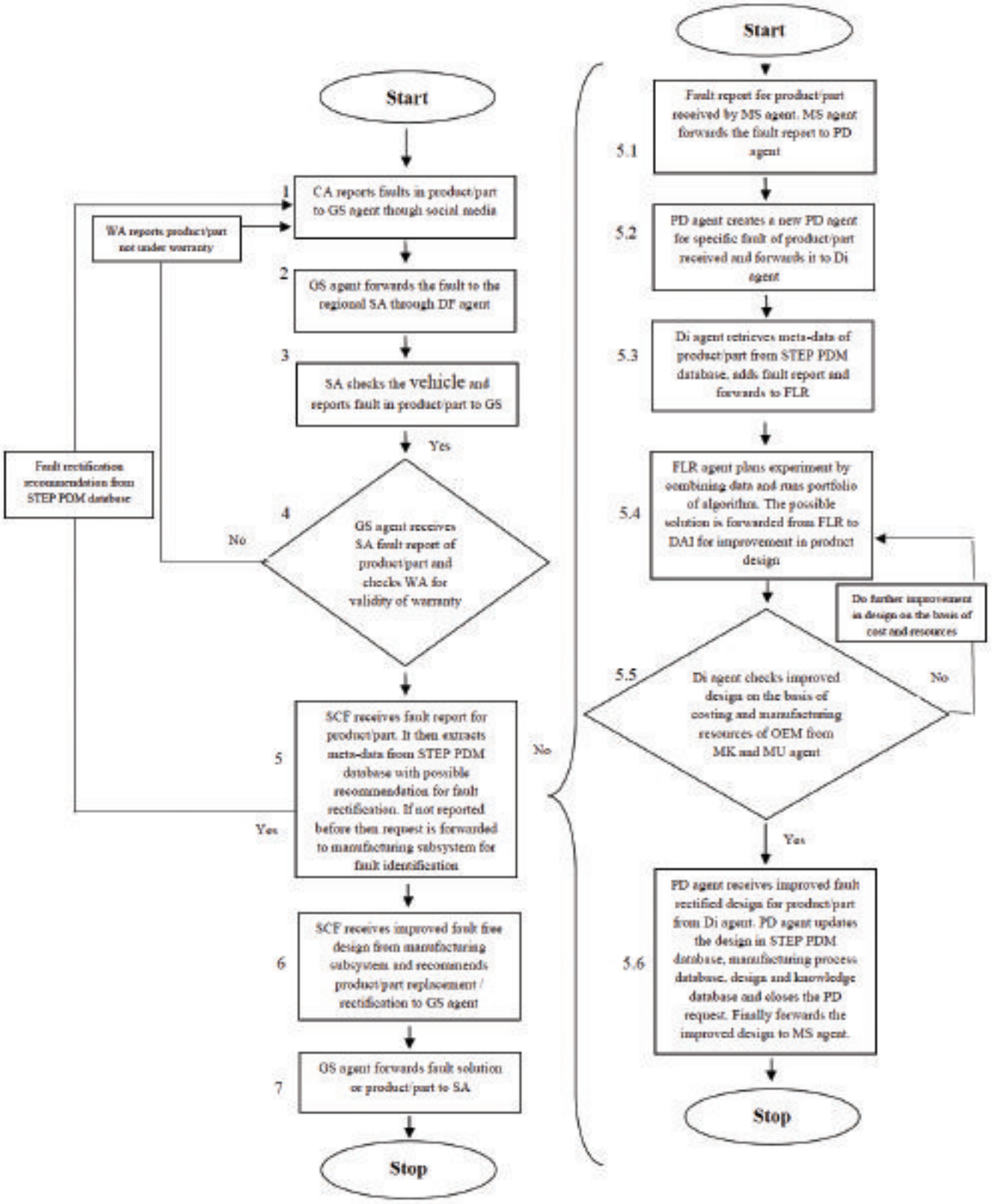


Figure 10: Flowchart for Fault Identification in product/part

conventional method of fault identification where the faults are analysed using a single dataset. The integration of data from multi-datasets concerning the whole supply chain can help managers in effective fault identification. For example, we demonstrate how the social media data can help in prompt start of the fault identification process. Thus, the framework has the potential to promptly identify faults, improve customer satisfaction and performance of the industry. The traceability of faults also becomes easier because of the information visibility aspect of CCT. This will not only help the customer to have feedback about the fault in their product but also help managers in tracing the fault.

We argue that our proposed framework makes fault identification easier by effective integration of warranty data. Moreover, managers can continuously monitor the progress of faults and their remedy. Moreover, the faults data stored in the cloud repository could assist engineers, designers and decision-makers in making robust products in the future.

8. Conclusion

Currently, there is some interesting literature and models available for fault identification during warranty. However, the business world is getting more and more agile, competitive and dynamic, so the emergence of new frameworks with technological improvements and management theories can make a difference. The proposed framework uses the PLM concept which is technology solution that could be used to streamline the flow of information across the supply chain. The framework achieves the aim of integrating multiple datasets across the distributed supply chain for initial fault identification. Private cloud deployment model is adopted by manufacturer because of confidentiality and greater control of data. Infrastructure is hosted on manufacturer's own private cloud. SaaS delivery model is used to provide services to supply chain stakeholders across the distributed manufacturing. Social media is utilized for initial fault identification and finally fault recovery by integrating the data with framework.

The following objectives have been attained. First, we extracted large volume of social data for fault analysis in vehicles. Second, we evaluated these for fault identification using sentiments and content analyses. Third, we designed a cloud-based framework to integrate warranty data from multiple datasets of supply chain. Finally, we elucidated the whole fault identification process using an illustrative step-by-step execution procedure. As shown throughout, our framework facilitates the mapping of the entire supply chain using CCT through autonomous smart agents, real time information visibility, prompt fault identification and collaborative decision making. We posit that our framework can boost coordination and make business processes more efficient. The framework is designed in a general context so it can be applied to any distributed industry. Future research is required, however, to develop automated business intelligence tools and effective algorithms to analyse data in a cluster of cloud databases for fault identification and effective warranty management. This can help in further exploring the vast and valuable amount of datasets which are growing at an exponential level because of the emergence of integrated systems and social media.

9. Declaration

A rough concept of the paper was presented in International Conference on Business, Economics, Management and Marketing (ICBEMM 2016), Oxford University, Oxford, August 15 – 17, 2016.



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ERP supporting job satisfaction and creating the innovative user in Australia and the UK: A case study evaluation

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Abstract

The purpose of this research is to address the phenomenon that organisations invest heavily in enterprise resource planning (ERP) yet many projects are not successfully assimilated, and organisations are unable to fully exploit the benefits.

It comprises of a literature review and a case study of two organisations one from Australia and one from the United Kingdom. Both organisations use the same ERP. Qualitative methodology is used to collect and analyse the data collected and therefore interpretive. The case study supports the literature that if the ERP is flexible and users can tailor it to their use without losing integrity and consistency of service. It shows that increasing job satisfaction then leads to higher productivity and the innovative user which allows sustainable benefits to be realised. It forms part of the emerging literature of the and offers recommendations how sustainable benefits can be achieved from ERP.

The research is a newly explored area comparing one ERP system in use in the same industry but two countries and two different organisations. Providing insight which can be used by organisations when implementing digital transformation or ERP. Identifying how innovative users support evolution and create sustainable benefits of ERP use, which contributes to distinction and competitive advantage. The case study presents a cross functional interdependency on the ERP a which creates self- managed assimilation.

Addressing a gap in the literature using case study evaluation of one ERP across different countries in the same industry and touches further on the importance of the users in successful assimilation. This research is limited by means of time to include more organisations and represent more countries in the study. It only makes observation of one specific ERP from only two organisations which represent only two countries. The case studies provides two examples of successful assimilation and can be used to give validity to the existing and emerging research in the topic area. Key words: ERP, Assimilation, Innovative user, sustainable benefits.

1. Introduction

The focus of this research was to identify and evaluate the benefits that enterprise resource planning systems (ERP) can bring to an organisation and how these benefits can be realised and contribute to a sustainable competitive advantage.

By using existing literature combined with case study evaluation to identify the benefits and how they are realised. This research evaluates two Small Medium Enterprises (SME) in respect to their ERP assimilation and the benefits that have been realised. The organisations are from the international removal industry and were carefully selected to ensure that the levels of service were consistent with one another and that they both used the same ERP system. The organisations are based Australia and the United Kingdom and work in partnership with one another and are multi branch operations.

2. Literature review

This section provides an introduction to ERP and the benefits it can provide. The common factors of success and the barriers to success are. Insight to the gaps in research and how the research intends to address these with the case study.

The economic climate dictates that organisations must consistently produce more with less to maintain market share and competitive advantage (Bangert, 2013). In its origins ERP would be found only in large corporations but it is now common place in SME's (Cukur & Svensson, 2016). One way in which organisations have chosen to achieve this is to implement an ERP system (Jinno, Abe, & Lizuka, 2017; Stratman, 2007; Nandi & Vakkayil, 2018).

Despite the high cost and investment (Eid & Abbas, 2016) some organisations are failing to realise the full benefits of ERP and resort to finding ways to circumnavigate the system and work outside of the ERP (Wyslocka, 2017).

Literature review presents that ERP failure is high (Akkermans & van Helden, 2002; Kanaracus, 2017; Ravasan & Mansouri, 2015; Shao, Feng, & Hu, 2017; Xu, Ou, & Weiguo, 2017). Given its high cost and company wide disruption to the organisation during implementation (Nandi & Vakkayil, 2018) it is a decision that an SME can ill afford to get wrong.

Benefits

ERP use has increased, the objective being to integrate the organisations functions, share common data in real time to provide cross functional cohesion and automate processes

(Jagoda & Samaranayke, 2017). It is understood that ERP assimilation provides a positive effect on organisational performance (Xu et al., 2017) this performance is increased as employees improve the way in which they use the ERP (Gattiker & Goodhue, 2005) this then provides distinctive use of the ERP and can be used to gain distinctive outcomes (Porter,1996).

It has been suggested that the focus of ERP has changed from functionality but to that of strategic importance (Singh, 2018) and to achieve competitive advantage organisations should learn how to strategically use ERP to gain this advantage (Porter, 1996).

Xu et al., (2017) postulate that if ERP receives the commitment of both financial support and time spent learning the capability of the system, in the pre-implementation phase and ongoing support then there is a positive effect on ERP assimilation which in turn has a positive effect on the performance of the organisation.

Organisations must find unique ways to efficiently use ERP to gain distinction in the market place (Porter,1996), in the endeavour to achieve competitive advantage the focus of ERP has changed from functionality to strategic importance to provide organisations the ability to be more collaborative and responsive (Singh, 2018). ERP should be able to provide organisations with agile solutions to adapt to their changing needs (Bangert, 2013).

In summary the table below offers the expected benefits of ERP derived from literature.

Benefit	Author
Cross functional data flow in real time	Jituri, Fleck, & Ahmad, 2018; Bendoly, Rosenzweig, & Stratman, 2009; Jagoda & Samaranayke, 2017.
On time delivery	Jituri, Fleck, & Ahmad, 2018.
Integrated planning	Bendoly et al, 2009; Jagoda & Samaranayke, 2017
Integrated resources planning	Bendoly et al, 2009
Greater efficiency	Jinno, Abe, & Lizuka, 2017; Stratman, 2007; Nandi & Vakkayil, 2018; Cukur & Svensson, 2016
Increase productivity	Jinno et al; Stratman, 2007; Nandi & Vakkayil, 2018; Lengnick-Hall & Lengnick-Hall, 2006
External engagement	Madapusi & D'Souza, 2012; Bendoly et al, 2009
Automate process	Jagoda & Samaranayke, 2017
Simplify process	Cukur & Svensson, 2016; Jagoda & Samaranayke, 2017
More responsive	Singh, 2018

Table 1 Expected benefits of ERP

Usability

Existing literature describes the need for ERP to be flexible and support the strategic outcomes of the organisation whilst meeting the users' needs to promote job satisfaction (Rezvani, Khosravi, & Dong, 2017) and the need to provide real time useable data to support management decisions. All of which is to meet the current operational need for the business and overcome the resistance to change.

Successful ERP assimilation has a positive effect on firms' performance (Xu et al., 2017) and this improves as employees use the ERP in different ways to enhance tasks and processes (Gattiker & Goodhue, 2005).

Usability has been attributed to be the most important factor to employees (Scholtz, Mahmud, & Ramayah, 2016), contributing to their job satisfaction (Liere-Netheler, Vogelsang, Hoppe, & Steinhuser, 2017) and in turn their productivity (Lengnick-Hall & Lengnick-Hall, 2006). The ERP system should support the work that is to be done to avoid circumnavigation of the system (Wyslocka, 2017), workarounds or customisation (Beijsterveld & Groenendaal, 2016).



Figure 1 Usability and its contribution to achieved benefit

To maintain their ability to provide competitive advantage to organisations it is essential that ERP vendors remain current with new innovations. Kanaracus, (2017) argues that the ERP vendors could do more to support organisations by way of customisation and implementation in the normal lifecycle of ERP and maintaining current focus.

The initial uptake of the ERP system drops significantly after implementation (Zhang et al., 2011; Rezvani et al., 2017) this drop results in circumnavigation and informal workarounds in place which affect the integrity of the output of the ERP (Wyslocka, 2017).

The offset of this is that there is a decline in user satisfaction and as Liere-Netheler et al., (2017) conclude that usability is the highest determining factor of job satisfaction and the work to be done is supported by the system. Supporting this Rezvani et al., (2017) state that perceived usefulness and user satisfaction determine continued use and the users intentions.

The importance of job satisfaction being that it affects employee behaviour, if this is positive then a happy work force is a more productive one and thus a competitive edge for the firm (Lengnick-Hall & Lengnick-Hall, 2006).

The largest successes have been found when the ERP is aligned with the desired strategic outcomes of the organisation (Bendoly et al., 2009) with top management support (Gattiker & Goodhue, 2005; Gupta, 2000; Jagoda & Samaranayke, 2017; Ewout & Hilletofth, 2018). Xu et al, (2017) conclude that successful assimilation is down to ownership type and the support of top management providing continued support and training in the early stages following implementation.

Research gaps

While there is a plethora of literature pertaining to the implementation of information systems that literature specifically dealing with assimilation and its contribution to competitive advantage is only just emerging (Ali & Miller, 2017; Xu et al., 2017). This research provides opportunity to gather a deeper understanding of this.

Further to the work of Xu et al., (2017) there lies a gap in of assimilation of a single industry, existing research has taken samples from a cross section of indutries who in the mainstream are manufacturing and who do not use the same ERP this research addresses this to provide deeper insight

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into one industry. While the use of a single industry and one ERP provides a narrow focus it offers a depth of comparison not already available.

This research gathers data from both Australia and the UK and forms comparison of the same ERP system in different organisations and countries.

Organisational issues have been linked to ERP failure, yet this has not been fully researched (Jagoda & Samaranayke, 2017;Kaveh, Aloini, & Karimzadeh, 2018). This piece of research will attempt to partially fill this gap and explore these issues as part of the case study.

This research explores organisation success based upon ERP assimilation level and the effect that different management techniques and organisation strategy have on this (Xu et al, 2017). It addresses these issues with its case study and offer some recommendations to for best practice to achieve the desired outcomes and overcome barriers to success.

3. Methodology

Qualitative analysis has been chosen for the collection of the primary data. The data was collected via nineteen semi structured interviews. This method was used for the value it offered to the explanatory and evaluative nature of the research (Saunders, Lewis, & Thornhill, 2016). This type of interview allowed for flexibility as respondents were from varying parts of the business and had different experience and length of service within the organisations. The semi structured interviews allowed for interviewees to be probed further on certain topics relevant to their role and level of experience in the organisation or on a point as necessary.

Some interviews were more difficult than others to conduct however in general all interviewees were happy to participate and actively responded to the questions posed. The interviews were conducted over four locations as two branches of each organisation were involved in the research. This provided opportunity to understand if there were differences within the organisations based on their locality, as Wyslocka, (2017) stated the ERP must meet the needs of multi branch organisations and their idiosyncrasies. The interviews were conducted in person in the UK and via video link for the interviews in Australia.

The literature review formed the basis for the questions used in the interviews. This literature was tabulated alongside the responses of the interviewees to identify common themes and patterns which could then be analysed to achieve the recommendations.

To evaluate assimilation this research identified the expected benefits then evaluates the extent at which these benefits are realised in the case study and the effect they have on operational efficiency. Research links the success of the initial implementation to consequent success (Jagoda & Samaranayke, 2017). This research explores implementation and the reported recommendations in contrast to how implementation was conducted in the organisations. The findings of these questions are then evaluated in respect to the level of assimilation in the organisations.

Limitations

While the research provides opportunity to close the existing gap in research pertaining to assimilation of one ERP in one industry, it is a small sample which only addresses two countries and two organisations out of the 162 organisations worldwide who use the system. As it only addresses a single industry when using the recommendations Managers should use them in context and with respect to the organisations own goals and objectives.

It is relevant that the ERP is industry specific so while it is an off the shelf package it has been developed for the removal industry rather than a broader audience as the larger more well - known ERP packages such as SAP and Oracle. This provides that while the results are meaningful it must be held in context when applied to other industries.

4. Findings and Analysis

As the literature seems to be at odds if vendors should do more (Bjelland & Haddara, 2018; Kanaracus, 2017) or if it is organisational issues (Shao, Feng, & Hu, 2017; Liu, Feng, Hu, & Huan, 2011) which contribute to the failure of ERP assimilation. Questions were posed to deduce the organisational culture, management support and vendor support and their effect on ERP success.

Recommendations are then made based on the performance of the organisations in contrast to the existing literature. The research chooses specifically the international removal industry and those companies who utilise the same ERP system. This presents data from across the globe and provides comparison of the same system in different organisations, identifying the benefits that are gained by the level of assimilation of the ERP and the value it contributes to the organisations strategic goals. Evaluating if there are identifiable differences present in various branches of the same organisation and between the organisations.

The data collected from the interviews conducted with the two organisations has been compared to the literature and identifies where the case study agrees with or differs in its opinion. In respect to the ERP life cycle and if the ERP in the chosen case studies delivers an integrated solution to the operation and are there benefits realised from its use and what those benefits are. Can the organisation create distinction in the marketplace by using the ERP and what or who drives this?

It was overwhelming that 100% of respondents reported that they felt that the ERP in place was successful and a good fit for their considering that the reported failure rate of 60-70% (Kumar et al, 2009).

It emerged that there were four types of user these are shown in figure 4.1 and explained below:

- Strategic Users: Directors and managers using the knowledge the ERP provided
- Innovative user: using own experience and others to enhance the way ERP was used provides support to others
- Transactional user: daily user: does as instructed: employee
- Super User: This type of user had developed an in-depth knowledge of the system and could be innovative or strategic

The level of user spanned more than one group, there were strategic users who were also transactional

managers who used the ERP only for what they required and innovative users who were managers and those who were employees.



Figure 2 User type

The combination of user type offers a collaborative and cross functional approach to evolution and change. Another benefit that it offers is communication flow between top management and users who could use the ERP as means to innovate.

The cross functionality of the ERP and the level to which it has been integrated has created an interdependency whereby all departments rely upon each other to use the ERP appropriately. As a result, the uptake and assimilation is self-managed as if one person circumnavigates the ERP it is easily recognised.

The organisations are fully reliant on the ERP to complete the day to day work and state that they are unable to work without it. This drives the use and the innovation of users to lean their processes and increase their own productivity. Their processes are deeply embedded in the system and they can see the benefits so take ownership and ensure it is used correctly. As a respondent said "…it's not just to make the process more efficient to reduce head count but also to ensure that they get their lunch and can go home on time…" UK organisation respondent 1.

If users do not embrace the ERP their job is more difficult and so is the next persons. In the event of a problem it is possible to see where the process has not been followed and whose responsibility it is.

Value of the research

This research identifies the benefits that can be realised and offers recommendations to organisations as to how these benefits can be achieved and how the ERP can be exploited to achieve a sustainable competitive advantage. It contributes to the existing research of ERP assimilationand implementation and addresses a gap that exists of case study evaluation of one industry across two countries and one ERP system.

5. Conclusion

It is determined that the case study is successful and while it is vital that the limitations are considered it is possible to learn from this success and how it is achieved.

The innovative user

Literature provides that user acceptance was crucial to successful implementation and assimilation and that change management was a critical success factor (Shao et al., 2017; Rezvani., 2017; Gattiker & Goodhue, 2002). The case study found that there were innovative users in both organisations that would offer feedback with regards to the ERP and how it could be more effectively used. Top management from both organisations supported this process to move forward.

The most significant finding is that of the innovative user and the organisations harnessing those innovations from the users and incorporating their ideas into everyday processes. Having this innovation combined with top management support provides for more efficient processes which results in higher productivity and job satisfaction.

The innovative user represents one way in which the resistance to change can be reduced. A crucial point with reference to innovative users is that while the organisation is pursuing efficiency it is not with the intent of reducing headcount but also to allow opportunity and time for innovation. Achieving efficiency through increased productivity and job satisfaction so employees can find the time seek opportunity to improve the service delivered to the clients. This attitude leads to openness of knowledge sharing and users offering suggestions for efficiency as they don't see their jobs being placed in jeopardy. In the same token ERP vendors must remain current with new innovations to maintain their ability to provide competitive advantage to organisations.

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Information exchange in supply chain management: Social media as an enabler

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1. Introduction

In today's competitive economy, supply chain executives are embracing extended supply chain networks to meet the objectives of supply chain management (SCM), which requires supply chain partners to work in an integrated manner (Saban et al., 2017). To strengthen supply chain integration (SCI) and achieve sustainable competitive advantage, a high degree of supply chain partnership is vital (Lambert et al., 1996). Studies suggest that information exchange enables both internal and external SCI (Lotfi et al., 2013), and is determined by the type of data exchanged and "willingness of sharing" (Chae et al., 2005). The benefits of information exchange is achieved only if strategic information is shared and understood correctly, which requires a high degree of communication, collaboration, trust and long-term relationships between supply chain participants (Prajogo and Olhager, 2012).

With the innovations in information technology (IT) and the advent of web2.0 (the second generation of World Wide Web) and user generated contents (UGCs) (publicly available media content created by end users), social media received its prominence (Kaplan and Haenlein, 2010). Social media fosters collaboration and communication which is a prerequisite for strategic information exchange (Ellison and Boyd, 2013; Ellison et al., 2015a). Consequently, this allows supply chain participants to make informed and collective decisions that contribute to organizational performance and competitive advantage (Wu et al., 2014). Thus, the objective of this paper is "to examine the role of social media in building long-term relationships and trust in SCM and present the research agenda".

2. Literature review

The literature review consists of two main sections. The first main section (2.1) supply chain management, starts with the widely cited definition by CSCMP to present the objectives of SCM and the need for SCI. Subsequently section 2.2.1 explores the topic of information exchange and present its significance in SCM. The topics of trust and long-term relationships are further examined to understand its consequence in information exchange (section 2.1.2). The next main section (2.2) presents the literature review on social media to explores its significance in enabling information sharing (section 2.2.1) and discusses the elements of various relational ties and trust (section 2.2.2). in the paper, the terminology 'information exchange' is used interchangeably with 'information sharing'. The next subsection explores the existing literature on social media in the SCM context. This paper presents the research gaps and research questions to set the research agenda (section 3) before conclusion.

The topics for literature review were chosen based on the relevance of this paper and the context of social media in information sharing. The relevant collection of literature identified for this review is carefully selected from major databases which include science direct, emerald insight, IEEE, wiley online library etc. The most common keywords used for literature search include supply chain management, supply chain integration, information exchange, social media, supply chain relationships etc., and these keywords were used individually and combined for the search.

2.1. Supply chain management

A plethora of definitions on SCM proposed by many academics are available in existing literature (Lambert and Enz, 2017; Mentzer et al., 2001; Shukla et al., 2011), examining these is not within the scope of this study. With many extant definitions, there exists a lack of common understanding on SCM. We examine the comprehensive and widely cited definition by CSCMP (2013) which covers the contemporary aspects of SCM:

Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies.

A definition of logistics management is appended which follows:

Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements.

CSCMP (2013) discusses "boundaries and relationships" emphasising SCM as an "integrating function" that links "major business functions and processes within and across companies" into a "high- performing business model". There is a specific emphasis on the different flows in the definition of logistics management. The significance of SCM as an "integrating function" and a "management of relationships" is notable for this study. Sweeney's (2011) consensus definition gives precisely the same point in fundamental three and fundamental four. Studies suggest that setting clear SCM objectives provides more focus towards achieving long-term relationships and sustainable competitive advantage, which can distinguish organizations in terms of cost and value advantage (Christopher, 2016; Sweeney, 2011).

Thus organizations need to engage with a "total systems perspective" (Mentzer et al., 2001) signifying the need for both internal and external integration (Sweeney, 2011). This can lower various operational costs and improve managerial efficiencies which may create structural changes to organization resulting in new supply-demand networks (Lambert et al., 1996; Sweeney, 2011).

2.1.1. Information exchange in SCM

Information exchange is the key characteristics of an integrated supply chain and has become more significant to organizations (Koçoğlu et al., 2011). The bullwhip effect Forrester (1958) can be kept away if demand and production forecasts data is available among supply chain participants (Dell and Fredman, 2002). Developments in ICT allows supply chain executives to increase the volume and complexity of information exchanged (Evangelista et al., 2012), and have a significant impact on supply chain performance (SCP) and effectiveness. This allows firms to make better decisions in both strategic planning and operational activities (Prajogo and Olhager, 2012).

Many managers consider information exchange as a technological issue, and have failed to achieve the desired information sharing capabilities and collaboration (Fawcett et al., 2007). This is due to lack of "willingness to share", which requires long-term and trusted relationships (Fawcett et al., 2007; Prajogo and Olhager, 2012). Nevertheless, some companies treated information exchange as being closely linked with organizational culture and behaviour, focusing on better relationships to raise information sharing levels (Fawcett et al., 2007). Information integration is effective only when firms understands the exchanged information, which is acquired through a long-term learning process (Prajogo and Olhager, 2012). This study presumes technology as just a tool to encourage and enhance information exchange, furthermore "willingness to share" is considered to bridge the gap (Fawcett et al., 2007). Willingness to share occurs when a partnership exists with a long-term strategic relationship, trust and commitment (Cagliano et al., 2003). The consequence is that, supply chain members tend to share operational and strategic information in a timely manner which helps in reducing inventory costs, decreasing order cycle and improving supplier service level (Kanda and Deshmukh, 2008).

2.1.2. Trust and Long-term relationships in supply chain management

Mentzer et al. (2001) provides a substantial emphasis on relational factors in SCM and claims that a fruitful supply chain should aim for long-term strategic partnerships. Studies show that many organizations struggle on the soft aspects of information integration (Kanda and Deshmukh, 2008), which suggests that firms need to connect socially (Prajogo and Olhager, 2012). Prajogo and Olhager (2012) show that long-term relationships boost collaborative practices, and stresses the significance of strong relationships in information integration. Empirical research shows that all relationships are not true partnerships unless they exhibit mutual trust, shared risks, shared rewards and openness, and only such partnerships can make channel more efficient to achieve a better business performance than which would be achieved by firms individually (Lambert et al., 1996). Studies suggest that relationships are key factors for establishing trust and commitment (Tsanos and Zografos, 2016). Saban et al. (2017) claims that supply chain collaboration is achieved when people, process and technology of a firm is successfully integrated (Figure1).



Figure 1: An integrated approach to supply chain collaboration; Source: (Saban et al., 2017)

Successful SCM is the outcome of high-level trust and commitment among supply chain participants fostered by information sharing. Kwon and Suh (2004) reported that many strategic partnerships were unsuccessful due to lack of trust among partners, as information exchange involves confidential data (Bowersox et al. 2000). As a result, decision-makers tend to spend a lot of time and effort analysing partner's credibility, reliability and reliability instead of optimizing their operations, thus increasing the transaction costs (Kanda and Deshmukh, 2008). Coherent decision-making helps in resolving conflicts among supply chain members handling any case of future uncertainty (Kanda and Deshmukh, 2008). If supply chain partners exchange information openly with a long-term perspective on the trusted relationship, there may be a reduction in the opportunistic behaviours (Cooper et al., 1997).

2.2. Social media

Social media, based on the foundation of web2.0 and UGC (Kaplan and Haenlein, 2010), has empowered individuals to connect, share and collaborate (Hanna et al., 2011). Web2.0 defines how organizations use the world wide web as a platform to connect people and "harness collective intelligence" (O'Reilly, 2005), while the term 'user generated content' signifies the way in which people make use of social media, and describes various publicly available and creative media content created by end users (Kaplan and Haenlein, 2010). Social media displays a participatory culture (Storey et al., 2014) and allows users to socialize (Kaplan and Haenlein, 2010). They include content sharing sites (e.g. YouTube), blogs, social networking sites (SNSs) (e.g. Facebook), micro-blogging platforms (e.g. Twitter) collaborative projects (e.g. Wikipedia) etc. (Kaplan and Haenlein, 2010). The outcome of social media engagement is building relationships, opportunities to collaborate (Boyd and Ellison, 2007; Kaplan and Haenlein, 2010) and to facilitate collective decision-making (Kehl, 2017).There are privacy concerns associated with SNSs (Boyd and Ellison, 2007), the options provided by SNSs may not have the flexibility for users' to handle confidentiality of their profile (Preibusch et al., 2007).

Social media is increasingly being used by companies for marketing and promotion, brand building, and to get wider reach to customers, subsequently benefiting business growth (Arora and Sharma, 2013). Supply chain executives

asked, if there will be a B2B impact or opportunity due to social media usage and suggests that the social media data can be converted to meaningful information based on which relationships can be build (CILT, 2015). The study by (Hines, 2018) indicates that many companies are utilizing social media capabilities to improve their operations through co-creation of information, relationship building, and working collaboratively to expand their business and networks. Privacy concerns associated with SNSs have caused many companies to adopt enterprise social networks (ESNs). Ellison and Boyd (2013) states ESN as a form of SNS that is used internal to the organizations and are formally sanctioned by the management. They include Yammer, Tibbr, Jive etc. and mimic many features from SNSs like facebook or twitter. In addition to relationship building, information exchange, issue resolution etc., ESNs are used for project management, and tasks coordination within teams in organizations (Riemer and Richter, 2012). There are proven examples for the usage of ESNs in organizations like the use of 'Communote' by Communardo and 'Yammer' by National Australian Bank (NAB) (Riemer and Richter, 2012).

2.2.1. Information sharing in social media

Social media (both SNSs and ESNs) allows enhanced sharing of knowledge and resources among members (Lee et al., 2014) and can gather information from crowd (wisdom of crowd) to mitigate any potential distortions in information (O'Leary, 2011). The functional representation of social media presented by Kietzmann et al. (2011) allows firms and individuals to monitor and analyze the identity, presence, networks and relationships, reputation and social media activities of individuals and businesses. Several studies reveals the effect of social media in knowledge sharing and observes that relational factors drive knowledge exchanges in social media (Beck et al., 2014; Leonardi, 2015). Information exchange between firms and between employees within firms benefits from innovative performance and can increase trust and relationship quality between members (Cui et al., 2018).

2.2.2. Trust and relationships in social media

Relationships and trust are social exchange theory (SET) based issues, that are significant to identify the beliefs of partners in building an alliance (Wu et al., 2014). According to SET social interaction is based on the expectation of reward and assumes that attitudes and behaviours can be evaluated by rewards of interaction minus cost of the transaction (Wu et al., 2014). Trust reduces transaction costs associated with information sharing (Laaksonen et al., 2009) and improves the quality of interactions, cooperative involvement, and commitment to a relationship (Kwon and Suh, 2005). Dwyer et al. (2007) notes trust as a critical factor for information sharing and development of new relationships, and is strongly related to information disclosure (Metzger, 2004). Studies provide evidence of trust existing between facebook members, whereas developing new relationships was prominent among MySpace members (Dwyer et al., 2007). Studies of interpersonal exchange situations confirm that trust is a prerequisite of self-disclosure, as it reduces apparent risks associated with revealing private information (Metzger, 2004). Similarly, inter-organizational trust encourages positive attitudes and behaviours among business partners Ireland and Webb (2007), therefore, an essential element of the social capital.

2.2.3. Social media in supply chain management

Several studies reported that SCM is falling behind in utilizing contemporary technologies to resolve business problems, and social media has a very low penetration in the supply chain industry (Markova and Petkovska-Mirčevska, 2013). Use of social media in SCM allows access to supply chain wide data (O'Leary, 2011) that can provide many advantages, such as quicker response to demand changes, networking and the identification of new partners, collaboration, increased visibility of the entire supply chain and understanding one's position in the industry (InboundLogistics, 2016).

(Gonzalez, 2013) says that supply chain managers are reluctant in the adoption of social media in their business, due to the misperception they have on the social media affordances and, the failure to visualize its benefits. Better understanding of the role of social media in SCM, can help supply chain managers to get over the primary obstacle (Gonzalez, 2013). Many businesses have started harnessing the power of social media for both their internal and external operations. Hines (2018) references the use of twitter by Adidas to manage their business units across the globe and to meet the supply requirements necessary to provide match balls for FIFA world cup. Many studies highlights the significance of social media in an enhancing organization's SCM activities and indicates that, social media can improve communications with all participants in the supply chain, increasing visibility of entire supply chain (Casemore, 2012; Fournier, 2015).

3. Research gap and research questions

Previous sections clearly articulates the significance of information exchange in SCM and the importance of trust in long-term relationships (2.1.1; 2.1.2). However, most of the studies have focused on the technological front and have largely ignored the social side of information exchange in SCM, which shows a gap in the existing literature. It is evident that information sharing and building relationships and trust are the major outcomes of social media usage (2.2.1; 2.2.2). The benefits of social media in organizational context (non SCM) was also discussed in previous section (0) which signifies the importance of social media as an enabler of SCI through strategic information exchange, relationships and trust. Section 2.2.3 shows that there exist several non-academic literatures on the use of social media in SCM, which indicates that this is clearly an interesting and important topic in practical aspects, and there is a lack of academic research in this area which shows another gap. Section 2.2.3 indicates that the role of social media may not be well understood by most of the supply chain practitioners as there is a failure to visualize its benefits. Though this paper presents a larger gap in the context of usage of social media on information exchange in SCM, to present the research questions, we mainly focus on the gaps in social aspects of information exchange i.e. relationships and trust. The development of research question is as follows.

Studies present the benefits and barriers of information exchange in a SCM context, especially its effect on the SCM objectives (Lotfi et al., 2013; Prajogo and Olhager, 2012). Most studies have explored the impact of ICT on information exchange, relationships and SCP (Evangelista et al., 2012),

on the technological aspect, nevertheless the social aspect is largely ignored (Prajogo and Olhager, 2012), which presents a gap. This gap presents our first research question.

1. Does collaborative communication and timely exchange of information through social media in SCM helps in better inventory management?

Several studies suggest that trust and long-term relationships are crucial factors for open exchange of strategic information which results in SCP (Mentzer et al., 2001; Sweeney, 2011). Some other studies have mentioned a few other factors that contribute to information exchange, but not in supply chain context (Kanda and Deshmukh, 2008; Prajogo and Olhager, 2012). However, none of the researches tries to identify the antecedents of significant information exchange in a supply chain context with regard to social media interactions. This gap frames our second research question.

2. What are the enabling factors that contribute to significant information exchange through social media among supply chain participants?

The use of social media in B2C scenario for promotion, marketing and customer service have proven successful to establish relationships between organizations and their customers (Arora and Sharma, 2013). Similarly B2B organizations use social media to manage their internal functions, to coordinate daily tasks and for knowledge sharing (Riemer and Richter, 2012). Such collaboration, coordination and information sharing fosters relationships and trust between employees within the organization (Ellison et al., 2015b). The fact that strategic information exchange requires intense communication (Kwon and Suh, 2004), and social media is a platform for powerful communication, forms the basis of the next research question. The collaboration and communication feature of social media can be extended to inter-organizational context in SCM to encourage trust and long-term relationships between supply chain partners (Ellison et al., 2015b). Thus, we present our third research question.

3. Does social media communication foster strong long-term relationships and trust among supply chain participants?

Prajogo and Olhager (2012) argues that the degree of information sharing is dependent on the degree of strategic relationships and claims that firms being technically connected doesn't mean that they are also socially connected (Prajogo and Olhager, 2012). The essence of this literature review suggests that social media fosters relationships and trust (Lee et al., 2014). Some studies have attempted to identify the characteristics of long-term relationships and trust to find if long-term relationships and trust are present. Kwon and Suh (2004) presents decision-making behaviour as a measure of trust among partners. However, studies have largely ignored the social and behavioural aspects due to social media in a SCM context, which forms a gap that leads to our fourth research question.

4. What decision-making behaviour is exhibited in the social media interactions between supply chain participants?

By addressing the research questions, we intend to achieve the research objectives 1) to observe and describe behaviours of supply chain participants on social media, 2) identify the role of social media in building long term relationships both upward and downward in the supply chain, 3) understanding the impact of such relationships in supporting decision making and improving inventory management.



Figure 2: Research view
Source: authors

4. Conclusion and next steps

This study reveals the significance of social media in building long-term relationships and trust in the context of information exchange in SCM, which allowed identification of gaps and the development of research questions. This work adopts an investigative approach to develop a deeper understanding of the issues under investigation. The next step is to prepare a detailed research design for the exploratory study to address the research questions and gaps. Considering the nature of this research, a pragmatic philosophical approach will be adopted, which allows methodological pluralism, hence a mixed method will be used: a quantitative content analysis and a qualitative netnographical analysis of data from social media communication. Ongoing research on this topic is carried out by the authors.

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Leadership and management

Leadership in logistics – in pursuit of enlightened management

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1. Introduction

The purpose of my research into the field of leadership in logistics is to present a practical insight for the manager to influence employees' in maximizing their contribution to the organization. The logistics industry is unique in construct, attracting diverse segments of society by virtue of its complexity in terms of skills, disciplines and activities. Managing individuals from such diversity requires that managers are able to recognise individual requirements so that they may act and communicate in a way that compels the employee to surrender their unconditional effort. The intended output of this research is to stimulate debate around the traditional techniques of leadership and management in context of its effectiveness in the 21st Century business environment, whilst also exploring the origin of key attributes and specifically elements that contribute to effective leadership. The research approach undertaken is qualitative in composition, drawing upon my practical findings throughout a career spanning more than 20 years in operational and strategic management within the logistics industry. The approach that I have adopted draws direct reference to the techniques and practices that have been of value in achieving efficiencies through effective leadership and influence.

2. The challenge

During the last 30 years the UK has experienced a significant change to the profile of employees working within the field of logistics. This particular point has been accentuated by the incremental increase in women working in logistics over the years. The Go Supply Chain Consultancy Group noted that since 1979, the number of women working in the logistics sector has risen by a huge 55% and is still on the rise. Further diversity has been seen through the influx of immigrants from the defined EU8 member states, Poland, Lithuania, Latvia, Hungary, Slovakia, Slovenia, Estonia and Czech Republic. The Office for National Statistics indicated that the highest migration from these EU members occurred from 2004 to 2007, (see figure 1). Some of these immigrates immediately sought work in the transport sector as they entered the UK with LGV class I & II entitlement, obtained from their military training through National Service. (Note: National Service was mandatory in Poland up until 2008).

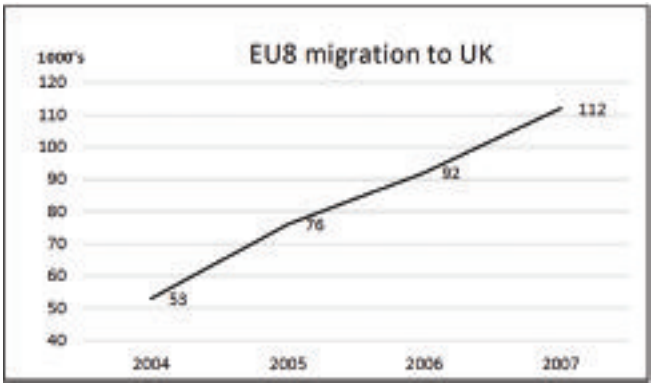


Figure 1
Statistical data from ONS 2018

Job roles within the logistics industry are diverse due to the plethora of activities that are required to deliver a functional supply chain or 3PL/4PL service. Role profiles range from warehouse operatives, drivers, administrators, planners, managers to senior executives and board members. Given the fundamental profile changes to the general workforce across these groups within this sector, management techniques of the past are somewhat outdated and less effective in the modern-day workplace. The practice of a kick to motivate individuals may stimulate an immediate response but is clearly not a sustainable approach according to Herzberg (2003). The historic method of KITA has less impact in today's 'new world' environment whose population has been enriched with shifts in culture and gender. More businesses are actively engaging their employees by adopting a greater emotional intelligence, identifying the individual's fundamental needs and then implementing infrastructure to accommodate these. This paper sets out to articulate in a purely qualitative way, my practical findings of best practice in terms of influencing people to maximizing discretionary effort.

3. Analysis

In the pursuit of defining the chemistry of effective management, Senge, P. (1990) notes that "If employees themselves are not sufficiently motivated to challenge the goals of growth and technical development, there will simply be no growth, no gain in productivity, and no technological development". It may be debated that cultivating motivation drives action and behaviour, but in terms of inspiring an individual to follow, it has been my experience that to follow someone despite agreeing with the proposed instruction is actually rooted at an emotional level. Eleanor Roosevelt, the American political leader and wife to President Franklin D.

Roosevelt supported this principle when she said, “To handle yourself, use your head; to handle others, use your heart.” This has always resonated with me because throughout my career, the most effective results in terms of leading teams of individuals has always been when I have applied what I have coined the 3 L’s, Love, Listen and Learn. I found that an effective way to motivate a person would be to engage with their emotional centre. What better way to achieve this than through love in terms of care and respect.

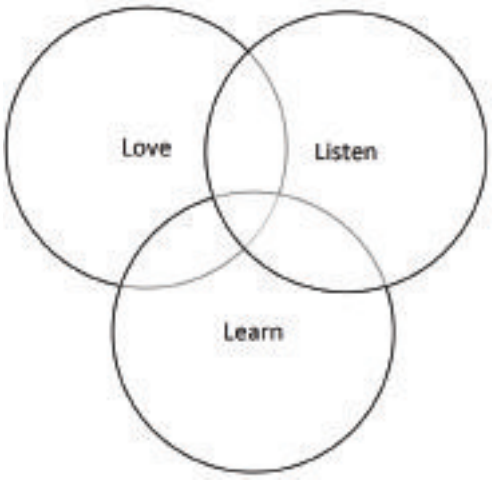


Figure 2 – The 3’L’s to effective leadership

Notably, the transport and logistics profession as indeed many other industry segments have historically been male dominated and it is only within the last 25 years or so has this position changed and evolved. So, the mention of love as an asset to a leader of people in this predominately male orientated environment was frowned upon and to this present day is still at times misinterpreted as inappropriate. If you truly love an individual in the purest sense, you hold their wellbeing at the centre of everything that you do within the business. More than that, you have an innate desire to support their growth, development and achievement throughout their career. Clearly this level of integrity displayed, has an inspirational force that cultivates a high level of trust, respect and commitment. You are more likely to follow someone who you truly believe has your wellbeing and best interests at the centre of every task or request that they ask of you.

Just simply affording an employee time by listening to them can have a profound impact upon performance. Taking the time to listen to someone’s fears, concerns, ideas or even points of view whether personal or professional is extremely powerful in terms of influencing that individual. Communication is one of the key components to effective leadership and it starts with the process of listening. When you commit your complete attention to listen to someone intently, objectively and without interruption it always seems to me to ignite a primeval spark that engenders care and respect. Somehow whether through physical expression or otherwise, there is this transfer of emotion where the duality between individuals dissipates. This then manifests as trust which in turn encourages the individual who has been spoken to, more receptive to listen and maybe accept something that may have been more challenging to communicate had this level of correspondence not taken place. Quite simple and basic but incredibly effective.

Having spent some time managing night shifts where employees are more susceptible to the fatigues that are associated with unsociable hours, my initial approach was to get amongst them and just listen. The plethora of topics would range from family members suffering ill health, complaining about the wife, husband or simply what their plans were for taking the kids on a weekend trip. This time was well invested because taking the opportunity to following up upon previous conversation, for example “How is your mother feeling now?” or “How was the trip to France last weekend?” would clearly demonstrate interest and care and that they had been actually listened to. At this point the duality between management and subordinate starts to erode affording one the opportunity to lead.

The bi product of love and listen naturally provides the opportunity to learn. Learning about the individual but more importantly learning about yourself. Leadership is not a state of being that you just arrive at but actually a state of being that constantly evolves. When you cease to learn you cease to effectively lead. I have seldom come across inspirational leaders who lack the capacity or humility to learn something new. My personal experience has been that I have learned something (mainly about myself) upon every day in the office. The gift of learning has not always managed to fit with the model that I have had about myself which on occasion has been uncomfortable, albeit these events seldom fail to provide an opportunity to change or improve something essential in the way that I have previously thought, spoken or acted.

It has been noted by many teachers that great leaders are also great story tellers. I have often come across this particular notion whereby the author would draw a parallel with Jesus Christ relaying stories to his disciples to teach life lessons or Mahatma Gandhi using stories to illustrate a point of view. Clearly there are many examples that one could cite here in terms of great leaders telling inspiring tales to demonstrate their point in the present situation. My view is that this is another potential example of bringing love into the relationship providing that the intent is motivated from a position of care for their audience.

Having had the opportunity to disseminate many messages to teams throughout my career, I have found this type of communication invaluable. Bringing a little humour into a tough environment through the medium of a story whether fictional or otherwise has always helped to make the situation more tenable and more so increase productivity. It has always surprised me of the way in which various employees have regaled some of these tales years later. Clearly, they must have had a profound impact on the individual at some level at the time. What has always been a fascination to me is the process in which this inspirational spark is implanted into the hearts and minds of individuals. How does it happen? Can anyone do it? Is it an innate ability in the chosen few or accessible to all given the correct coaching and training? In an attempt to understand and answer these questions I have set out the qualities and actions of a leader and the consequences of leadership in the matrix below, figure 3.

Quality of a leader	Action of a leader	Consequence of leadership action
Truthful	Tells the truth in all situations without exception.	Truthfulness engenders love, the most persuasive emotion (reference the 3 L's).
Moral	Subscribes to a strict code of conduct, unconditionally choosing righteous action.	Creates a high level of trust and respect.
Considerate	Demonstrates care and compassion to fellow human beings.	Care and compassion are frequently reciprocated.
Empathetic	Emotionally intelligent to others feelings, needs and requirements.	This level of understanding empowers the individual by providing support and 'soul food'.
Passionate	Enthusiastic about success and failure, demonstrating high levels of energy and commitment.	Invigorates individuals and dispels fatigue.
Courageous	Fearless in every aspect of life experiences and events.	Reassures followers and engenders empowerment and confidence.
Pioneering	Always looking beyond the horizon and challenging what is considered to be normal.	Prevents stagnation and promotes betterment.
Creative	Innovative with an innate desire to evolve.	Stimulates thought processes within others and inspires innovation.
Inspirational	Infuses individuals and teams with enthusiasm and cultivates the desire to be better from within.	Creates a desire within individuals to follow unconditionally and offer discretionary effort.
Focused	Unwavering attention to every individual task and event, past, present and future.	Motivates individuals to understand and get into the fine detail.
Confident	A firm faith and belief in one self's thoughts, words and deeds.	Reinforces credibility and reassurance.
Intelligent	The ability to assimilate events and data to use this information in making informed decisions.	Affords the opportunity to minimise failure and maximise upon success.
Aware	Always remaining in the present moment, stimulating alertness and awareness.	Allows choices and decisions to be made at a conscious level, resulting in higher performance.

Figure 3

To be clear, I am not suggesting that the list set out in the "Quality of a leader" column is either exclusive or comprehensive to leadership. What I have observed however is that when these specific qualities have been converted into action, the consequence or outcome frequently aligns with what we have here. I am hoping that this goes some way in addressing how this process happens.

The question of whether these qualities reside as an inherent gift within what is sometimes coined a natural born leader or whether one may develop these attributes through a learning process has been a topic for much debate. My position is that they fall into 3 separate categories\...

1. What a person choses to do or be without persuasion.

2. What a person choses to do or be through experience.

3. What a person choses to do or be through education.

Let's have a look at these in some more detail.

1. By this choice I am referring to someone's inherent nature. Although quantifying this is complex, it may be a consequence of an individual's physical makeup or DNA configuration such as the ability to be naturally alert. One may argue that conditionalization at an early age could be a possible influencing factor crossing over to an experience category, however I am specifically talking about a person's nature. For example, two children brought up in identical environments may have polar opposite behaviour patterns, personalities and traits.

2. Similar to 1, albeit experiencing events throughout life can frequently change someone's model of the world in relationship to themselves. This may then manifest in adopting one of our leadership qualities such as becoming more truthful or compassionate. Experience is potentially a powerful antecedent, the old adage of being burned from putting one's hand near a flame has particular relevance in confirming this position.

3. Through education an individual may acquire more knowledgeable or indeed adopt a more confident position. Education could be considered less potent from an academic perspective but enlightenment in whatever form is certainly persuasive. It is clear that though closely reviewing these 3 categories there is a natural overlap in terms of some of these qualities falling into more than one category. It would be fair to conclude that many areas of leadership maybe learned through coaching, training or maybe just experiencing. Does this then mean that some individuals are born with these qualities inbuilt and naturally assume a position of leadership whilst others aspire to this status through experience and education? It is quite likely that this is actually the case, given where our discussion has taken us. What seems to be a constant is that leadership occurs when there is a task, event or circumstance that involves individual input. In their absence it is likely that there will be an attrition to direction, enthusiasm, morale and loyalty.

If you research specific leadership styles you will undoubtedly uncover many differing and opposing versions. Notably, depending upon which author or business guru you subscribe to you may find "The 3 Types of Leadership" or maybe "The 9 most common ways to lead". Indeed, I once read an article where the author promoted 12 types of leadership styles. For the purposes of this paper I am going to discuss two styles which I believe are most relevant for comparison. Before getting to this I would just like to discuss their origin of motivation. This is important because it is my position that there exists a hierarchy between both styles. The first style which I consider the lesser in terms of effectiveness is initiated from the head and the second style, which I consider to be more effective emanating from the heart. I would like to reaffirm this point by drawing reference back to figure 3 and noting that the majority of the qualities listed in this illustration emanate from the heart. To extrapolate this assertion, I have used figure 4 below as a point of reference.

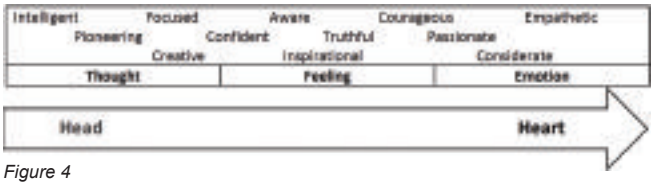


Figure 4

For the purpose of appraisal and comparison, I am going to tag the leader who manages from the head (H_1) and retrospectively leading from the heart (H_2).

Generally, H_1 tends to be detailed orientated displaying a high level of intellect. They are very reliant upon facts and figures as to them the devil is in the detail. It would however be prudent to note that H_1 is not necessarily devoid of passion or lacks the ability to be empathetic. It's just that their dominant attributes will gravitate around intellect and focus, possibly exploiting data to make decisions upon and influence the way that they lead. Their general thought process will be biased to the left-hand side of the brain. H_1 is a real thinker and not necessarily distracted by emotion.

At the other end of the scale, H_2 is guided by the feelings and emotions within. Some refer to this as the soul or the divine spark. H_2's overshadowing dominance is love and compassion operating at a higher level of emotional intelligence. Again, this is not to say that H_2 has less intellect than H_1 or that the

detail is irrelevant to him or her. They do however have the ability to get out of the detail to facilitate getting into the detail. By this I mean that if you are amongst the weeds how may you see what is around you or indeed where the horizon is? Being in a conscious state when leading individuals as being in the present is a prerequisite to knowing which way to go and what to do next whilst also stimulating togetherness amongst the team. It is therefore unlikely that effective leadership is managed unconsciously.

The question of how to stimulate togetherness between the team is a key component that requires satisfying by H_1 or H_2. Promoting ownership through empowerment may be arrived at by applying the 3 L's. Quite simply, love your people. Conscientiously listen to them and learn from them. Empower them to make decisions so that they may become the architects of their successes and failures. They will build on their triumphs and learn from failure allowing them to grow, develop and subsequently evolve. In the same way that children learn, grow and develop into adults; leaders follow a similar process. As I have accentuated previously, "leadership is not a state of being that you just arrive at but actually a state of being that constantly evolves." This evolutionary process is intrinsically linked to the significant change to the profile of employees working within the field of logistics as I clearly identified at the outset. Furthermore, given the diverse nature of the workforce, accompanied with the significant changes in gender and ethnicity, it is logical to conclude that for future management strategies to be effective in terms of leadership, they will have to adapt in accordance with these variable factors.

4. Conclusions

Leaders inspire people to follow and it is this notion that stimulates action and influences behaviour. Ultimately, the overriding objective that organisations continually focus upon exploring and developing, are new ways and means to increase output. The way in which they communicate with their employees provides the cornerstone to developing good effective relationships, and it is therefore critical to understand the requirements and needs of a rapidly changing workforce.

Acknowledging that leadership is articulated through the head and heart helps businesses understand what may be required in achieving these objectives. Given that it was clearly argued that some of the attributes of leadership may be learned through experience and taught through education, investing in leaders, becomes a more important issue for businesses in the future.

It was noted that in the wake of new members joining the European Community, the UK experienced significant growth in volumes of migrants joining the workforce. Many of these have been employed by the logistics industry increasing its diversity in profile. Furthermore, with the general shift in social and domestic expectations, the industry has experienced a significant alignment within levelling the male and female gender gap. Managing change is inevitable and this is perfectly represented with the current uncertainty influencing our trading relationships with Europe and the rest of the Global Economy. It is certain that further change will introduce wider diversification within the industry.

With the imminent changes afoot, it is likely that increased diversity within the logistics industry will be the natural consequence. Given that this is the case, leadership styles of the past will need to adapt to accommodate the emergence of a new work force. Would this then require leaders of the future to become more proficient in developing skills to love, listen and learn?

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A macrologistics response to a damaged world: The emergent trade-off

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1. Introduction

Major technological advancements, supported by significant regulatory liberalisation, enabled exponential global trade growth far in excess of GDP growth since the 1950s. The technological advancements enabling increased trade include the development of the standard shipping container and rapid advances in information technologies. Notable regulatory enablers include the deregulation of the transport industry, trade liberalisation and increased capital mobility. These developments facilitated industrial specialisation through offshoring manufacturing to lower labour-cost geographies, increasing the time and place disparity between production and consumption (Van den Berg and Lewer, 2007; Savy and Burnham, 2013). The resulting elongating freight supply chains heralded a new era where national logistics efficiency became a key driver of economic growth and international competitiveness (Rantasila and Ojala, 2012).

Advances in freight logistics efficiencies were however insulated from the ecological and societal damages incurred by the increased logistics footprint. Externalities, such as emissions, are still mostly unaccounted for in logistics costs. The transport sector contributed 22% to global carbon dioxide (CO_2) emissions in 2015 (International Transport Forum, 2018). A reduction in CO_2 emissions, one of the major contributors to climate change, is a key focus area of sustainable development goals. In 2018 global CO_2 emissions reached the highest levels on record, creating fears that the global intent to halve emissions by 2030 will not materialise (Dennis and Mooney, 2018). Logistics is therefore entering a new age where the focus has to shift from being the great enabler of trade to becoming the great enabler of sustainability. This elevates the role of logistics to the macroeconomic realm, i.e. the emerging field of macrologistics, defined as the collaborative development of sustainable freight logistics responses on national and industry levels, taking cognisance of broader ecological, social and economic trade-offs, to support the drive towards sustainability (Havenga, 2018).

The purpose of this paper is to contribute to debate and encourage research on the role of macrologistics in enabling sustainable economies. The paper is based on a broad literature review and is structured as follows. At the outset, the principles of sustainability are described, touching on how a cultural shift towards dematerialisation, and eventually degrowth, can support sustainability. This cultural shift can also inform the intensifying climate change trade-offs required from logistics, while enabling a 'human face' to these trade-offs in striving towards an ecologically sustainable society with a high degree of well-being that is widely and equitably shared (Zencey, 2017:419).

2. Methodology

A broad literature review was conducted using a desktop research methodology with Google Scholar as the main literature source. Google Scholar is an extensive academic indexing source, drawing material from academic publishers, professional societies, online repositories, universities and other web sites, and includes peer-reviewed publications, theses, books and industry publications. It encompasses resources associated both with practitioners and academics (Francis et al., 2017). The reference lists of relevant sources were also studied to expand the review where applicable.

Given the nature of the research topic, a broad literature survey was undertaken, not limiting the search to predefined search terms. The context for this paper is within the freight logistics realm, although the principles can be applied to logistics in general. At the outset, aspects such as 'key drivers of logistics', 'future trends in logistics', 'macrologistics', 'sustainability' and 'externalities' were searched. Based on learnings from these results, further searches included 'dematerialisation', 'Industry 4.0', '4th industrial revolution', 'Logistics 4.0', 'decarbonisation', 'degrowth', 'climate change', 'mitigation', 'adaptation'. Various combinations of these search terms were also used. Many of the sources are publically available. Subscription-based sources were obtained via Stellenbosch University Library and Information Service located in Stellenbosch, South Africa.

The nature of the research outputs are qualitative and exploratory, to support the purpose of the paper, therefore a broad range of literature was consulted and a keyword or publication-type analysis neither feasible nor the goal of the review.

3. The sustainability imperative – a shift towards dematerialisation and degrowth

In this section sustainability perspectives are described, touching on how a cultural shift towards dematerialisation, and eventually degrowth, can support sustainability goals.

Sustainability perspectives – culture as the omitted driving force

Sustainable development is defined as a balanced focus on the economic, social and ecological impacts of economic activity (United Nations, 1987). Unsurprisingly this is a challenging goal due to the seemingly conflicting aspirations encompassed in the three sustainability perspectives. This is evidenced in the disproportionate focus on economic growth over the past few decades which resulted in what Sustainable Aotearoa New Zealand (2009) referred to as the 'Mickey Mouse version' of sustainability, where rampant economic growth is rapidly depleting natural resources, harming the environment, concentrating welfare in but a few people and leading to a myriad economic failures this century. They proposed that the balanced view of sustainability should be replaced by a 'strong' model where ecological protection and social development supersedes economic growth.

Paulson (2017) contends that the modest progress that has been made towards sustainable development, despite the significant technological developments and policy interventions over the past 50 years, can be ascribed to the failure of scientists and policy-makers to take cognisance of society's paradigms that lie beyond reason and rational decision-making, what she terms 'systems of culture and power'. This principle was recognised by Gestalt psychologist Kurt Koffka (1886-1941) as "the whole is other than the sum of the parts", and was also aptly described by Hardin (1968) as the 'tragedy of the commons effect'. He elucidated this through the example of herdsman using common grazing land: each herdsman acts rationally based on self-interest, exploiting common grazing land by adding as many cattle as possible until, in the long run, the carrying capacity of the land is exceeded. A positive return for each single economic actor in isolation, without accounting for the impact on the 'common good', could therefore lead to a negative collective result in the long term. Only when aggregate impacts are understood, and stakeholders are held accountable for the impact of their individual choices on the common good, can this effect be counteracted. This full accountability principle has still not been implemented. Two decades ago Yencken and Wilkinson (2000) already proposed a fourth dimension of sustainability (reiterated by Paulson (2017), as mentioned earlier), namely a sustainable culture, in an attempt to eradicate Hardin's (1968) 'tragedy'. Hawkes (2001) emphasised that this cultural vitality should be a core component of a sustainable society, on par with social equity, environmental responsibility and economic viability.

For the purposes of this paper, a hybrid between the (now four) perspectives of sustainability, a so-called environmental humanism model, is therefore proposed (refer Figure 1). Two distinctions with the strong model mentioned earlier are suggested: (1) while the biosphere is still proposed to be the dominant trade-off perspective, there could be specific cases where priority is given to goals in the socio- and econospheres, such as growth objectives in developing economies to alleviate poverty and disease; and (2) a culture of sustainability envelops the triple bottom line perspectives in order to bring these goals to fruition. This culture of sustainability talks to an increasing inclusion of change management and behavioural psychology principles in sustainability discussions (Tokar, 2010; Tsai et al. 2012; Nguyen, 2017), that is an understanding by humans of how to harness their own potential to meet their need for a sustainable future.

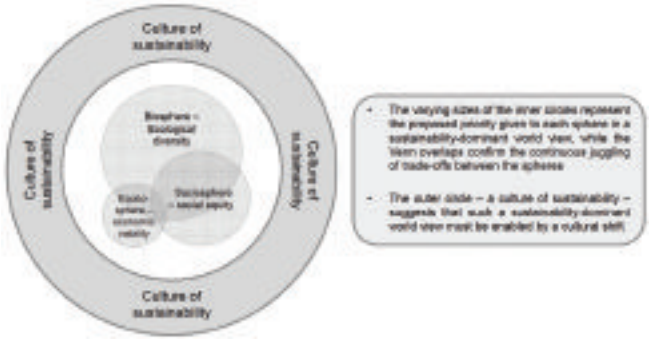


Figure 1: Proposed sustainability model – the environmental humanism model (developed by authors)

A key emphasis of such a culture of sustainability will be the increasing drive towards treading more lightly on the earth, i.e. a drive towards dematerialisation and, eventually, degrowth. These concepts are discussed in the next section.

Dematerialisation and degrowth as key elements of sustainability

Dematerialisation means doing the same, or more, with less. Building on the dematerialisation of manufacturing (through miniaturisation and light-weight materials) that started in the mid-1980s (Junnen et al., 1989), Schütz and Welfens (2000) redefined dematerialisation as reducing the use of material and energy per unit of output, extended by Riele et al. (2000) to a reduced environmental impact of material flows. Santos (2011) expanded this downstream in the value chain with a view "to shift the relationship between consumer satisfaction and the need for materials to provide such satisfaction", i.e. reducing absolute demand. The recent shift towards the development of a circular economy completes the vision of dematerialisation in the value chain through attempting to retain as much as possible of the resource value embedded in existing products (Hannon, 2016).

It is here where the advent of the 4th industrial revolution (or Industry 4.0) is pertinent, i.e. the convergence of dematerialisation and the digital revolution. This is creating an exponential number of secure connections between machines, devices, sensors (the IoT) and people (through mobile technology) to create an Internet of Everything (IoE) with ubiquitous real-time information-sharing and communication abilities. This creates the basis of a three-way collaboration: human-to-human, human-to-machine and machine-to-machine (Hermann et al., 2016) to enable intelligent industrial operations using advanced data analytics for transformational outcomes (Industrial Internet Consortium, 2018). Logistics 4.0 – fully integrated, collaborative supply chains that respond in real-time to meet (and match) changing demand and supply conditions in the value chain – is a natural extension of this. It will allow for a step change in demand forecasting, logistics efficiency, scheduling and inventory reduction, i.e. delivering similar or more logistics outputs with fewer inputs in support of the dematerialisation of logistics.

There is a hierarchical process towards logistics dematerialisation. Firstly, the goal is to induce the lowest possible level of absolute demand; a broader societal goal which speaks to the sustainability culture referred to earlier. Secondly, the most sustainable supply chain has to be

implemented (or invested in) to service this (lowest possible) level of demand. Thirdly, optimum productivity of this chain must be engineered. And, lastly, the supply chain services must be executed with the minimum resources, i.e. optimum efficiency.

In the quest for sustainability, the lowest possible level of absolute demand – the first step in logistics dematerialisation – implies degrowth (Balatsky et al., 2015). Demaria et al. (2013) define degrowth as "a democratically led redistributive downscaling of production and consumption … to achieve environmental sustainability, social justice and well-being". These ideas are however not new. A global think tank, the Club of Rome, resurfaced this debate in the 1970's (Meadows et.al., 1972). They modelled restraints on economic growth and forecasted that, within a hundred years, a collapse of the economy and ecosystem could be expected. Halfway through their prediction horison, Turner (2008) illustrated that the predictive timeline by Meadows et.al. (1972) has been uncannily accurate and the quest for a turnaround of conspicuous consumption continues. This turnaround is imperative in an attempt to counter the expected impacts of climate change.

In the next section, a succinct description of expected climate change impacts is provided, followed by an overview of the responses to and potential trade-offs relating to these.

3. Climate change

At the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP24), held end-2018, an agreement was reached to deliver on previous commitments of limiting global temperature increases to below 2°C above pre-industrial levels, with an aspiration of 1.5°C (McGrath, 2018). The purpose of this commitment is to minimise the adverse effects of climate change, which could include increased temperatures, rising sea-levels, ice mass loss and extreme weather events (NASA, nd). The main societal knock-on effect of these events will be the impact on human health due to food and clean water shortages, flooding and housing losses (Klausner, 2018). For logistics, significant adverse climatic changes can result in severe damages to the transport network, such as the flooding of transport infrastructure, curtailment of barge operations, damage to bridges, buckling of road pavement or rail track, and disruptions in power supply. This, in turn, will result in severe disruptions of freight and passenger flows (McKinnon, 2015).

Two main approaches are being pursued to limit the negative effects of climate change, i.e. mitigation and adaptation, with an emerging understanding of a third perspective, i.e. managing the damage that does occur due to adverse climatic impacts, some of which seem unavoidable. These are discussed in the next section.

Responses to climate change

Climate change mitigation refers to the reduction of greenhouse gas emissions. To a large extent, this approach entails efforts to protect and promote carbon sinks through land-use and habitat management, e.g. forests and wetlands are significant carbon sequestrators (Berry et al., 2009; Schwartz, 2016). Mitigation also refers to efforts to encourage switching to non-carbon or carbon-neutral energy sources, as well as improvements in energy efficiency (Berry et al., 2009). Climate change adaptation is defined as adjustments in ecological, social or economic systems to alleviate the observed or expected impacts of changes in climatic stimuli (Adger et al., 2004). A comprehensive approach implies minimising the carbon intensity of adaptation activities to limit positive feedbacks loops into climate change (McKinnon, 2019). The third response to climate change is the management of residual damages. Despite mitigation and adaptation efforts, climate change is expected to have an impact, the cost of which has to be borne (Van Vuuren et al., 2011).

The increased concentration of freight in terms of nodes (e.g. hub-and-spoke systems, centralized inventory warehousing), on densified freight corridors and in production clusters or freight villages, increases the vulnerability of the freight system to climate change (McKinnon, 2019). In logistics, climate change mitigation strategies are typically pursued by increasing the efficiency of freight provision, so-called green logistics. Pro-active adaptation strategies to reduce the potential impact of climate change on the transport network include retrofitting or relocating facilities, upgrading storm water facilities and investing in new facilities that are more resilient to climate change. Adaptation strategies to reduce the consequences of climate change on existing freight and passenger flows include rerouting flows, shift to alternative modes and preparedness for rapid rebuilding of facilities (McKinnon and Kreie, 2010; McKinnon, 2019).

In addition to logistics sector-specific responses, macrologistics should also contribute to the development of probabilities of major climate change upheavals, both for companies to prepare and for societies to develop nation-wide strategic responses. Considering and ranking a range of scenarios can mobilise humanity to search for novel demand- and supply-side climate change responses which could enable a trajectory towards better outcomes. This requires an understanding of the trade-offs related to climate change policies and approaches, as discussed in the next section.

Trade-offs between climate change responses

A comprehensive response to climate change is challenged by the lack of cross-sectoral integration and a limited understanding of the relationships, synergies, and risks in the trade-offs between mitigation, adaptation and damage control (Berry et al., 2009). Addressing these challenges can be aided through developing a common understanding of these trade-offs so that priorities (based on impact) can be determined. Ideally, a macrologistics think tank should develop and analyse climate change scenarios, and prioritise and script possible responses, in order to prepare the logistics industry for the most likely outcomes, akin to De Geus' (1988) 'planning as learning' principle. De Geus defined this as a strategic construct, i.e. learning faster than competitors in order to create a sustainable competitive advantage, translated in this context that the ability to fast-track learning about possible climate change fallouts over the next 50 years, and create capacity and strategic fitness to respond, might be a key to our survival.

As an example three possible pathways are depicted in Figure 2. The mitigation axis depicts various scenarios of global temperature increases (in degrees Celsius) above pre-industrial levels: successful mitigation requires less

adaptation, while failure to mitigate temperature increases will require more adaptation, and if the combined effect of mitigation and adaptation is not high enough the world will have to live with the impact of environmental damage. In a likely scenario of somewhere between 1.5°C to 2°C warming, certain supply networks will have to be redesigned and a global drop in average living standards will be experienced ('abc' in Figure 2). Living standards is likely to reduce more in the developing world and the required network redesign will probably entail support from the developed world. If mitigation is less successful, i.e. more 2°C degrees warming, the required reconfiguration will be more difficult and larger in scale, i.e. the world will have to prepare for major logistics redesign and mass migration ('a1b1c1' in Figure 2). In a best case scenario where mitigation is more successful and warming is lower than 1.5°C, less adaptation will be required and damage intervention is therefore expected to be less ('a2b2c2' in Figure 2).

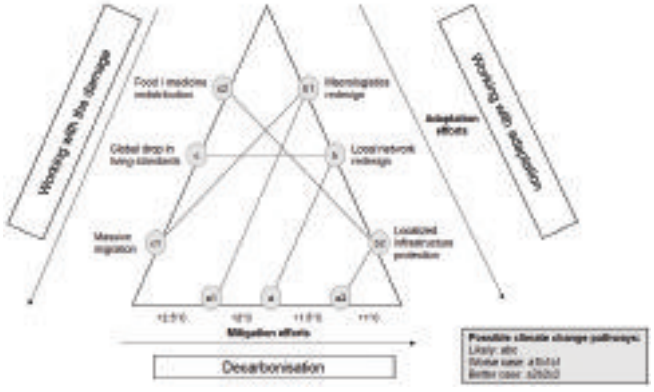


Figure 2: Possible pathways in the climate change trade-off (trade-off triangle by Van Vuuren et al. (2011); pathways developed by authors)

Unfortunately, the climate change impacts of rising sea levels, food insecurity and disease outbreaks (all resulting in mass migrations) are expected to hit the developing world the hardest. Bhardwaj (2018) discusses climate injustice, i.e. that the developing world historically contributed less to climate change, but will most likely be more exposed to its impacts. Macrologistics can contribute to improving these outcomes, partly because of its inherent systemic view to problem-solving, but in large part also if attempts to reverse the contribution of logistics to climate change are successful.

4. Conclusion

The dematerialisation of the economy and logistics is imperative in striving towards a sustainable future. There is a technological background enabling this, driven inter alia by lighter materials, smarter logistics and disruptive technologies. There is, however, also a shift towards a culture of sustainability that talks to 'less': less end-consumer demand, more ecologically sustainable supply, fewer activities (reduced distances and handling) and using less resources (fuel, driver hours, externalities) to deploy these activities. Eventually, however, the world could be faced with reduced growth and even degrowth where the success of logistics, in the next 50 years, will be measured both on its contribution to withstand the expected impacts of climate change, and its contribution to innovatively leverage economic and technological opportunities to produce improved societal outcomes. The success of these initiatives is expected to hinge on a successful shift towards a culture of sustainability, based on intent awareness of the interrelationships between the economy, environment and society at large, while actively and collaboratively working towards outcomes of increased sustainability and equitability within and between the developed and developing worlds.

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Improving the performance of supply chain finance through value-creating stakeholder programs

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Abstract

Purpose – Supply chain finance (SCF) is an interdisciplinary field involving and affecting a broad range of internal and external parties. Companies willing to implement or already driving an SCF programme are faced with a variety of concerns and challenges. This paper complements existing research on the variety of concerns and challenges in approved payables SCF programmes from the perspectives of different stakeholders. Moreover, by combining SCF and stakeholder theory, this research categorises selected stakeholder groups using key factors and possible action steps based on value-creating stakeholder programmes to recommend the most applicable stakeholder approaches in approved payables SCF programmes.

Research approach – The data used in this research were collected from 24 interviews with eight leading companies using SCF and compiled into an extensive list, presenting all challenges and concerns expressed by different stakeholder groups. The analysis is split into two parts. First, the list of challenges and action steps is summarised for each stakeholder group. Second, the stakeholder groups are categorised further, using key factors derived from the combination of SCF and stakeholder theory.

Findings and originality – The findings of the analysis coincide with and complement existing research. The results suggest an offensive stakeholder approach for approved payable SCF programmes and indicate defensive and holding programmes as occasionally applicable.

Research impact – Previous studies have focused on the challenges of SCF. However, most papers lack practical recommendations about possible action steps and measures managers can take to overcome their individual stakeholders' issues. The empirical results of this research address this research gap in SCF- related theory and highlight the relevance and use of stakeholder categorisation in SCF.

Practical impact – The findings highlight the requirement of offensive measures and action steps in approved payables SCF programmes for addressing stakeholder challenges. Companies implementing SCF programmes can use the insights from this study to derive appropriate strategies.

Keywords – Supply chain finance, Reverse factoring, Stakeholder theory

1. Introduction

The competitive landscape of supply chain finance (SCF) is vast and complex. Its proper implementation depends strongly on companies trying to use it to their advantage and the industries in which they operate. Companies willing to participate in an SCF programme may find themselves lost when confronted with its variety of challenges (More & Basu, 2013), which oftentimes stem from the complex network of involved groups and stakeholders promoting their own interests and concerns (de Meijer & de Bruijn, 2013; Wuttke, Blome & Henke, 2013) and their interactions with each other. According to Smith (2003), stakeholder relationships are a 'zero-sum game', meaning that, when a company allocates its resources for the benefit of one group, it is taking away resources from another. This is where the combination of supply chain finance theory and stakeholder theory can be used to demonstrate the means for improving such networks. The application of SCF can be used to create a win-win situation among stakeholders (Hofmann & Zumsteg, 2015), thus it offers the potential of managing stakeholder networks to maximise their value gained from the relationships. Companies require clearly defined approaches and recommendations on how to overcome these concerns and challenges, in order to manage the interactions among the parties involved and facilitate the win-win environment of SCF (Dyckman, 2010; Hofmann & Zumsteg, 2015). This paper aims to address the challenges stakeholders face in SCF programmes by examining both existing SCF theory and stakeholder theory and combining it with empirical research data. As previous research on these challenges has taken a more theoretical approach (More & Basu, 2013), this paper aims to close this research gap by offering a practical analysis and formulating recommendations about what action steps and measures managers can take to overcome their individual stakeholders' issues.

The first research question in this study explores the challenges stakeholder groups face when implementing an SCF programme and what managerial actions managers can take to overcome them. The second question examines the combination of SCF theory and stakeholder theory and impugns what recommended stakeholder

programmes companies have at their disposal to manage the interactions and concerns of the stakeholder groups in an SCF programme. The focus of this study lies on the application of approved payables SCF programmes and centres around empirical data gathered from focal companies representing the buyer's side in a so-called 'reverse factoring' programme (Wuttke et al., 2013). More precisely, it focuses on the concerns and challenges that companies may face when implementing approved payable SCF programmes. Furthermore, this research aims to develop previous research on the difficulties associated with SCF (de Meijer & de Bruijn, 2013; More & Basu, 2013; Liebl, Hartman & Feisel, 2016) by taking a practical approach and combining existing SCF theory with stakeholder theory, to better understand the challenges emerging from the interactions among the actors involved in such programmes.

2. Theoretical background

2.1. Literature review on SCF

Existing literature introduces SCF theory as a part of working capital management theory that is used to examine the integration of financial flows into a physical supply chain (Stemmler, 2002). The field of SCF literature explores two perspectives. First, the supply-chain oriented SCF approach focuses on exploring potential optimisation of the financial flows within supply chains and offers insights about both financial and non-financial solutions (Hofmann, 2005; Pfohl & Gomm, 2009). Second, the finance-oriented SCF approach explores the financial products of companies in supply chains (Stemmler, 2002; Sugirin, 2009; Zhao & Huchzermeier, 2018) and oftentimes focuses on an approved payable programme called 'reverse factoring' (Wuttke et al., 2013). Existing research on SCF theory explores this application of approved payable programmes and their influence on operational decisions and the performance of companies in supply chains (Lekkakos & Serrano, 2016) and discusses the challenges and implementation barriers companies face in the process (de Meijer & de Bruijn, 2013; More & Basu, 2013; Liebl, Hartman & Feisel, 2016). Furthermore, SCF research investigates the benefits that companies can gain through the implementation of SCF programmes (Klapper, 2005; Iacono, Reindorp, & Dellaert, 2015) and the creation of possible win-win scenarios for the actors involved (Dyckman, 2010; Hofmann & Zumsteg, 2015).

2.2 Literature review on stakeholder theory and its implications for SCF

The existing literature defines stakeholder theory as a component of management theory that is used to examine stakeholders' behaviours and interactions in different scenarios (Parmar, Freeman, Harrison, Wicks, & de Colle, 2010). The aim of stakeholder theory is to find solutions for three interconnected problems (Parma et al., 2010; Freeman et al., 2018): First, the value creation for companies in uncertain and ever-changing environments; second, the understanding of the ethics of capitalism; and third, how managers can use this knowledge to their advantage. Since its emergence in the 1980s, the literature on stakeholder theory has continuously expanded in different areas of research, such as corporate social responsibility (Harrison & Freeman, 1999; Steurer, 2006), strategic management (Freeman & McVea, 2001; Parmar et al., 2010; Freeman et al. 2018) and finance (Cornell & Shapiro, 1987; Zingales, 2000; Smith, 2003). The term 'stakeholder' is broadly understood to refer to any group or individual that has an interest or a 'stake' in the activities of a company and which affects or is affected by the achievement of its objectives (Freeman, 1984; Mitchell et al., 1987; Freeman, Harrison & Zyglidopolous, 2018). Two kinds of stakeholder groups are involved in SCF programmes, namely internal and external stakeholders. Each of the stakeholders plays its own role in an SCF programme, which in turn influences its interactions with other stakeholder groups, according to Freeman et al. (2018). Their tasks and responsibilities vary depending on the company, and each of these involved stakeholders has its own personal interests that are affected differently by SCF programmes (de Meijer & de Bruijn, 2013; Wuttke, Blome & Henke, 2013; Wuttke, Blome, Foerstl & Henke, 2013).

2.3 Analytical stakeholder framework for SCF programmes

Freeman (1984) introduces a framework to divide stakeholders into four categories and draws a link to the five competitive forces that shape strategy (Porter, 1979). The stakeholders are distinguished by their relative competitive threat (CT) and their relative competitive potential (CP) toward a company, relative to four descriptors (see Figure 1).

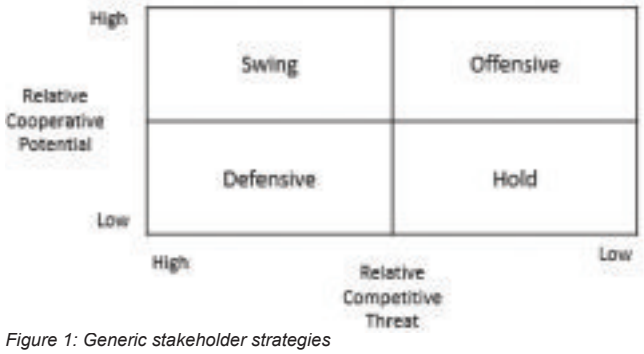


Figure 1: Generic stakeholder strategies

Specific programmes can be applied for a company to interact and work with stakeholders from each stakeholder group and to manage the challenges created through these relationships. Each category requires a specific programme that can then be adapted to match the particular behaviour of that stakeholder. Four kinds of programmes exist for dealing with stakeholder groups, namely the swing-the- rules programme, offensive programme, defensive programme and hold programme (Freeman, et al., 2007; Freeman, et al., 2018). This is where the strategic framework is applied to the topic of SCF to formulate specific recommendations for the successful relationship between a company and its stakeholders in SCF programmes and to offer a platform for creating the aspired win-win situation. The SCF-specific programmes are formulated based on the generic programmes introduced by Freeman (1984). Swing programmes aim to change the current structures and boundaries of stakeholder interaction (Freeman, et al., 2007). Offensive programmes are applied when a company intends to raise its cooperative potential with stakeholders (Freeman, et al., 2018). The use of defensive programmes intends to strengthen, or at least not harm, the relationship with stakeholders through collaboration

(Freeman, 1984). Lastly, hold programmes are used to maintain the status quo in stakeholder relations, as in cases where the current state of the relationship means that no advancements of the programme are necessary or beneficial (Freeman, 1984; Freeman, et al., 2018). The SCF-specific stakeholder value-creation programmes are presented in Table 1.

SCF Swing Programmes	SCF Offensive Programmes
1. Negotiate specifics to smooth the attitude toward SCF programmes for state-owned companies 2. Change who takes responsibility and makes decisions for SCF programmes 3. Shift the focus and attention to another specific set of issues 4. Change the transaction processes among SCF stakeholders	1. Change the beliefs around the application of SCF programmes 2. Introduce different approaches to SCF-related issues 3. Negotiate specifics of the agreement to create win-win situations 4. Accommodate the specific goals of stakeholders in the programme 5. Include beneficial stakeholders in the programme 6. Change the transaction processes among SCF stakeholders
SCF Defensive Programmes	**SCF Hold Programmes**
1. Reinforce and promote a positive attitude toward the application of SCF programmes 2. Support stakeholders in the current application of the SCF programmes 3. Establish connections among stakeholders to create beneficial additions to the programmes 4. Offer stakeholders the tools to expedite an SCF programme from their side	1. Put the SCF programme on hold and examine potential future applications 2. Maintain positive attitudes toward the application of SCF programmes 3. Protect against changes in the transaction processes of SCF programmes

Table 1: Stakeholder value-creation programmes in SCF

3. Methodology

3.1. Study design and case selection

The empirical data were gathered via semi-structured interviews (McIntosh & Morse, 2015) aimed at identifying the different challenges internal stakeholders of a focal company face in SCF programmes. In the interest of being succinct, this paper aims to offer an inside-out perspective, which is achieved by addressing the topic from the internal perspective of the company. Therefore, the analysis will focus on internal stakeholders who are significantly influenced by the implementation of SCF programmes. The finance and treasury department plays a significant role in the employment of SCF programmes, representing the communication link among the parties involved; therefore, its input during the interviews was considered. However, the department's specific concerns and challenges were not included in the analysis, as it initiates the programme and does not directly face the resulting consequences. The implementation of an SCF programme has a substantial impact on the legal and compliance department, too, as significant reclassification implications might occur. Furthermore, the procurement department has to adapt its interactions with suppliers in the course of a SCF programme's implementation. Therefore, the concerns and challenges that the legal and compliance department and procurement departments face were the subject of the interviews and the following analysis. The sample selection included eight large corporations, with the shared following characteristics, to allow for an easier comparison. The corporations were all large companies (i.e., revenues greater than €50 million), were highly familiar with SCF and reverse factoring, represented focal companies that were the driver for the implementation of SCF solutions in their supply chains and were all promoters of SCF programmes or already had an established and functional SCF programme. These eight corporations included two entities in the transportation sector, four in the manufacturing sector and two in the food and beverages sector. Seven companies were from Switzerland, Germany or Lichtenstein, whereas one company from the US was included in the research.

3.2. Case analysis method

The results from the interviews were compiled into a structured list separating the challenges and concerns of stakeholders in an SCF programme from the possible action steps available for companies to address these issues. The challenges and action steps were categorised based on different layers that have been derived from data gathered from both the interviews and existing literature on SCF and stakeholder theory. The first layer divides the data based on the different stakeholder groups directly involved in SCF. The second layer subdivides these groups based on key factors affecting their stance and role in an SCF programme. The third layer classifies the action steps based on strategic stakeholder programmes. The allocation of these stakeholder programmes to the formulated action steps follows the general categorisation presented in the existing stakeholder literature (Freeman, 1984; Freeman, et al., 2007; Freeman, et al., 2018). Subsequently, the challenges and action steps were counted and categorised based on their key factors and value-creating stakeholder programmes and displayed in a summary for the evaluation of results. Further, the recommended approach for each stakeholder and its respective key factor was derived.

4. Results

4.1. Key factors per stakeholder group

Throughout the interviews, key factors for the stakeholders were formulated as a means of differentiating the challenges and action steps that facilitate a critical discussion of potential approaches and explaining disparities in the results. The key factors of the legal and compliance department, for example, compare the challenges of a local or international implementation of an SCF programme, as regulations and legal boundaries vary for different countries (de Meijer & de Bruijn, 2013). Further key factors may involve the know-your-customer or general compliance aspect of SCF (Hofmann & Belin, 2011). As the procurement department plays an important role in the SCF programme, its willingness to collaborate with other departments is crucial for a smooth implementation (Caniato, et al., 2016). Therefore, the key factor offers the foundation for discussing the situation of the procurement department taking a more collaborative or antagonistic role towards an SCF programme in the process (Liebl et al., 2016).

4.2. Challenges and action steps for each stakeholder group

A selection of the most important identified challenges and possible actions, as well as solution approaches, is summarised in Table 2.

Legal and Compliance
[Key factor: Local vs. International implementation of the programme]

For the legal and compliance department, the challenges mostly include an increase in overall complexity, resulting

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in a cost–benefit imbalance, according to the interviewed companies. More specifically, due to the nature of SCF, the contracting process may collide with legal boundaries and regulations and require individual contracts; this finding coincides with the existing literature (Hofmann & Belin, 2011; More & Basu, 2013; de Meijer & de Bruijn, 2013). In this context, the key challenge is that SCF programmes are not necessarily scalable, and they postulate specific contracts for each counterpart and country in which they operate (Liebl et al., 2016). To handle these challenges, early and clear communication about the legal environment and boundaries affecting an SCF programme is crucial. By expressing the areas of conflict in both local and international fields, the legal and compliance department can find ways to optimise and potentially standardise certain aspects of an SCF programme and smooth the implementation early on (Hofmann & Belin, 2011).

No	Concerns and challenges	Possible actions and solution approaches
Legal / Compliance *(Key factor: Local vs. international implementation of the programme)*		
1	Uncertainty about whether an early payment creates a new obligation for the buyer toward a bank, or whether the original payable persists	Promote transparency and clear communication to avoid a mismatch of information. No new obligation is created for the buyer when an early payment occurs.
2	Insecurity about the design of new payment terms	New payment terms should stay within the ordinary industry / sector norms and should not be tied to the participation in the reverse factoring programme. Verify if parts of the contracting process can be standardised for multiple countries in specific regions / areas.
3	Risk of re-classification of debt	New payment terms should continue to avoid debt-like features, such as interest and fees paid by the buyer to the bank or supplier. An explicit use of cross-default clauses in buyer agreements with the banks may also indicate a debt-like arrangement.
Procurement *(Key factor: Antagonist vs. Collaborator of SCF programmes)*		
1	Lack of motivation to participate in an SCF programme, since performance measurements are only focused on cost decreases	Establish the right incentive system to guarantee the collaboration of procurement officials (e.g., through the integration of cash-flow KPIs in target agreement)
2	Lack of financial know-how to discuss the specific terms and conditions of the SCF programme with the suppliers	Provide training for all involved employees, covering the necessary financial and procurement content
3	Difficulties with onboarding new suppliers, as the high degree of complexity deters many suppliers from participating in SCF programmes	Formulate a standardised onboarding guide explaining the fundamentals of the SCF programme and the onboarding process, to make it easier for the parties to understand and explain

Table 2: Selected concerns, challenges and possible actions and solution approaches

Procurement
[Key factor: Antagonist to vs. Collaborator with SCF programmes]

Generally, the challenges and concerns of the procurement department noted in the interviews stem from the communication efforts and relationships among companies and their suppliers. First, suppliers may be 5

difficult to convince or uninterested in participating in an SCF programme. Second, the suppliers lack knowledge about SCF in general, or do not have the necessary human resources to drive the process. These, too, are challenges evident in previous research (Lekkakos et al., 2016; More & Basu, 2013). Third, due to a lack of information, the procurement departments fear their relationships with their suppliers will be threatened, because either the supplier will feel taken advantage of or will resort to practices to return the perceived, but not actual, additional costs back to procurement. This fear is also a key challenge for the procurement department, as it relies on a fair and sustainable relationship with its suppliers. This finding is in line with the existing literature (Liebl et al., 2016; de Meijer & de Bruijn, 2013).

To maintain healthy relationships with suppliers and to overcome information asymmetry, the interview partners recommended the establishment of clear communication channels and the promotion of transparency. The formation of designated SCF task forces equipped with the necessary know-how to help in negotiations, or conducting workshops with both suppliers and procurement officials, are some examples of how to create a healthy foundation for SCF. It should always be clear how, and to what extent, the involved parties can benefit from an SCF programme, a point also presented in the existing literature (Lekkakos et al., 2016).

4.3. Evaluation of strategic stakeholder programmes

A total of 31 different challenges and action steps were identified during the interviews. A summary of the number of challenges and action steps per stakeholder group and key factor are presented in Table 3.

Legal / Compliance
[Key factor: Local vs. International application of the programme]

The legal and compliance department counts eight different challenges, with an even distribution between the two aspects of the key factor. When managing the local implementation of an SCF programme, the recommended approach for all identified challenges is offensive. This result may arise from the need and potential to adapt actively to local standards so that they are more in line with the requirements of an SCF programme (Templar et al., 2018). An international implementation requires a more defensive and passive approach, possibly due to the restrictions of international integration of an SCF programme. Due to the fact that a multitude of different regulations and boundaries are in effect when using an SCF programme internationally, a more passive stance may be more beneficial for doing proper due diligence and, coincidentally, creating the most value from the challenges (de Meijer & de Bruijn, 2013). In summary, the challenges, action steps and strategic value-creating programmes for the legal and compliance department require contrasting approaches depending on their key factor. The offensive stance for local challenges calls for an active approach, due to a standardised legal system with which the legal and compliance department of the company is familiar (Templar et al., 2018). The international challenges, by contrast, require carefully implemented plans, due to the complexity of foreign legal systems or regulations (More & Basu, 2013; de Meijer & de Bruijn, 2013).

Procurement
[Key factor: Antagonist to vs. Collaborator with SCF programmes]

The 23 challenges of the procurement department are marginally unevenly distributed between the two key factor aspects of the collaborator or antagonist role in an SCF programme. The category of the strategic value-creating programme, when faced with the challenges of a collaboration with a procurement department, is predominantly offensive. As the actors already support the programme, the challenges they face are mostly caused by a lack of technical know-how or communication channels, which is the reason why they rely on active support and collaboration with another department to overcome these issues (More & Basu, 2013; Caniato et al., 2016). For an antagonistic procurement department,

most applicable measures are also offensive, though due to different reasons. When examining the concerns expressed and action steps required, they revolve mostly around convincing the procurement department of the benefits and specifics of an SCF programme, compared to needing only to convince suppliers, in the case of a collaborating procurement department.

In summary, the procurement department needs an active involvement of the SCF management, which pushes the programme forward to facilitate the collaboration among all involved actors. Depending on the stance the procurement department has towards an SCF programme, these actions may focus more on either improving know-how and the relationships with suppliers or on the general attitude toward the potential benefits of an SCF programme (Hofmann & Belin, 2011; More & Basu, 2013; de Meijer & de Bruijn, 2013).

Stakeholder [Key factor]	Sub-categorisation	No. of challenges and action steps	Swing	Value-creating strategy Offensive	Defensive	Hold	Strategic recommendation
Legal / Compliance [Programme distribution]	Local	4	0	4	0	0	Offensive
	International	4	1	0	3	0	Defensive
Procurement [Attitude toward SCF]	Collaborator	13	0	7	5	1	Offensive
	Antagonist	10	0	5	2	3	Offensive
SCF		31	1	16	8	6	Offensive

Table 3: Summary of results of the empirical analysis

5. Discussion

When looking at all the numbers combined, the results of the value-creating strategies are overwhelmingly one-sided, with 16 out of the 31 action steps identified as offensive approaches. Defensive and holding action steps are relatively even, with the defensive ones taking the majority. The number of swing approaches is negligible, compared to the numbers of the other approaches and countermeasures. The reason for the low number of swing approaches might be due to the fact that SCF does not necessarily change the established systems in a stakeholder network, but rather aims to optimise existing structures to free hidden potential, as Dyckman (2010) and Zhao and Huchzermeier (2018) suggest. Specifically, an approved payables solution like reverse factoring is already extensively standardised, leaving little room for changes to the programme structure (Liebl et al., 2016). Further, regulations and laws are difficult to change, and the upside potential of changing them for an SCF programme might not outweigh the effort (de Meijer & de Bruijn, 2013). Therefore, the low result for recommended swing programmes is perspicuous. The requirement of offensive approaches is evident when examining the overall results. This turnout can be explained by understanding the nature of approved payables programmes or, specifically, reverse factoring, which are initiated by the buyer (Camerinelli, 2009; Cavenaghi, 2013). The motivation behind implementing such a programme requires initiative from the buying company (Klapper, 2005), compared to other financing solutions. Therefore, the need to onboard participants actively into the programme and help them with their issues is palpable. Further, facilitating the communication and collaboration among involved stakeholders requires active managerial initiatives and a conviction to establish these internal and external relationships (Hofmann & Belin, 2011; Wuttke et al., 2013; Caniato et al., 2016).

The eight defensive countermeasures may be the result of measures designed to protect the company and, more specifically, the relationship with the involved stakeholders. As a healthy relationship between the parties is crucial for the smooth implementation of an SCF programme and sustainable development in the future (de Meijer & de Bruijn, 2013), passive and more diplomatic approaches are recommended. Further, protecting the company from internal and external threats when making decisions in an SCF programme coincides with the necessary due diligence (Templar et al., 2018). The need for holding programmes in SCF, despite being less than the offensive or defensive categories, is self-evident. As the nature of SCF requires adaptability and the right timing (Parma et al. 2010), taking a step back and revaluating one's position is sometimes the right approach to take. Moreover, it is not unusual in SCF programmes to reanalyse specific aspects of the programme thoroughly (Templar et al., 2018) and, consequently, to wait for the right moment for key stakeholders to be ready.

The results gathered in the analysis of the identified challenges and action steps coincide with and contribute to the current state of SCF theory. The examined challenges and concerns imply a common theme of insecurity and a lack of understanding of SCF and SCF-related concepts (de Meijer & de Bruijn, 2013; Lekkakos et al., 2016). This issue corresponds with the lack of knowledge and trainings for involved stakeholder groups implied in previous research (More & Basu, 2013). Furthermore, the findings determined that the lack of commitment to participate (de Meijer & de Bruijn, 2013) and the lack of structured allocation of responsibilities (Bals, 2018) are common restrictions in SCF programmes, complementing and confirming previous research. The results postulate the requirement of internal and external collaboration among involved stakeholders to improve communication (Hofmann & Belin, 2011; Wuttke et al., 2013) and overcome information disparities (de Meijer & de Bruijn, 2013; More & Basu, 2013), which corresponds with the existing literature. Subsequently, the motivation to evolve an SCF programme through mutual understanding of the processes inside a multi-stakeholder network (Roloff, 2008; Liebl et al, 2016) postulate explicit recommendations on what measures need to be taken to reach aspired results. This aspect coincides with findings on issues related to incentives (Lekkakos et al., 2016) and cost–benefit imbalances (Hofmann & Belin, 2011; Wuttke et al., 2013), which influence the way stakeholders promote or antagonise (Liebl et al., 2016) the implementation of an SCF programme and how understanding the value proposition of SCF can create a win-win environment (Hofmann & Zumsteg, 2015; Bals, 2018). Furthermore, the threats and restrictions imposed by legal boundaries and regulations (Hofmann & Belin, 2011; More & Basu, 2013; de Meijer & de Bruijn, 2013) and system structures in a company (Templar et al., 2018) are evident in the findings of this research. Therefore, the compiled list of challenges and action steps presents different and complementary perspectives on established issues in the existing SCF literature.

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6. Conclusion and Outlook

This paper investigates the challenges managers promoting an SCF programme may face when dealing with a variety of stakeholders involved; thus, it is directed toward managers in the field of SCF. It offers a practical tool that can be used as a source of information or guidance. The results gathered from the analysis of the challenges and action steps list highlight a variety of impediments that coincide with and complement existing research. The main challenges are related to the general lack of know-how and information disparities in SCF, a missing commitment to participate in an SCF programme, deficient collaboration among actors, cost–benefit imbalances and legal regulations. These factors negatively influence the creation of the aspired win-win environment of SCF.

The findings highlight the requirement of offensive measures and action steps in approved payables SCF programmes to address most stakeholder challenges. Reasons for these results are rooted in the nature of approved payables SCF programmes, as they are initiated by the buying company. Such programmes require the initiative and active promotion by managers tasked with their implementation, to facilitate the necessary communication among all stakeholders involved. Furthermore, the results indicate the occasional need for defensive programmes to strengthen the relationship with stakeholders and expedite sustainable business practices within the network. Moreover, the findings suggest sporadic use of holding approaches to re-assess current processes and identify opportunities and the right timing to act. Lastly, the application of swing stakeholder programmes has been identified as negligible in this research.

Despite the above, there are certain limitations of this study's empirical research and analysis. The research has been conducted from a buyer's perspective in an approved payables SCF programme focusing on selected internal stakeholders; therefore, the research does not offer a holistic perspective. Since the interviewed companies are all large corporations, the findings might not be as accurately applicable to SMEs. Future studies might investigate the topic of SCF programmes from different perspectives than the buyer's side. Furthermore, it would be valuable to examine different approved payables programmes or, more broadly, distinct SCF categories like accounts receivable or inventory finance programmes.



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Maritime



Implementation of electronic maritime single window for trade facilitation

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1. Introduction

One of the obstacles in product supply chains in developing countries is procedures at ports, airports and customs. Long, complicated procedures leading to delays at border crossings and ports have adversely affected trade, particularly regarding time and cost (Abeywickrama and Wickramaarachchi, 2015). In addition, choi (2011) revealed that active use of information and communication technologies (ICT) for Customs administrations is a crucial to become more effective and efficient. In order to reduce the complexity, time and costs, a Single Window is a one-stop facility that facilitates exchange of information among all parties involved in trade (Keretho, 2013).

Therefore, this paper aims at improving trade facilitation through the applicability of Electronic Maritime Single Window (MSW) and proposes a roadmap to assist policymakers and stakeholders to systematically execute MSW concept. The remainder of this paper is organized as follows. In the next section, the MSW concept, challenges and ways for successful implementation are reviewed. In section 3, a framework for the proposed method is presented. In section 4, a case study is illustrated to demonstrate the applicability of the proposed method. Finally, conclusions are presented in section 5.

2. Literature review

A. Single Window Concept

Creating a single-window facility is one way of solving the problems facing international trade. Government authorities and the business community in the developing countries having to deal with large volumes of information and documents of international companies submitted to many different agencies, with different systems and paper forms (UN/CEFACT, 2005).

Recommendation 33, published in (UN/CEFACT, 2005), defines Single Window as “A facility that allows parties involved in trade and transport to lodge standardized information and documents with a single entry point to fulfill all import, export, and transit-related regulatory requirements.” However, UNECE (2011) describes a Single Window as a one-stop facility, mostly enabled by the use of ICT, that allows for the electronic exchange of information between traders and government in a simpler, cheaper and more time-saving way.

Moreover, UN/CEFACT (2005) indicates that the application of a Single Window can be considerably useful for both governments and trade. For governments, it can lead to better risk management, improved levels of security and increased revenue yields with enhanced trader compliance. Clear and predictable analysis and utilization of rules and a better distribution of human and financial resources are beneficial for the trading communities, resulting in noticeable gains in productivity and competitiveness.

Furthermore, Keretho (2011) observes that according to the initial definition of SW, this facility should virtually link not only traders and customs but also several regulatory agencies involved in trade and transport through an electronic Single Window environment. According to the UN/CEFACT (2005) Recommendation, in the best case, a regulatory electronic Single Window may include some key features such as a) standardized information and documents through a single entry point to meet all import, export and transit related regulatory requirements, b) sharing relevant information with several government agencies involved in trade, c) offering coordinated controls and inspections by various government authorities, d) allowing electronic payment, e) facilitating private participants including banks and insurance companies as well as other public agencies such as immigration and vehicle registration authorities, and presenting a single source of trade-related regulatory and statistical information.

UNESCAP/UNECE (2012) reviewed the following concept of SW evolution or incremental development levels in their Planning and Implementation Guide: First Level is paperless Customs which seeks to the Development of paperless customs declaration system; second Level is the Regulatory Single Window which Integrate paperless customs with other regulatory bodies issuing trade/import/export/transit- related permits and certificates, and other relevant documents. Third Level is Port Single Window or B2B Port Community System which means extending of the Single Window to serve entire trade and logistics communities within the airports, seaports and/or dry ports. Fourth Level is the fully Integrated Single Window which target the creation of an integrated domestic logistics platform interlinking the administrations, companies and the service sectors to better trade facilitation throughout the entire chain of import-export operations.

However, Koh (2011) mentioned several forms of ‘limited’ SWS such as: a) Customs Single Window which provides a single interface between the trading parties and the Customs Authority; b) Port Single Windows is a system focuses on local level information about the vessel to the port authorities; c) Subnational “Single Window” whereby the regulatory agencies and local trade community can be grouped together at city or national level to establish a community-based trade “Single Window” system.

Keretho (2011) expressed the need to establish a common plan for Single Window planning and development that contains and links various forms of Single Window models. Such a perspective must consider the different Single Window models convenient also to the least developed and landlocked economies and developing countries and with rising technologies and conditions of international trade. The implementation of an accepted evolutionary model for Single Window development will aid policymakers and managers to find out the state of their national Single Window and specify objectives for the next step of application. Furthermore, Benhayoun (2016) sorted out in his study three essential trade facilitation pillars for electronic single window implementation; firstly the physical flows which include modern infrastructure (Ports, airports, highways, logistics platforms, etc.), Strong connectivity (By sea, by air, by roads, by rails and hinterland) and mature services providers. Secondly the data flow which mainly involves the supply chain automation. Third pillar is the payment flow which constitutes suitable payment instruments, Electronic payment culture and Harmonized payment system for import and export operations.

Also, Choi (2011) proposes an overview of Customs cargo clearance systems that are the main foundation for a single window environment; to determine the SW implementation in its practical and operational practices; to highlight the technical tools for data harmonization and to review obstacles facing developing single window system. The study also suggests that Customs administrations need to give more attention to single window security governance. However, Fjortoft, et al.(2011) discussed different types of single window systems and enabling development methodologies and platforms, particularly focused on a maritime centric model which support ship clearance, cargo import/export, and port clearance services.

The following section will review the challenges and the key success factors that are argued in previous studies.

B. Challenges of single window implementation:

There are numerous complex challenges to be managed so that the SW Vision could be converted into reality. Complexity of single window application can be dealt with breaking down its challenges into smaller and more controllable components. Lim (2012) discussed 10 challenges that must be carefully focused on, which are classified into 4 categories by Keretho (2013) as following:

First category is the strategic level which include: 1. SW Vision Articulation and Political Will Creating 2. Stakeholder Collaborative Platform Establishment 3. Business and Financial Models Formulation

Second level is at the management & technical level: 4. Business Process Analysis and Improvement, 5. Data Harmonization and Document Simplification, 6. Service Functions (Applications Architecture) Design, 7. Technology Architecture Design including Technical Standards and Interoperability 8. Legal Infrastructure Institution

Third level is the implementation level: 9. IT Infrastructure and Solutions Implementation and Finely, the operation level: 10. Change Adoption and Operations

All those 10 critical challenges should be analyzed, refined and have the best conditions for the context of the economy agreed upon, and this analysis needs to go through several rounds of fact finding, articulation, feasibility check from each other angle since they are all inter-related.

C. Critical Success Factors for Implementing Single Window

The following is a principal set of guidelines and an introduction to priorities and essential actions for the successful application of Maritime single window:

ESCAP (2012) discussed that the most necessary prerequisites for the fruitful application of a Single Window facility are the political will of the government, Stakeholder coordination, business model, legal framework and Technical issues. However, according to UN/CEFACT (2005) Strong leadership weather private or public sector, Coordination and integration of all stakeholders, User-friendly system, Investments in modern technologies, transparency and reliability of the proposed technical solution; are listed the key success factor for SW implementation.

Based on the previous literature, there is no unique system or model to implement Single Windows. Organizational set up and funding, IT architecture, scope and coverage will affect the way of SW implementation. Moreover, ESCWA (2011) has mentioned that many of the most advanced examples of single windows have evolved in the Asia Pacific region. Some of them go back 25 years or so-and virtually all of them are still in a state of continuous modification and development, much of which does not impact the information and communication technology (ICT) infrastructure. Therefore, this research focusing tackling the reasons and the challenges facing the implementation of MSW to propose a road map to facilitate MSW implementation for trade facilitation and speeding up paperless environment.

3. Development methodologies for SW systems in Egypt

Several methodologies relevant for the development of SW systems can be exploited. A number of available methodologies focus on the analysis and design phase using various process modeling techniques, while other methodologies are related to the technical implementation of a SW system (Rødseth et al., 2011; Ndonga, 2015).

The nature of the research problem should drive the choice of research strategy (Denzin and Linclon, 1998). For this reason, this research is considered highly exploratory to uncover possible avenues for reaching decision makers' objectives. For this reason, a qualitative approach is employed for data collection due to the exploratory nature of the problem. The research consists of two phases; theoretical phases and empirical phase. The theoretical phase started by understanding the SW concept and the different frameworks adopted through the literature review. The second phase is the empirical phase that mainly aims at refining the several SW roadmaps identified through the literature by different SW stakeholders from Egypt. Thus, Interviews were used for data collection of the empirical phase in order to investigate the obstacles that may face the SW stakeholders and to identify their needs from the system.



Participants in the interviews were from the maritime trade and transport industry and they are directly involved in the implementation process or are users of the SW system. 20 interviews were conducted with different several stakeholders, such as: freight forwarders, clearing agents, customs authority, Alexandria port authority, ministry of trade, ministry of transport, banks, insurance companies, and shippers. It was a requirement that all participants had some experience with the system. An information sheet was prepared and presented to all the participants to introduce them to the research topic and the purpose of the research. The number and content of interviews were based on non-probability sampling techniques; purposive (judgmental), and snowball sampling. The initial participant sample is based on the participant's interest to participate in the research. Apparently, there was an intention to involve a larger sample size since different participants might have different opinions and perceptions, however, if a large sample is used, the data may become repetitive (Glaser and Strauss, 1967).

To conclude, this research uses qualitative approach based on the interviewee opinions on the subject being discussed through conducting semi-structured interviews. Each interview audio file was transcribed word- for-word in order to avoid missing any data given by the interviewees. The interviews started by asking general questions to understand how far the knowledge of the MSW is understood.

Afterwards, the interviewee were asked to discuss the value that the MSW would be add, and what would be the challenges that would face the stakeholders while using the system. Furthermore, the interviewee were asked to suggest the operational steps to implement the system from their standpoint. Finally, the interview ended by several recommendations to policy makers and to all stakeholders engaged in the system. In the next section, further details concerning the data collected and analyzed will be discussed.

4. Results and analysis

The interview was designed as a tool targeting key stakeholders in the implementation of the SW to investigate the several challenges that developing countries may face while implementing the SW.

The subsequent data was analyzed based on the interviews conducted:

- The Egyptian customs authority observed that the SW system is a system whereby all actors in the supply chain in the country will hook up to a single system for data sent in only once and the system works on the data and transfer to relevant agencies who have need for it. It is very important in the maritime sector to help reduce the time and cost of doing business.
- The ministry of transport considered the SW systems as a way to provide an electronic platform as a one-stop shop for declarants/ traders in the submission of their documents in the clearance process.
- Alexandria port authority viewed the SW systems as an electronic platform that coordinates the submission and issuance of import and export related forms and documents between traders and the government. Furthermore, it allows the payment of duties to eliminate any risks that may affect any of the parties involved.
- Shippers viewed the SW system as a governmental initiative that would strengthen Egypt's' trade competitiveness and enhance the participation of the business community in the global market, thereby creating new trade and business opportunities. Furthermore, the SW is expected to facilitate the quick movement and delivery of cargoes to final recipients (consignees) at an optimum cost and in good time too and also to remove and reduce the human interface in day-to-day trade transactions amongst agencies in the maritime sector, consistent with the presidential initiative (Egypt Vision 2030). However, it has been obvious that there are efficiencies in the area of siting and location of shipping containers and lodging of trade documents now are another concern raised by the Customs.
- The analysis revealed that elimination of the use of paper documents and the sharing of information amongst service providers can be said to be efficient. However, this cannot be attained without enhancing the area of internet connectivity. It also brought to light that submission of documents through one portal is efficient.

Stakeholders, those in the public sphere in particular, generally find it difficult to accept any evolution of operational procedures, even if the said evolution is likely to step up the efficiency of their daily operations. On the whole, private stakeholders (Banks, Insurance companies, etc.) are not resistant as they do identify quickly the operational and economic benefit of such an evolution like the implementation of a SW. The difficulty lies in public stakeholders and, it is recommended to properly expose the risks of the SW project to all parties in a bid to reach consensus and proper appropriation.

Likewise, the findings showed several challenges in the implementation process of the SW system that would affect Egypt trade competitiveness and the following opinions came up from the various stakeholders:

- Total acceptance of the concept by the stakeholders in the maritime sector.
- Inadequate logistics in the participating agencies like internet facilities and internal Information Technology (IT) systems to operate the internal systems which can be hooked on to the SW.
- Adequate IT expertise in the participating agencies.
- Resistance to change as a result of fear of insecurity.
- Failure to engage all relevant stakeholders before its implementation.
- Failure to hook up all relevant parties onto a single platform; such as agencies responsible for the issuance of permits.
- Legal framework as some government authorities are by law mandated to operate within or has access to import cargo for inspection.
- Delay in cargo clearance for importers
- Additional cost in terms of demurrage/rent and other charges may arise.
- Congestion on the land side of the port

Maritime SW road map

Based on the data collected, analyzed, and presented in the previous sections, a SW implementation roadmap have been developed (Figure 1)

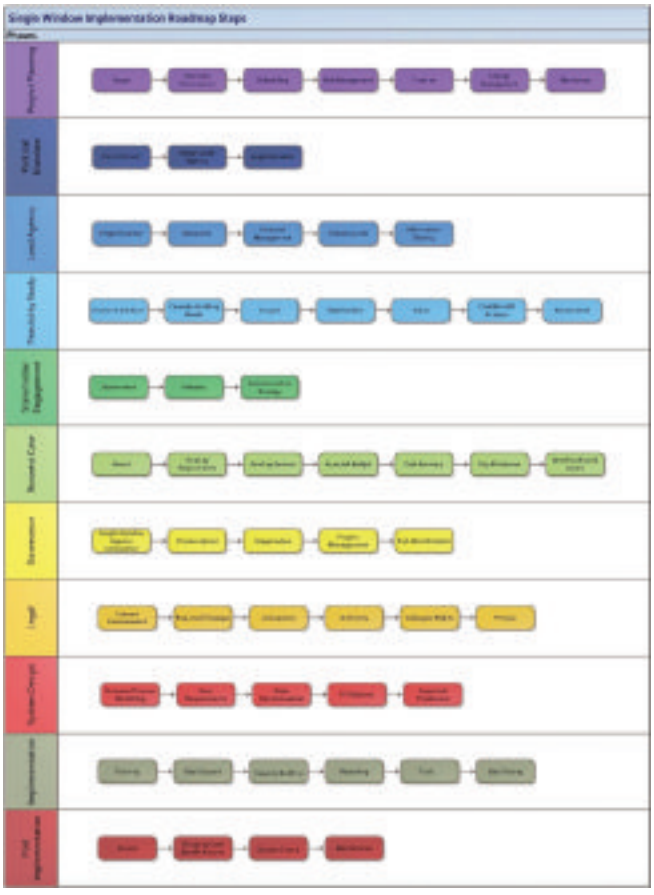


Figure 1

5. Conclusions and recommendations

Trading goods across borders requires traders to duly comply with a vast number of commercial, transport documentation and regulatory procedures requirements which causes delays and high cost of doing business for traders. In recent years, these requirements have become more complicated as a result of increasing attention to safety and security issues and health measures, border protection and control by governments. However, to remain competitive in this rapidly changing and complex trading environment, stakeholders and governments have the challenge to conduct their business and regulatory procedures faster but at lower costs and with more effectiveness. For this reason, the concept of the single window system is to eliminate the wasteful process, trade facilitation and create value for the trader. Nevertheless, perfection in the case of the single window is a continuous engagement with stakeholders to maintain or improve the level of efficiency of the system.

Since it is recognized that Single Window is an essential tool that can be used to eliminate inefficiency and ineffectiveness in business and government procedures and transport documentation requirements along the international supply chain, reduce trade transaction costs, in addition to improving border control, and security, therefore, many governments globally have adopted the Single Window initiative as a national Programme of trade as mentioned in UNECE (2011) However, they all face similar challenges that relate not only to the technical aspects of SW systems, but also to the organizational and inter-organizational, managerial, financial, political, legal, and national and international settings. Dealing with these challenges requires strong political will, long-term commitment and support from top management, a reliable institutional platform for collaboration, effective management of stakeholders' expectations and perceptions, workable business and architectural models, and necessary business and regulatory reforms (cf. UN/CEFACT, 2005). Even after applying all the previous conditions, policy managers and stakeholder still need to develop a strategy transforming their vision into implementation. Therefore, a strategic road map or framework that informs how these challenges can be systematically addressed is much needed.

For this purpose, this paper argued that policy makers and managers need a systematic approach to address SW implementation procedure for trade facilitation. An evolutionary SW roadmap is proposed as a long-term development roadmap as a helping tool for easier SW implementation through guiding policy makers, policy managers, and relevant stakeholders on how to conduct and manage the implementation. Also, the research sorted out some recommendation for better SW implementation:

- Internal and external stakeholders should be identified to brainstorm on the action plans to be adopted to ensure inefficiencies in the SW operations are tackled and thereby leading to an improvement in service quality among shipping service providers within the SW roadmap.
- All agencies should have service standards which they can be held against, with all agencies on the SW operating with service standards, they will have targets to meet the national consensus of all participating parties that should be sorted first.
- The need for governmental leaders to have a total understanding and acceptance of the concept so that government policies will be tailored in this direction
- The current presidential directive on paperless processes in the ports is totally synchronized with SW concept.
- The government should ensure a legislative backing and sanctions regime on non- conforming players to cover the SW System.
- There should be formal guidelines developed for continuous improvement in technological updates of the SW.
- The internet connectivity should be enhanced to ensure uninterrupted services.
- A robust feedback mechanism should be developed by the change managers of the SW to ensure stakeholder inputs for addressing operational challenges.
- This research recommends that future research may adopt quantitative research particularly to estimate the cost to port users arising out of service quality dimensions of the SW system.

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Hazard identification of maritime autonomous surface ships

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1. Introduction

Human error is the main risk factor contributing to the occurrence of accidents. Research indicates that around 80-90% of shipping accidents are caused by human error directly and indirectly (Heij and Knapp, 2018). Maritime Autonomous Surface Ships (MASS) are attracting increasing attention in the maritime industry because it aids to control such risk, while reducing labour cost for improving shipping sustainability and competitiveness.

Although MASS can help significantly reduce accidents caused by human error, it cannot eliminate all of them in maritime operations. In addition, MASS consists of several interconnected systems, and the associated technologies develop fast; MASS may introduce new types of risk thus it cannot be assumed that it will be safe (Komianos, 2018). Rødseth and Burmeister (2015) proposed 18 initial scenarios relating to MASS safety issues in the project of Maritime Unmanned Navigation through Intelligence in Networks (MUNIN), in which 10 scenarios are categorised as malfunctions, including flooding, global navigation satellite system (GNSS), manoeuvring, communication, on-board system, pilot unavailable, piracy, rope in propeller, open sea mode, and unmanned ship in search and rescue.

There are several studies related to MASS (e.g. Haworth et al., 2016; Schmitt and Goddard, 2016; Norris, 2017) in the literature, but the discussion of MASS is still at a fledgling stage and most of previous studies focus on the software applications and its direct applications in the military field. There is an obvious research gap of addressing risk assessment in the scenario of using MASS in the commercial world. In light of the above research gap, the aim of this paper is to identify hazards in developing commercial purposed MASS.

This paper is structured as follows. Section 2 conducts a literature review related to the concept of MASS. Section 3 identifies a list of hazards associated with MASS operations/ developments. Section 4 proposes control options for dealing with the identified hazards in MASS. Discussion and conclusion are drawn in Section 5.

2. Literature review

2.1. Definition of MASS

An MASS is still a conceptual vessel, there are several definitions available to describe it from different perspectives. The most common one is defined by Rødseth (2012) as “a vessel with no persons on board for the whole or only parts of the voyage. The ship, with partial support from remote control, must be able to conduct a deep-sea voyage on its own”. The Maritime Safety Committee (MSC) has defined MASS as “ships which, to a varying degree, can operate independently of human interaction” (IMO, 2018). The European Waterborne Technology Platform describes the autonomous ship as a next generation modular control and communications technology system of systems which will “enable wireless monitoring and control functions both on and off board. These will include advanced decision

support systems to provide a capability to operate ships remotely under semi or fully autonomous control” (Waterborne TP, 2011).

2.2. Level of MASS

MASS do not fall into the traditional definition of ‘autonomy’ but instead is broken down into sub- categories by the IMO (see Table 1). Level 1 MASS are the most closely related to traditional vessel operations. The risk assessment that this study conducts is based on level 3 and 4, where the level of man machine interface is remote or completely removed and the hazards to be identified are the operational risk for a MASS.

Level	Type	Definition
1	Ship with automated processes and decision support	Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated.
2	Remotely controlled ship with seafarers on board	The ship is controlled and operated from another location, but seafarers are on board.
3	Remotely controlled ship without seafarers on board	The ship is controlled and operated from another location. There are no seafarers on board.
4	Fully autonomous ship	The operating system of the ship is able to make and determine actions by itself

Table 1 – Categories of MASS as defined by the IMO
Source: IMO (2018)

According to MUNIN (n.d.) the level of MASS can be categorised into four levels, including manned ship, remote ship, automated ship, and autonomous ship (Figure 1). A manned ship is the traditional operations, which on board sea crews receive data/information from radar or Electronic Chart Display and Information System (ECDIS), control the ship after making decision. Remote ship refers to ashore staffs receive data/information from radar or ECDIS and control the ship action. Automated ship is that computer will make the decision to control ship action based on the received data/information. Autonomous ship refers to the combination of benefits of remote ship and automated ship. This can significantly reduce the human and computer error operations.

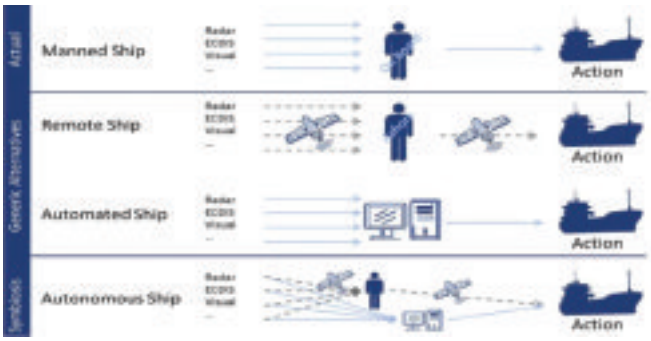


Figure 1 Level of MASS
Source: MUNIN (n.d.)

3. Hazards in MASS operations

3.1. Human error

Although MASS will significantly reduce human error, Ahvenjärvi (2016) argued that human error or human-task mismatch cannot be eliminated totally from unmanned ships because human element is involved in design and remote operational period. Human error might swift from an incident moment to a pre-voyage stage, due to a large scope of coding and programming (Burmeister et al., 2014b), which cannot be fully tested or reviewed until the ship is running. Due to the huge package of software programming and complicated coding, there is a big possibility that programme engineers would make some mistakes during design and programming phase and cause programme errors in the system. In addition, poor design and interface will cause more human factor problems in the further operations (Ahvenjärvi, 2016). Moreover, operators in the shore control centre (SCC) face the same or new human error hazards that they may not be fully aware of the actual conditions on the scene (Burmeister et al., 2014a). Apart from these, MASS also need periodically maintenance, either through remote control or physical contact. Both maintenance manners will cause human error as well and should be considered as the hazards of MASS operations (MUNIN, 2015). Based on above literature, this study identifies six hazards in this category, including (1) human error due to a large scope of coding and programming when designing the system, (2) failure due to poor design of on-board programme, (3) failure due to poor design of remote control centre programme, (4) human error due to remote control maintenance,(5) human error due to physical contact maintenance, and (6) human error due to unfamiliarity of how MASS may react in a unknown scenario.

3.2. Interaction with manned vessels and detection of objects

Some research addressed the interaction with manned vessels and detection of objects (MUNIN, 2015; Ahvenjärvi, 2016; Van Den Boogaard et al., 2016; Höyhtyä, et al., 2017; Wróbel et al., 2018). Van Den Boogaard et al. (2016) stated that interaction with manned vessels and other objects (like rigs, buoys and etcetera) will be a hazard to MASS as they need to be either programmed into the system or control will need to be sent to operators, either aboard or ashore. Although Komianos (2018) has stated that MASS can largely reduce the risk of collision and comply with the COLREGs, he also argued that MASS do not satisfy Rule 5 of COLREG, which requires proper look-out by sight and hearing on every ship to assess the situation and the risk of collision. MUNIN (2015) identified several relevant hazards in MASS operations, including, “collision with conventional ships in heavy traffic”, “collision with floating objects”, “failure in detection of small objects - fail to observe castaway/ wreckage”, and “failure in detection of semi-submerged towed or floating devices”. In this research, five hazards in this category are identified, including (1) collision due to poor interaction with manned vessel(s) in heavy traffic, (2) collision due to poor detection of objects or vessels, (3) failure in detection of small objects such as castaway/wreckage (4) failure in detection of semi-submerged objects that are adrift (5) failure to determine correct action when interacting with vessels that are: towing, restricted in an ability to manoeuvre, or trawling.

3.3. Interaction with the physical environment

Another category of hazard comes from interaction with the physical environment. This may include heavy weather, low visibility, areas of icing, ice navigation and strong tidal systems (MUNIN, 2015; Wróbel, Montewka and Kujala, 2017, 2018). Of these natural phenomena, icing would be the most difficult to deal with if no crew on board as it requires physical removal of the ice. This means that routeing away from the area of possible icing is the only solution to a MASS vessel without crew but may not be possible due to the trade route. In winter navigation ice conditions, weather, and navigational expertise are the factors that the most influence safety of vessels. Heavy weather manoeuvring may entail low speed manoeuvring to avoid structural damage to the vessel. All these types of manoeuvring is traditionally done in manual steering (Wróbel, Montewka and Kujala, 2017). These factors make effect on MASS operations, as the scenario may change due to location and other influences that make analysis of the situation a critical function of MASS (Burmeister, Bruhn and Walther, 2015; Rødseth and Burmeister, 2015). This study identifies four hazards in this category, including (1) failure due to heavy weather, (2) failure due to ice navigation, (3) failure due to strong tidal effect, and (4) collision due to low visibility.

3.4. System failure

Since MASS largely relies on IT, one debate is whether the system is capable as human being in the operation. The autonomous system is based on machine-learning, which requires massive training to cover most the potential situations in the real life (Bureau Veritas, 2017). However, it cannot cover all situations, and the exceptional situations are linked to the most difficult and dangerous system errors because the behaviour of the system is not predictable (Ahvenjärvi, 2016). Furthermore, the systems and software design should have certain tolerance when unexpected failure occurs (Bureau Veritas, 2017), but how to quantify the tolerance to make the system running smoothly and at the same time ensure the safety of the voyage is a challenge. Several hazards related to system failure have been discussed in previous studies (Burmeister et al., 2014b; Ahvenjärvi, 2016; Komianos, 2018). For example, Burmeister et al. (2014b) argued that communication link breakdowns will be a new hazard of MASS. MUNIN (2015) has identified a hazard related to system failure as “Jamming or spoofing of AIS or GPS signals – collision with other ships”. Based

on the above literature, this study identifies a couple of hazards related to system failure, including (1) failure due to the breakdown of communication link, (2) failure due to the jamming or spoofing of AIS or GPS signals.

3.5. Cyber risks

Due to largely rely on ICT to control the autonomous ships, cyberattacks are considered as a threat in MASS operations (Komianos, 2018; Wróbel et al., 2018), especially, it is becoming a crucial issue in the maritime industry. Many cyberattacks have been reported in recent years, such as COSCO US in 2018, Maersk in 2017, port of Antwerp in 2011-2012, Port of Houston in 2001, etc. Hand (2016) reported a speech from Lar Jensen (CEO of CyberKeel) who claimed that "autonomous ships will not become a mainstream reality in the next few years due to unresolved cyber-security issues on the technology". MUNIN (2015) also identified a couple of hazards related to cyber-attacks, including "Jamming or spoofing of communication, hacker attack, also on SCC (e.g. in case of pirate or terrorist attack) – collision with other ship", "Hacker attack on system as above – grounding in critical area (port appr.)". In this study, two hazards related to cyber risks are identified, including (1) communication between ships and SCC due to hacker attacks and (2) failure of the operation system due to hacker attacks.

3.6. Equipment failure

Equipment failure during sailing will be a problem since no sea crews work on an autonomous ship, so that the ship needs to wait for repair from a repair team from the nearest port. MUNIN (2015) has identified six relevant hazards, including "fire loss of ship or systems", "sensor failure – loss of control", "temporary loss of electricity (e.g. due to black-out) - loss of control", "failure of the ship's IT structure (e.g. due to fire in the server room) - no control", "total loss of propulsion", and "total loss of rudder function", which are also adopted in this study.

4. Control options for hazards in MASS

4.1. Education/training

Although massive learning cost has been considered as a challenge of MASS development, establishing a systematic training or educational programme is necessary in order to deal with the challenges and possible hazards in the MASS operations. Komianos (2018) suggested that maritime schools should start to introduce autonomous shipping concept to students and build simulation centres, so that students could prepare for the changes in the future. Training centre, institution and maritime organization should work together to develop the standard for the training, both in control centre on land and works at sea. Sea crews from manned ships also need to update their knowledge about how to interact with the unmanned ships (Ahvenjärvi, 2016).

4.2. Redundancy

Massive cost of duplicate equipment and system is treated as a challenge of MASS development, yet it is no doubt a solution for the emergency of equipment failure when no sea crew on board (MUNIN, 2015; Rødseth and Burmeister, 2015; DNVGL, 2018). MUNIN (2015) stated that to avoid disable critical functions by a single failure, selected systems, power generation, distribution, propulsion and steering must be redundant. Hogg and Ghosh (2016) also stated that efficient operation of MASS should equip specialised systems all with sufficient redundancy and backup operations.

4.3. On board maintenance

Solutions from other industries and within the maritime sector may offer insight into how on board maintenance may be conducted in a fully autonomous system. For example, utilising smart machines to carry out the maintenance on board; these machines may be deployed both internally and externally on a maintenance routine governed by the input from the MASS on board control station. This system may aid in detecting anomalies in the system and carry out simple maintenance task (Lane et al., 2016).

4.4. Shore Based Maintenance

Without engineers physically sailing on board, some planned maintenance cannot be done at sea. The only option for such maintenance is to do it in the port, which is called shore based maintenance (Lucas and van Zon, 2012). Shore based maintenance is becoming ever more common especially in short-sea shipping and inland waterway shipping. The shore based maintenance routine may fall under the technical control of SCC operators, who would be in control of analysing the data being received from MASS to determine a maintenance plan (Burmeister et al, 2014a). This is called a condition-based maintenance system, similar to that are found in the aviation industry (Vartdal, Skjong and St.Clair, 2018). The monitoring for the condition-based maintenance system is done while the MASS are sailing between ports and is used to prioritise what maintenance needs to be done in the next port of call and what maintenance may be postponed due to lower priority. Any non-routine maintenance may be required due to damage may impact on either the successful completion of the voyage or an efficient port operation of the MASS (Burmeister et al, 2014a).

4.5. Regulation

The challenge of regulatory barriers will increase with the increasing of the level of autonomy (Danish Maritime Authority, 2017). Komianos (2018) has addressed several regulation issues to be adopted in MASS, including SOLAS, STCW, COLREG, MARPOL, SAR, UNCLOS, etc. He argued that some of these regulations should be amended to include the scope of MASS, whereas some of them should be clarified the responsibility of MASS. For example, MASS might be able to follow SAR to provide the required assistance and it may also be difficult to avoid a man overboard or an unconscious castaway. As long as the regulations are amended the scope that includes MASS, it will be easier for the developers to design systems that are implemented at early stages that are devised for reducing or preventing accidents. To achieve this regulations, MASS may be approached through a goal-based regulation framework, orientated around industry-specific technical standard and codes of conduct for MASS (Danish Maritime Authority, 2017).

4.6. Connectivity

To support efficient and safe operations, a robust wireless communication system is deemed to be one of the critical systems in MASS. For systems to communicate internally and externally, systems need to be bidirectional, accurate

and scalable (Höyhtyä et al., 2017). The systems should be supported by multiple systems to create redundancy and minimise risk. A citadel system may be one built in system that is secured against external communications and only programmed prior the MASS departing port with key voyage information. In case any of the programmed parameters are exceeded by the main system, the citadel system will follow a pre-programmed set of security control measures and relay the incident over a secure communication system to SCC (Delft et al., 2016). Though this citadel control system may play a critical aspect of reducing risk to the vessel, the need for a robust wireless system may help support the communication system.

4.7. Insurance

Many uncertainties exist in the conventional maritime operations, and insurance is a common method to mitigate the possible negative impacts from uncertainties. In the content of MASS development and operation, insurance can also be an option against the potential hazards. This can be supported by a report from MarineInsight (2018), which mentioned that Gard is collaborating with Yara to provide the hall, machinery and P&I insurance to the first autonomous container ship - YARA BIRKELAND.

A barrier of insuring the MASS will be that it involves many Internet activities (e.g. information exchange), which will cause higher likelihood of cyber-attacks. Most of current insurance companies do not insure cyber-attacks based on the insurance policies. However, it should be reconsidered if insurers are to keep abreast of emerging technology (HFW, 2018).

5. Discussion and conclusion

This paper, as the kick-off step of developing effective risk control measures for MASS, is to conduct a state-of-the-art survey on the hazards of MASS operations. In total, six categorises of hazards for MASS have been identified, including human error, interaction with manned vessels and detection of objects, interaction with the physical environment, system failure, cyber risks, and equipment failure. Each category consist of several hazards. In addition, seven risk control options are also identified, including education/training, redundancy in equipment and system, on board maintenance, shore based maintenance, regulation, connectivity, and insurance.

For the further research, a set of interview will be conducted to validate the identified hazards and risk control options and explore more if they are not identified from the literature review. Based on the results of interview, another questionnaire will be sent out to collect the likelihood, consequence, and probability of failure detection of each hazards. Failure Modes and Effects Analysis (FMEA) with Fuzzy Rules Bayesian Network (FRBN) and Evidential Reasoning (ER) are used to evaluate the importance of the hazards in MASS. Risk matrix will also be conducted to present in a simple and common way of the results to the maritime industry.

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The influence of power and trust on potential for modal shift

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Introduction

Modal shift from road to more energy efficient transport modes, such as rail and sea, is one prioritized strategy to cope with sustainability goals (Woodburn and Whiteing, 2015). Less use of trucks reduces climate change, and limits congestion on roads and related local emissions. Research also shows the cost effectiveness of de-speeding logistics (McKinnon, 2016), and thereby, the further use of rail and sea transports should be attractive for companies' environmental work. In light of this, it is somewhat discouraging that modal shift from road to rail and sea is slow. For example, European modal split figures of 2016 show a slight decrease since 1995 of using rail, inland waters and sea for transportation in comparison with road (European Commission, 2018).

One reason for the slow progress is that several actors influence the decisions regarding mode of transport, thereby making the decision-making process more complicated. The mode of transport is often decided by transport providers or companies sending and receiving goods (shippers) (Bask and Rajahonka, 2017). Shippers need freight transport to move their goods and place requirements on that transport. Arranging and executing transport is the responsibility of transport providers, since a majority of shippers sub-contract their transport operations (Lammgård and Andersson, 2014).

To obtain modal shift in shippers' supply chains to a larger extent, change is needed. Such change requires the participation of both shippers and transport providers and interaction between them is a prerequisite for success. In fact, Styhre et al. (2019) highlights a need for improving relationships between shippers and transport providers, based on their study of modal shift from a shipper perspective. In order to do this, a better understanding of relational factors influencing modal shift is needed. Two critical change management principles, influencing the interaction between actors, are power and trust. Power balances and trust between actors may through its impact on the interaction between transport providers and shippers influence potential for modal shift, for example facilitating instigation and realisation of modal shift. Therefore, the purpose of this paper is to increase the understanding of how power balances and trust between shippers and transport providers influence a change from road to more environmentally sustainable modes of transport. This includes illuminating specific aspects of power and trust of relevance for modal shift.

Frame of reference

Numerous definitions of power exist in the literature, for example "the ability to evoke a change in another's behavior" (Gaski, 1984, p. 10). Further, power's influence on business relationships is related to the level of power an actor possesses, as more power means larger possibilities to determine the nature of exchange in inter-organisational relationships (Cook, 1977). For an actor that want to induce a change towards modal shift, high power over other actors could therefore be of importance. The amount of power can be said to stem from the power bases, i.e. the sources of power, possessed by actors in a relationship. A highly referred-to set of power bases are those introduced by French and Raven (1959) and include reward, coercive, expert, referent and legitimate power (Table 1).

The bases of power presented in Table 1 are, naturally, of different character. One distinction can be made between coercive power and the other bases of power presented. Coercive power is related to punishments, whereas the other four are non-coercive (Hunt and Nevin, 1974) and can therefore be said to relate to a brighter side of power. Indeed, there are different views in the literature concerning

whether power is "good" or "bad" (see e.g. Belaya and Hanf, 2016; Kumar, 2005). The bad side of power could for example mean that the powerful actor takes advantage of its position and acts opportunistically, whereas the good side could mean that a powerful actor uses its position to foster well-functioning relationships (Belaya and Hanf, 2016). This paper is not restricted to one of these views, but instead opens up for the possibility that power can be used in both coercive and non- coercive ways to induce modal shift.

Power bases	*Description*
Reward power	An ability to mediate rewards to a target actor
Coercive power	Includes punishment to that target
Expert power	Includes a skill or knowledge desired by the target
Referent power	The target values identification with the source
Legitimate power	A belief by the target that the source has a natural right to influence

Table 1: Bases of power (based on French and Raven, 1957)

Closely related to the discussion about the two sides of power is the discussion about power and trust. These two constructs are often seen as interlinked, but in different ways. Some authors namely view power as the opposite of trust (Kumar, 1996). Interestingly, the same author also acknowledges that trust indeed can be established in relationships with a powerful actor, as long as the weaker actor is being treated

fairly (Kumar et al., 1995). This paper takers this latter view and thereby reasons that the use of power for modal shift does not stand in contrast to the presence of trust.

Trust can be defined as "an expectation held by an agent that its trading partner will behave in a mutually acceptable manner" (Sako and Helper, 1998, p. 388). As opposed to power, trust is treated as a positive aspect of business relationships (Terpend and Ashenbaum, 2012). According to Sako (1992), there are three different types of trust: contractual, competence and goodwill. Contractual trust means a belief that collaborating actors will stay true to the contract, while competence trust entails a belief that a collaborating actor has the ability to conduct specific tasks. Finally, goodwill trust occurs when actors are willing to exceed the expected contractual agreements. The three types of trust can be said to be levels of trust, where contractual trust is the lowest level, but as relationships develop, trust also can develop and turn into competence trust or goodwill trust.

Method

Six semi-structured interviews were conducted: two with shippers and four with transport providers (Table 2). The companies were selected according to intensity in terms of modal shift and use of rail or sea, where the persons interviewed could provide information regarding performing a modal shift and activities aimed at modal shift. Each interview lasted 1-1.5 hours. The questions focused on their goods flows, drivers and barriers for using rail and sea, activities taken to increase sea and rail transport, examples of modal shifts, descriptions of how specific modal shifts were initiated, and the relationship between transport providers and shippers. At least two researchers participated at each interview. Detailed notes were taken during each interview and an interview protocol was compiled. The interview protocols were coded using NVivo, first into power and trust, and thereafter into the types of power and trust presented in the frame of reference. An analysis of types of power and trust within each interview was conducted, with attention to initiating actor and who influenced whom. The instances of power and trust were then sorted by type of power and trust. All three authors were involved in the analysis and discussion about conclusions.

Empirical results

Table 2 provides an overview of the trust and power identified in each interview in the relationships between shipper and transport provider in order to initiate and realise a modal shift. Thereafter, the presence of power and trust are described respectively drawing on all interviews.

Trust

All three types of trust (contractual, competence and goodwill) appear useful to induce a modal shift. Of contractual nature both transport providers and shippers mentioned that long-term commitment was important to dare to make changes, such as investments. Guaranteeing a long-term commitment can act as an enabler of modal shift.

Interview	*Modal shift*	*Types of power and trust*
Shipper A	A large Nordic retailer of building products described its decision to move goods flows between Poland and Sweden from road to sea.	*contractual trust*: Transport provider trusts that the shipper considers it long-term collaboration. *competence trust*: Transport provider proactively suggested the new sea transport based on knowledge about shipping and the shipper's goods flows. *goodwill trust*: both parties invested time understanding the goods flow, needs and sea possibilities. The shipper valued open and honest discussions with the transport provider. *expert power*: The transport provider knew shipping while the shipper lacked such knowledge. *reward power*: The shipper benefited from reduced costs and improved environmental performance
Shipper B	A large DIY retailer described its move to and use of rail between the seaport and warehouse.	*contractual trust*: shipper invested and guaranteed long-term commitment, signed contracts. *competence trust*: knowledge regarding goods flows is important. *goodwill trust*: shipper and transport provider are transparent and open. Both involved in awarding contract to rail operator. *reward power*: Shipper benefited from improved environmental performance
Transport Provider A	A large transport provider described its move of goods flows between the north and middle of Sweden from road to rail.	*contractual trust*: shipper guaranteed goods volumes *competence trust*: shipper and transport provider shared knowledge and had joint meetings *goodwill trust*: shipper and transport provider invested time in understanding each other. The shipper was prepared to make adjustments. *coercive power*: Transport provider only offered rail to shippers (road was not an option). *reward power*: Shipper gets improved environmental performance
Transport Provider B	A Swedish transport provider offering rail transport as their main business described how they initiate rail transport with shippers.	*expert power*: Transport provider has expertise in the niche of rail transport; the shippers lack knowledge *referent power*: shippers contact transport provider due to reputation of providing rail transport *competence trust*: shipper and transport provider jointly seek rail solution. Shipper with past experience of the transport provider returns with other goods flows. *goodwill trust*: Transport provider is honest regarding when rail is not suitable for shipper.
Transport Provider C	A Swedish transport provider described its interactions with shippers to use rail.	*competence trust*: Transport provider and shipper jointly seek possibilities during strategic meetings. *expert power*: Transport provider wants to start discussion with shipper, e.g. bring rail specialist to meeting. Shipper needs knowledge to join in discussion.
Transport Provider D	A Swedish transport provider described its work to move shippers' goods from air to sea.	*competence trust*: Transport provider and shipper jointly seek possibilities during strategic meetings. Solutions are based on shipper requirements and knowledge of goods flows and transport provider knowledge regarding transport options. *referent power*: shippers contact transport provider due to reputation

Table 2: Types of power and trust identified in the interviews

Trust in competence was the most noted of the three types of trust: level of competence, use of that competence to develop suggestions for modal shift, and joint contribution to solutions. While the knowledge level regarding use of sea and rail is low among many shippers, there is confidence that transport providers have expertise regarding using these modes of transport. Based on this trust in competence, the shippers expect transport providers to make proactive suggestions, and the transport providers take it upon themselves to make these. However, to identify when a modal shift is most suitable, the transport providers and shippers need to join their competences: the shippers' knowledge regarding the goods flows and characteristics, and the transport providers' knowledge regarding transport alternatives are both needed to find good transport solutions and modal shift. One specific example was when Transport Provider A decided to start using rail instead of road as their main offer for a specific region, and arranged meetings with one of their main customers in order to find a mutually well-functioning solution. Another example is Shipper A, who had a continuous dialogue with its transport provider regarding ideas, matching needs and possibilities. In both examples, the transport provider and the shipper shared their knowledge and needs, involving competence from various functions, such as purchasing, when needed.

Further, trust in terms of goodwill was exemplified in the interviews, including investing in the relationship, being honest and showing a willingness to make adjustments. Goodwill trust acted as an enabler of identification of suitable modal shifts, from both a shipper and transport provider perspective. In the strategic meetings, as well as meetings with a focus on a specific solution, the dialogue between the shipper and transport provider makes it possible to create such understanding of each other. For the shipper to involve also other functions can be seen as a clear sign of willingness to collaborate and invest in the relation between the two parties. There were also a few examples of shippers that were willing to make adjustments to requirements that were important to them, such as lead time and pick-up time, which enabled modal shift, as an outcome of the dialogue. As stressed by one Shipper A, the value of open and honest discussions between the parties were important to get the new sea transport solution in place.

Power

In the relationships between transport providers and shippers, a number of power bases have been identified that appears to influence the initiation of modal shift. In terms of expert power, transport providers that have a higher expertise than shippers about sea and rail and possible transport solutions can drive modal shift by making suggestions and arguing for rail or sea. For example, Transport Provider B experienced that the expertise in the niche of rail transport attracted shippers that did not have enough competence to know what rail solution fit them. Further, a Shipper A stressed the lack of expertise of sea transport in terms of “I have very limited shipping competence”, exemplifying the reliance on the transport providers’ knowledge when implementing a new sea transport solution.

Further, the transport providers may be able to drive modal shift through referent power, as can be the case when shippers contact transport providers well known for using or suggesting sea and rail. Indeed, several of the transport providers described how they were contacted, based on their reputation, by shippers.

Related to legitimate power is shippers’ susceptibility to changes. The transport providers perceive that shippers may have difficulties changing to a new transport mode since continuing with a current transport solution may be seen as more legitimate than making a change. Interestingly, Transport Provider B noted a difference in willingness to discuss modal shift depending on how long decision- makers at shippers had been at their position. Specifically, managers new to their roles were more open to modal shift, in particular if they had earlier experience of other modes. In these situations, shippers allowed transport providers to contribute with their expertise.

Coercive power was only identified for Transport Provider A, who had decided to push the shippers towards use of rail. The transport provider made this decision due to a new strategy of only offering rail in a specific region (northern Sweden). In this situation, the transport provider was clear towards the shippers in that rail was the only option provided. This meant that customers who were not willing to adapt to this change had to choose another transport provider for the desired service. For shippers, the new rail service meant adapting to earlier pick-up times, as well as later delivery times, which not all customers were willing to accept.

A modal shift to rail or sea can also provide rewards for both shippers and transport providers, mainly through improved environmental performance of the transport and in some instances lower costs. Both shippers and transport providers expressed their interest in lowering their environmental footprint and/or costs. The shippers can actively seek a rail or sea alternative from a transport provider, thus providing a reward for themselves. Alternatively, transport providers can use the benefits in their argumentation for modal shift towards shippers. Shipper A emphasised the reward of reduced transport costs from shifting goods from road to sea, and added that environmental benefits were a bonus.

Discussion

The interviews revealed instances of both power and trust as important enablers and drivers for modal shift. The five power types (expert, coercive, referent, legitimate and reward) can act as drivers towards modal shift, to initiate modal shift discussions between transport providers and shippers. A main driver for modal shift for both shipper and transport providers are the benefits to costs and environmental performance (reward power). Transport providers can initiate modal shift discussions by using their skills (expert power) to broach the subject, market or even strongly recommend sea and rail. Taken to its extreme, shippers can be told that road is not an option (coercive power). Transport providers could also use their reputation for rail and sea solutions to attract shippers (referent power). For shippers, decision-makers new to their roles can challenge traditions and evaluate modal shift (legitimate power). Transport providers with a clear niche (rail or sea transports as their main offer) could put pressure towards shippers to use their offered mode of transport. This could be an effective way to evoke a change using a combination of their expert power, coercive power, as well as referent power (attracting new customers based on reputation).

The three types of trust (contractual, competence and goodwill) are important to enable modal shift in terms of agreeing on details and actually realising a modal shift. The trust centres on establishing a setting that fosters modal shift solutions. In such a setting, shippers and transport providers can jointly discuss and find solutions with rail and sea (competence trust), and both parties commit to the new rail or sea solution (contractual trust). While Sako (1992) discussed contract trust as the first level of trust and goodwill trust as exceeding expectations, this does not appear to fit into the context of realising modal shift. Indeed, the findings suggest that it is the goodwill trust that, in the form of mutual understanding, openness and willingness to adapt, is the base for fostering modal shift solutions. When such mutual understanding and willingness to adapt exists, joint discussion and finding solutions using rail and sea (competence trust) is easier. Willingness for long-term commitment (contractual trust) may also be based in the goodwill trust.

Even if power and trust separately appear to drive and enable modal shift, the findings illustrate the importance of both, i.e. a combination of power and trust elements. One example

is if the strategic goals of the shipper and transport provider coincides. In such a case, the incentives for both parties form the basis for joint discussions regarding modal shift, as in the example where Transport Provider A made the strategic change of only offering rail. In this case, the transport provider and a shipper with large goods volumes both strived towards improving environmental performance. Thus, reward power (environmental performance) was positive for competence trust. Further, trust fills a role when the initiation of modal shift stems from power. When initiating modal shift, trust is needed for the other party to listen and from there derive solutions that will work for both parties. For example, when Transport Provider A applied coercive power and offered rail as the only solution, a few of its customers decided to change to another transport provider that could provide road transport. The decision to stay or to change may be influenced by trust, shown in willingness for shippers to take part in joint discussions and adapt their requirements.

In relation to power and trust, it is of interest to resolve which actor that has which part in a relationship. Specifically, definitions of power and trust (e.g. Sako and Helper, 1998; Gaski, 1984) start off from one actor that in one way or another have trust in, or want to evoke a change in, another's behaviour. In relation to modal shift, these roles do not seem entirely clear. Both the transport provider and the shipper may initiate the modal shift. For transport providers to initiate change, the level of trust needs to be higher than when the shipper drives the change. This could be related to the power advantage shippers have due to their supply chain position. Findings indicate that shippers' trust in transport providers is crucial to agree to a modal shift, but also that transport providers' trust in shippers was important to invest in the relationship and arrange the transport.

In addition to the five types of power and three types of trust studied, two other aspects were found as important power bases to realise modal shift: supply chain position and size of goods flows. Due to the shipper positioned as a customer in relation to the transport provider, there is a customer-supplier relation, where the transport provider depends on the approval of the shippers, to be selected or avoid being replaced (see e.g. Sallnäs, 2016). Such dependence may also act as a barrier to transport providers making suggestions regarding sea and rail, since such suggestions may involve adjustments to shippers' requirements. Therefore, in many cases the shippers need to take the initiative towards using rail or sea. Further, the findings strongly point to the transport provider being eager to meet the shippers' requirements. One exception found in this study was Transport Provider A that made a strategic decision to offer rail. This is interesting in relation to the discussion whether power is "good" or "bad" (e.g. Belaya and Hanf, 2016). The example from Transport Provider A is namely the only one where a partially bad side of power was found, as the transport provider can be said to exert coercive power towards shippers with goods flow within a specific region. In all other instances found in the interviews, the good side of power, along with trust, appears to be necessary for modal shift to take place.

For the other additional power base, i.e. size of goods flows, the findings indicate that shippers who can provide a sufficient base flow of goods are valuable to the transport providers to start a service. Indeed, findings illustrate how transport providers can initiate a new rail service as long as a shipper guarantees sufficient volumes. These goods flows can then be complemented by adding goods flows from more shippers with lower volumes. Further, another example (Shipper A) showed that a new sea transport solution was initiated where one shipper had enough volume to use available capacity on a vessel and the vessel's routing adjusted to call a small port in western Sweden were the shipper's distribution warehouse was located.

Conclusions

This paper analyses power and trust between transport providers and shippers and their influence on modal shift from road to rail and sea. Interviews with shippers and transport providers indicate that both power (expert, coercive, referent, legitimate and reward) and trust (contractual, competence and goodwill) can drive and enable modal shift. In addition to these power bases, which are common power and trust elements in previous literature, supply chain position and size of goods flow were apparent sources of power for shippers influencing modal shift. Power seems effective in order to draw the attention to, or initiate, new transport mode solutions. Trust, on the other hand, is an important element to get the other party to listen to the details and discuss possibilities, as a response to an initiative taken by the other party, but also as a base for joint discussions in which modal shift solutions are created.

Both the shipper and the transport provider could be the initiator of a modal shift where power and trust work together to evoke a change in transport modes. It appears that change is unlikely to happen if only one of these is present in a relationship between shippers and transport providers. Also, each interview revealed several types of trust and power and a combination of these therefore appear important for realising modal shift, even though the exact combination differ for each situation. Due to the shipper's power in terms of supply chain position, trust may be more important when transport providers drive the change.

The results are useful for transport providers or shippers that want to initiate modal shift. Specifically they can understand how different types of power can drive modal shift and trust enable a long-term change. To benefit more from expert and referent power, transport providers should position themselves more clearly regarding offering rail and sea solutions. Shippers can use their supply chain position power to initiate a change, but should also invest in goodwill trust and be willing to adjust their requirements.

This research contributes the field of green logistics, specifically to the literature on modal shift. While earlier literature on selection of transport mode has focused on finding the most efficient transport solution and preferences of decision-makers (Bask and Rajahonka, 2017), this paper addresses the relationship between transport providers and shippers. It adds to earlier studies on facilitators for modal shift, such as Elbert and Seikowsky (2017) by describing how power balances and trust can influence modal shift. Further, the findings confirm the results of Meqdadi et al. (2017) as this paper also finds that power influences adoption and trust facilitates implementation in a sustainability setting.

A limitation of this study is the specific focus on the relationship between shippers and transport providers,

as other actors may be of relevance in the realisation of modal shift. In the example where Transport Provider A used coercive power towards shippers, this may be a reflection of the coercive power in turn applied from the rail operator towards the transport provider. The rail operator only agreed to start the rail shuttle if the transport provider guaranteed a certain goods volume. To reach this goods volume the transport provider may have resorted to the use of coercive power towards the shippers. In the light of this, one suggestion for future studies is to include other actors than shippers and transport providers. One possibility would be to study power and trust for modal shift in networks, inspired by the study by Meqdadi et al. (2017).

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Strategy, security and defence

Military logistics – An unappreciated field of endeavour

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Introduction

This early research paper presents a systematic and narrative literature review of the current position of military logistics. The paper establishes the level and extent of UK military logistics writing within open sources literature. The works adopts a UK focus and in so doing aims to capture the both the practitioner and academic view of the state of UK military logistics. This paper forms part of an ongoing PhD. The work establishes a baseline for the review through the work of Rutner et al (2012) and Yoho et al (2012) which are critiqued and examined to establish both trends and gaps in current work. The work then moves to justify the range of literature explored and to develop a knowledge map of locations and genres of literature. The review will then identify key themes from the literate. These themes will be presented as findings and offered as research positions worthy of further research and investigation. Future work might test the current thinking through comparison of current military trends with that of the commercial supply chain management.

Literature Review

The planning review identified two baseline papers which have been used to prime the initial development of the research. Each paper reports to reflect on the current position of military logistics. Rutner et al shows the decline of military logistics output while the Yoho et al's paper shows some development in the area in peer review journals. This is challenged in that the majority of their sources reside within specialist military journals.

Rutner et al in a paper from 2012 set out the development of military logistics thought in comparison with commercial thought through the investigation of literature outputs. This paper identified the leading position of military logistics thought until the 1960s when the commercial view took the leading role in the output of literature. The Rutner et al model is challenged in the sources they adopt. Although accepting within their work that the review "…is not intended to be a complete listing of every key paper,…" (p98) the review has a bias towards a single journal with 28 "key works" of 43 coming from [US] Army Sustainment (previously Army Logistics). This has clear implications on the results and the focus towards the US with no justification of what key works means. To address this gap this review turns to Yoho et el who in a special edition of the International Journal of Physical Distribution & Logistics Management in 2013 developed a wider review of literature in which they used the ABI database to capture a range of sources. For this work they identified 276 articles using the terms "military logistics"; "Defence Logistics" and "Defense logistics" from 1952 - 2010. It is of interest to note only that this reflects an average of only 5 papers per year.

Their results although captured from a range of sources still showed a biases within the specialist practitioner journals. For their work they traced 177 articles to such publications this represents some 64%. Work by Tatham (2010) in Yoho et shows that of 1150 articles rated by Gibson et al in 2004 and Menachof in 2009 in their index of logistics research just 9 where on defence. This shows a clear disparity of results with practitioner literature taking the lead and only minor attention being placed on defence literature within graded academic journals. In addition the work of Yoho investigates peer reviewed work although they accept that "…peer-review journal has less currency among military decision makers…" (p82). This seems to identify a gap in which non peer-reviewed material needs to be captured to offer a more robust review of the current position in UK military thinking.

Description of the challenge

The challenge, outlined above, is that current literature reviews are now a decade old, reflect a heavy bias towards specialist journals particularly from the US. They do not offer a full picture of the current position in UK military logistics thinking with no real discrimination in the literature to the UK.

This paper proposes to build on the work by Rutner et al (2012) and Yoho et (2012) to update their review of literature from 2010 – 2019 through a systematic review of peer-reviewed work in UK military logistics. In addition the work develops a new narrative review of books which as Yoho argues shows the main outputs of military logistics knowledge. The work then turns to UK focused practitioner journals both from a non-uniformed specialist view such as the Royal United Services Institute and a uniformed view through organisational specific journals. The work will also review open sources military publications with the aim of capturing policy and doctrine.

Research work

This section outlines the research methods adopted to complete the literature review. This is summarized in Table 1. This paper has adopted a basic mixed and iterative approach to the literature review as outlined by Saunders (2016) and adheres to the 3 stage process outlined by Tranfield building on Moher (2015) of Planning, Conduct and Dissemination (Tranfield, Denyer and Smart 2003). This position has been driven by the nature and location of the source. Bryman argues that a systematic review offers a more robust and repeatable review which address a more comprehensive capture of the literature – clearly a desirable position (Bryman 2016). However, such a review relies on the sources being in a format which offers the ability to apply



a systematic approach. The military literature is not located in a single open source indeed personal conversations with senior practitioners acknowledge that this is weakness and gap within the MOD. This has made it impossible to apply a systematic review to literature such as military doctrine and specialist journals leading to the adoption of a traditional narrative approach (Bryman 2016) . However, the work has tried to apply the same search criteria to offer some consistency. It is accepted that this only offers what might be described as a reasonably comprehensive review (Bryman, 2016 p91).

To start the systematic search of the literature there must be an outline and justification of the terms that will be used within the search (Bryman 2016, Saunders, Lewis and Thornhill 2016). To start this there is a need to define those search terms which were used this allows the work to be focused, systematic and meticulous within its results (Tranfield, Denyee and Smart 2003). Referring back to the bassline articles the use of military as a search term is used by Rutner et al as the key theme. This however is not justified in detail and so leaves a question to its robustness as a key search term. Yoho et all partly address this by widening the search term to include a more holistic view captured in the term defence and defense. But again these terms are not justified. There is a clear need to confirm the terms used to offer validity to the research

The focus of this work is both the UK military and logistics and so each term will be justified while accepting their precedence sent in previous reviews. Such an all-encompassing phrase, as military, is firstly explored through it generally accepted view as seen in a dictionary. For the new Penguin New Dictionary Military as a noun is: a countries armed forces. This would seem appropriate until we try to develop the scope of the word. Within the UK armed forces there are three uniformed services: The Royal Navy (RN) (including the Royal Marines), Army and Royal Air Force (RAF). But this reflects a very traditional view of the term military. Modern defence organisations include the uniformed armed forces but extend beyond this to include its home base and industry (Tuttle 2005)(Kress 2016). For the UK the concept of the Whole Forces Approach has been adopted (Smith 2018, Land Warfare Devlopment Centre. 2017)(MOD. 2015). This moves the defence organisation into the boundaries of the MOD and its associated infrastructure such as the Civil Service as well as industrial partners. For the MOD the Whole Force Approach is about establishing partnering arrangements between the military, civil servants, contractors and the wider defence industry(MOD. 2015, Smith 2018) (Moore 2014). This can be seen as an historical theme and summaried with Clausewitz's triad of people, army and government (Strachan 2007). From this perspective the whole force approach offers a wide coverage of what might be deemed military into a defence theme. Therefore the work uses both military to capture the uniformed service and defence to reflect the wider Whole Force component parts.

The next step in the review will be to consider the search term for the logistics elements of the review. For the military the terms logistics is used comprehensively both as a substitute for the commercial view of SCM and as a functional activity within the SC. The standard definition, for the UK armed forces would be the NATO definition (MOD. 2015).

"The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations which deal with:

- design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel;
- transport of personnel;
- acquisition or construction, maintenance, operation, and disposition of facilities;
- acquisition or furnishing of services; and
- medical and health service support."

This NATO definition is clearly wide in scope and reflects the need and ability of the Armed forces to be able to sustain themselves in any conditions. This is not a new view and can be traced back to a scientific definition with Thorpe in the first war (Thorpe 1986), through the second war refinement (Huston 1966, Eccles 1959) and into the NATO handbook (NATO. 2012). Indeed the definition of Eccles in 1959 is not substantially different from the current definition within the UK. This vast topic needs to be treated with care to ensure that it offers a quantifiable and useful position. To address this and offer a filter in which the broad spread of military logistics is refined into a commercial view of logistics the work adopted the practitioner definition of logistics of the CSCMP (2019) which is also used by Mentzer (Mentzer, et al. 2004) in his application to defining a unified theory of logistics:

"Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements."

This definition acted as a test to confirm that the article was indeed focused within the traditional commercial view of logistics operations. But this did not offer a model to synthesise the literature into describable groups. Tranfiled argues that the systematic review must also offer a structure for its analysis of the data (Tranfield, Denyee and Smart 2003). For him "Research synthesis is the collective term for a family of methods for summarizing, integrating, and, where possible, cumulating the findings of different studies on a topic or research question." (217). For this work a simplistic data-extraction form was used- see Table 1. The work accepts the limitations of this in terms of personal bias and single user interruption. But argues that this step allows a record of the analysis to be developed and offers evidence of scrutiny and repeatability based on a pragmatic approach which Pawson calls "what works for whom in what circumstances" (218). Further minor refinement was added to the search terms to reflect the UK focus. For example English and UK only within the post 2010 timeline set out above.

Results/analysis

Building on the methodology of Yoho this paper follows the initial work based in the ABI database but then applies a systematic review. The results shown in Table 1 only capture 5 results using the search terms. This clearly shows a gap. To test this the same search was applied to a second database

Scopus with the result of 33 matches. Of the combined total of 38 results (2 were matched on both searches leading to a total of 36 results). Of these 10 were identified as No Relevant Content (defined

as no significant logistics/SC content- tested against the agreed definition). The 26 remaining were coded into groups to reflect the main theme of the work. 14 of these were coded as Equipment Support/News (defined as news of equipment such as missiles being exported). The remaining 12 can be seen as reflecting more traditional content of logistics academic thought based on the definitions of NATO and Mentzer explored above including research (Table 1 offers detail). The literature, at the peer reviewed level, seems to offer only 12 articles which might be seen as based on logistics or SC theory. The Non-uniformed specialist professional journal Royal United Services Institute for Defence Studies can be seen as a base for more critical review of defence thinking and its application to the MOD. This review based on an EBSCO review continues the systematic approach. Of the 18 articles matched 8 were coded as No Relevant Content and 2 reviewing historical case studies with minor links to logistics. 3 offer insight into the role of logistics as a strategy enabler which reflects a theme from often cited texts such as Martin (Martin 2016)and Kane(Kane 2001) going back to strategy thinkers such as Sun Tzu (Griffith 1971), Jomini and Clausewitz (Van Creveld 2007, Thompson 1998, Sarin 2014). The final 5 fit into traditional view of logistics and procurement operations. With the support of the Army Library services a systematic review of the Defence Management Journal was also completed identifying only 2 sources. 1 a review of a logistics organisation the other a reflection on an operation.

The Books offer three genres. The first is that of the Historic case studies. These follow a tradition within the Genre that go back to the seminal work of Van Creveld (Kane 2001, Van Creveld 2007). These explore the role of logistics trough explorations of military campaigns and then reflect on the lessons to be applied to logistics. Although work such as Macdonald (2019) and Maginniss (2018) follow an historical prisms of research representing the story of campaign. Sarin represents the practitioner academic who reflects on the role of logistics in their service, It should be caveated that Sarin (Sarin 2014) represented a view of the Indian Army but offers an insight into the lineage of such writing going back to 1917 with Thorpe (Thorpe 1986) and continuing through to Eccles in 1959 and onto Thompson in 1998. The final genre is that of the academic. These capture the military SC and make links to the underpinning theory often with commercial logistics comparisons. Kress for example makes strong links to operational management and the transformation model. An important point is that 2/3 of the texts sit within Cranfield University and the Defence Academy. The review of Smith et al (2018) reflects an Integrated Logistics support focus with platform support being a core theme. While Moore and Antill (2014) offer a procurement focus linked to some case studies. Although the case studies often wander from the logistic and procurement focus. The work of Kress (Kress 2016), outside of Cranfield, presents the core logistics themes within the prism of operational logistics which can be seen as the coordination of the SC at the operational strategy level reflected by academic operational management thinkers (Slack 2017).

The Uniformed journals are in house magazines and might be seen as Grey literature (Saunders, Lewis and Thornhill 2016). These can be seen as offering the view of logistics from the practitioner and therefore an insight into current practice. The British Army Review, with access support from the Army Library Service, identified only two articles with a distant link to logistics. The RAF Logistician is shown in detail here within 8 monthly issues only 11 articles which might be linked to the definitions adopted and have a basis in academic theory are captured (details can be seen in Table 1). Of these 5 explore the developing nature of the SC and the support network.

The Open Source Military doctrinal publications have been sourced through both library and internet searches. However some guidance has been provided by military practitioners in the themes and areas to search. The nature of these publications are hierarchical and can be seen as a prescribed strategy making model. This reflects a top down approach for the creation of the logistic resources required. Smith argues the utility of force and its strategic development is best explored through the military idiom of end, ways and means (Smith 2006). He see this as a structure in which to capture the strategic outcome outlining how this will be achieved and then the resources needed to achieve the aim. This resonates strongly with other strategy making models such as seen by Lynch (Lynch 2018). The end is articulated through the national strategies of the UK and its articulation in the

Defence Strategy which sets the national agenda. Here the driving doctrine of way to achieve the ends are prescribed in The NATO Logistic handbook (NATO. 2012). This in turn radiates into the national joint doctrine underpinned by NATO philosophy (MOD. 2015, Cheif of the Defence Staff. 2015). The culmination of this is the development of single service doctrine which outlines how each armed force will achieve its mission and the resources they use to support it.

Discussion and conclusions

This review has moved beyond the boundaries set by Rutner et al and Yoho et al to develop a knowledge map of the location and scope of both practitioner and academic sources of thought within military and defence logistics and is shown below:

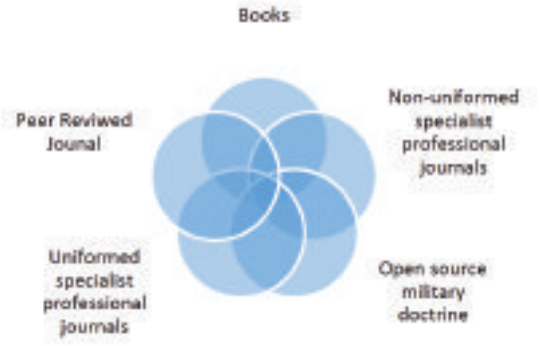


Figure 1

It is clear that to capture an epistemological position which offers an accurate picture of the current thinking then military/ defence logistics thinking has to be extended into fields which do not readily allow systematic reviews. This impacts the

deployment of a comprehensive review of all materials to a narrative approach reliant on what might be described as breadcrumb search from one text to the next through citations. Although this offers an approach it does not match well to the mix of databases and semi closed location of available sources. This acts as a barrier to research particularly within the need to build a coherent review based across silo organisations such as the military and defence sector as called for in the Whole Force Approach. The work also shows the limited sources available to the researcher. A simple count shows 86 sources captured through the review that matched the criteria and were tested against the definitions. An average of 9 texts per year. This clearly shows a gap in the articulated output of UK military and defence logistics.

While this work has deliberately set in place a time window to build on the work of others it acknowledges that much of the underpinning theory within the military can be traced back to previous ages and needs to be included to offer a coherent context for modern logistics thinking. An example would be the use of Jomini and Clausewitz in many texts as a starting point for the need to build a triumvirate of strategy, tactics and logistics and ensure their alignment to meet outcomes (Kress 2016, Huston 1966, Eccles 1959, Martin 2016, Kane 2001, Van Creveld 2007, Thompson 1998). Similarly the reach back also shows some underpinning and enduring concepts such as logistics being the bridge from the home industrial base to the deployed force (MOD. 2015, Thorpe 1986, Van Creveld 2007). The work has identified some key themes which will underpin future study and these are briefly articulated:

Project logistics – This is the need to build infrastructure as required for particular operations. The literature demonstrates that the SC and logistics activities need to be aligned to the declared strategies (Moore 2014, Martin 2016, Pagonis 1992). This makes logistics an enabler of the ways adopted to meet ends (Thorpe 1986, Eccles 1959, Van Creveld 2007, Thompson 1998)and an arbiter of opportunities for the commander (Huston 1966, Kane 2001). Each SC is built to meet unique situations and needs.

Contradiction of austerity V flexibility – A theme of discontinuity can be seen between the declared aims particularity at government level and the capacity enabled by funding(Smith 2018, Sarin 2014, Foxton 1994) For example the challenge of meeting austerity targets while reaming flexible and agile enough to meet new demands on defence. It offers a view of the need to build SC strategies that meet low cost and agile apparitions as outlined in Leagile or hybrid strategies (Christopher 2016).

Platform Centric Logistics - As warfighting has evolved the use of “platforms” to deliver military effect has grown and become a focus for the logistician. This is seen within the literature as the growth of complexity (Tuttle 2005, Smith 2018).

Future Work

Echoing the unanswered call from Yoho in 2013 this works calls for research into a sector which is a core function of government and attracts £38 billion in the UK. The work concludes with a call to move the study of military logistics away from the Unappreciated Field of Endeavour of The fictional character of “Gunny” Highway played by Clint Eastwood into a central theme to enable the delivery of the military effect so now dependent on sustained logistical support.

Type of Literature	Methodology	Search terms	Source	Coding
Peer reviewed academic journals.	Systematic literature review (Bryman 2016) (Saunders, Lewis and Thornhill 2016) (Tranfield, Denyee and Smart 2003).	Military Logistics AND Defence Logistics OR Defense Logistics 2010- 2019- Full text - Peer reviewed- UK- English Abstract, Title,	ABI =5	Supply network= 1 Procurement= 1 Research needed = 1 Reverse Logistics = 1 No Relevant content= 1
		(TITLE-ABS-KEY (military AND logistics) AND TITLE-ABS-KEY (defence AND logistics) OR TITLE-ABS-KEY (defense AND logistics)) AND (LIMIT-TO (AFFILCOUNTRY , "United Kingdom")) AND (LIMIT-TO (EXACTKEYWORD , "Logistics")) AND (LIMIT-TO (LANGUAGE , "English"	Scopus =33	Logistics and Stagey= 1 Equipment Support/news= 14 No Relevant content= 9 Contracting= 5 Integrated Logistics support= 2 Procurement= 2
Books	Narrative Review (Bryman 2016)	Military Logistics AND Defence Logistics OR Defense Logistics and Supply chain	Privratsky (2014) Macdonald (2014) Macdonald (2019) Maginniss (2018) Boiland (2017) Stone (2017)	Historic case studies Falklands Military catering World War 1 World War 1 World War 2
			Sarin (2014)	Practitioner academic
			Smith et al (2018) Moore & Antill (2014) Kress (2016)	Academic
Non-uniformed specialist professional journals	Systematic literature review (Saunders, Lewis and Thornhill 2016)	Search title Logistics 2010 = 2018 Academic journal Great Britain Military Defence or Defense was not applied as this is the focus of the journal	Royal United Services Institute =18	Logistics and Stage = 3 Historical view= 2 Operations and Logistics= 3 No Relevant content= 8 Procurement= 2

	(Trainfield, Denyee and Smart 2003).	Military Logistics AND Defence Logistics OR Defense Logistics 2010- 2019- UK	Defence Management Journal = 2	Logistics Organisation overview= 1 Operational report= 1
Uniformed specialist professional journals	Narrative Review (Bryman 2016)		British Army Review = 2 The RAF Logistician = 11	Capabilities review=1 Case study=1 Contractor Support= 2 Operational report= 4 SCM= 3 Logistics Policy=1 Defence Support network= 1
Open Source Military doctrinal publications	Narrative Review (Bryman 2016)	Military Logistics AND Defence Logistics OR Defense Logistics and Supply chain	NATO Logistics Handbook (2012) Allied Joint Doctrine for Logistics (2018) National Security Strategy and Strategic Defence and Security Review (2015) UK Defence Doctrine (2104) Logistic for Joint operations (2015) Army Doctrine Primer (2011)	NATO Logistics Doctrine NATO Logistics Doctrine UK Defence Strategy UK Defence Strategy UK Joint operational Procedures Army Doctrine introduction

Table 1: Literature Review Findings and Methods

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Constructing the defence strategies criteria for maritime piracy attack in the shipping companies

Po-Hsing Tseng, Zhao-Cher Her, Nick Pilcher

To help ships improve their defence against piracy attacks and strengthen their protection mechanisms and risk management abilities.

1. Introduction

Maritime piracy is defined as any illegal act of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship based on Article 101 of the 1982 United Nation Convention on the Law of the Sea (UNCLOS)[1]. In recent years, maritime pirate attacks and armed robbery have evolved to become more organized and international crime activities (e.g. Somali piracy (Gikonyo, 2018)) and have also been connected with terrorism (Pristrom et al. 2013). Such a phenomenon has brought serious global problems and shipping economic loss (Abila and Tang, 2014). A US study found that maritime piracy costs the global economy between $7~12billion a year.[2] Also, piracy involves the hostage, ransoms, human cost and mental health problems (e.g. post-traumatic stress disorder). What is more, piracy is a perennial issue and despite attempts to prevent piracy, it remains resurgent today, showing a doubling in attacks from 2016 to 2017 off the horn of Africa (Africa News, 2018). In 2011, Witherby Publishing Group (2011) published "Best Management Practices for Protection against Somalia Based Piracy" and provided planning and operational practices for ship operators and masters of ships transiting the high risk area. Yet, piracy attack strategies are dynamic and not readily predictable due to the fact that pirates already understand how ship operator and masters defend their ships based on available information and past attack experiences (Witherby Publishing Group, 2011). In terms of solutions to piracy, these are fraught with challenges and obstacles to their achievement. It is generally considered ideal, although not currently feasible, to deal with piracy by making the social conditions and welfare of the countries the pirates are from greatly improved (Baniela and Rios, 2012). This however, is only be possible through strong state aid, and Somalia, where a major source of piracy is from, remains, a 'stateless' country according to some (e.g. Baniela and Rios, 2012). Indeed, levels of corruption are so high in Somalia that in Transparency International's Corruption Perceptions Index of 2017 Somalia was ranked in last place at number 180 out of 180 (Transparency International, 2017). Not only this, but current legal situations mean it is often extremely challenging to reprimand, incarcerate, and then prosecute pirates (Pristrom et al. 2013). There are issues involved in the fact that once a vessel has been boarded, the situation changes from one of piracy to one of hostage/ransom (Fawcett, 2010). Furthermore, proceeding with legal prosecution of piracy often involves the need for crew members to be away from the ship for a lengthy period of time, and captains are reluctant to lose valuable crew members for such time (Fawcett, 2010).

Another ideal solution to protect ships is that of navy protection, and whilst successful, the investment required to ensure navy protection is simply unfeasible. Not only is the area and hotspots (Pristrom et al. 2013) or 'chokepoints' (Fu et al., 2010) of piracy that vessels would be required to patrol unfeasibly extensive at 2.5 million square kilometres (Fawcett, 2010), but the ideal of convoys (Fawcett, 2010) is simply impractical given the different schedules of shipping companies. Not only this, but there is arguably a vicious cycle whereby in times of economic hardship, not only does serious crime, and also piracy, increase in times of economic hardship (Bateman, 2010), but ship owners are also forced into cutting costs and substandard ships may be used. It is these substandard, aged ships that are the most vulnerable to piracy attacks (Bateman, 2011). The extreme severity of piracy attacks is explicitly illustrated by the case of the Rak Afrikana. After pirates had hijacked the ship, Captain Kumar was subjected to mental and physical torture, and suffered a brain hemorrhage and died shortly after the ordeal (Bateman, 2011).

Given this severity and the huge challenges involved with dealing with piracy onshore and protecting ships through naval convoy, it is fully understandable that ships have taken matters into their own hands and attempted to protect themselves. In order to reduce potential life and property loss in commercial vessel and ransom payments, shipping companies have developed various strategic measures against pirates, such as crew security training, employment of armed guards on vessel from the professional security companies, insurance, and so on. (Phillips, 2009; Fu et al., 2010; Pristrom et al., 2013). Although some international organizations (e.g. international maritime organization, international maritime bureau, etc.) have a number of conventions or regulation polices to solve pirate issues, pirate attack incidents still happen. For example, in 2009, a containership (Maersk Alabama) was attacked by piractes and Captain Richard Phillips was taken as hostage in the Indian Ocean by pirates led by Adduwali Muse. This incident gained international fame through being made into a film starring Tom Hanks in 2013.[3]

For the Europe-Far Asia shipping trade, the Gulf of Aden is a key gateway since most ships must access the Suez Canal. Otherwise, they must shift to the alternative route via the Cape of Good Hope and consequently spend extra time and costs. However, the piracy threat near the Gulf of Aden has inevitably affected shipping companies' sailing decisions and schedules (Fawcett, 2010). Based on the statistics of

1 http://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm
2 http://www.bbc.com/news/world-africa-15623805
3 https://en.wikipedia.org/wiki/Captain_Phillips_(film)
4 https://www.icc-ccs.org/icc/imb

International Maritime Bureau[4], there are 180 pirate attacks all around the world in 2017. Past studies on piracy have focused on various aspects, such as international law or community (Baniela and Rios, 2012), insurance (Tseng and Li, 2013; Tseng, 2014), regimes (Gikonyo, 2018), economic impact and human cost (Yang, 2010; Bateman, 2011) and the influence of economic development (Fu et al., 2010), ship vulnerability (Bateman, 2010), and research into strategic evaluation of approached to defence is still limited. Critically, given the urgent need to defend themselves in times of economic hardship and tight time schedules, ships are under pressure to prioritize scarce resources and time to the optimum value when protecting themselves against potential piracy attack.

In order to investigate effective methods for ships to defend the piracy attack and strengthen the protection mechanism and risk management ability, this paper adopts a fuzzy analytic hierarchy process to construct the key strategic criteria and sub-criteria for protection of ships against piracy attack by shipping companies. The research findings can be used for risk evaluation of sailing safety with the underlying aim to reduce the potential human life loss and injury, shipping economic loss (including vessel, cargo and crew costs) and international regulations on the subject. The remainder of this paper is organized as follows: Section 2 reviews current pirate attack situation and defensive criteria based on past studies. Section 3 describes the methodology of Fuzzy Analytic Hierarchy Process. Research findings are illustrated in Section 4, and Section 5 discusses these results and draws key conclusions for policy makers and shipping companies.

2. Literature Review

2.1. The statistics of maritime piracy attack

According to the International Maritime Organization (IMO)5, major piracy attack areas are the South China Sea and West Africa, followed by Straits of Malacca and Singapore in 2016 (Table 1).

Area	South China Sea	Straits of Malacca and Singapore	Yellow Sea	Indian Sea	Arabian Sea	East Africa	West Africa Coast	South America (C)	West Africa	South America (P)
In international waters	19	0	0	1	0	0	0	0	33	0
In territorial waters	27	4	2	1	4	0	0	2	4	2
In port area	26	17	5	8	0	4	1	11	25	93

Table 1. Statistics of global piracy attack areas in 2016
Source: International Maritime Organization http://www.imo.org/en/Pages/Default.aspx

Regarding the countries comparison, based on data from the International Maritime Bureau[6], Table 2 shows the number of piracy attack during 2013~2017 and majority are Indonesia and Nigeria.

Location		2013	2014	2015	2016	2017
S.E.Asia	Indonesia	106	100	100	49	43
	Malacca Straits	1	1	3	--	--
	Malaysia	9	24	15	7	7
	Philippines	1	6	11	10	22
	Singapore Straits	9	8	9	2	4
	Thailand	--	2	1	--	--
EAST ASIA	China	--	--	4	7	2
	South China Sea	4	1	--	--	--
	Vietnam	9	7	27	9	2
INDIAN SUB CONT	Bangladesh	12	21	11	1	7
	India	14	15	15	14	4
AMERICAS	Brazil	1	1	--	--	--
	Colombia	7	2	5	4	6
	Dominican Republic	1	-	--	--	--
	Ecuador	1	--	--	--	2
	Guyana	2	1	--	2	1
	Haiti		--	1	1	1
	Mexico	--	--	--	1	--
	Peru	4	--		11	2
	Venezuela		1	1	1	12
AFRICA	Angola	--	1	--	2	1
	Benin	--	--	--	1	--
	Cameroon	--	1	1	--	--
	Democratic Rep. of Congo	--	1	3	2	--
	Egypt	7	--	1	--	--
	Gabon	2	1	--	--	--
	Ghana	1	4	2	3	1
	Guinea	1	--	3	3	2
	Gulf of Aden*	6	4	--	1	1
	Ivory Coast	4	3	1	1	1
	Kenya	1	--	2	2	1
	Liberia	--	1	2	--	--
	Mauritania	1	--	--	--	--

Table 2. Location of actual and attempted attacks (2013~2017).
Source: ICC International Maritime Bureau 2017
*Note: All incidents with *above attributed to Somali pirates*

During 2013~2017, as Table 3 below shows, the major type of piracy attacks were boarding the ship, followed by attempted boarding, hijack and attempted.

Type	2013	2014	2015	2016	2017
Attempted	28	28	27	22	22
Boarded	202	183	203	150	156
Fired upon	22	15	--	12	10
Hijack	12	21	19	7	0
Total	264	249	248	191	188

Table 3. Comparison of the type of attacks (2013~2017).
Source: ICC International Maritime Bureau 2017. https://www.icc-ccs.org/icc/imb

Regarding the types of violence towards the crew, Hostage taking was the most used strategy by pirates, followed by Kidnapping, Injury, Threats and Assaults. Arguably, pirates take hostages to help them obtain more negotiating power and ask for more ransom money from ship owners or related units (e.g. insurance company, government organization) (Table 4). In total, the number of violent acts towards crew were 191~479 and the trend was one of decreasing to 2017, although as noted above (Africa News, 2018) these numbers may show an increase as more recent figures are released.

5 International Maritime Organization. http://www.imo.org/en/Pages/Default.aspx
6 https://www.icc-ccs.org/icc/imb

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Type	2013	2014	2015	2016	2017
Assaulted	–	1	14	5	6
Hostage	304	442	271	151	91
Injured	21	15	14	8	6
Kidnap	36	9	19	62	79
Killed	1	4	1	–	1
Missing	1	1	–	–	–
Threatened	10	9	10	10	10
Total at year end	373	479	353	236	191

Table 4. Types of violence to crew (2013~2017).
Source: ICC International Maritime Bureau 2017

Regarding the ship types, tanker chemistry/product and bulk carriers were more frequently attacked by pirates due to the following reasons: (1) the speed of these vessels is quite slow compared to other types of vessels; (2) they have lower standards of ship maintenance and crew proficiency and; (3) they have a lower freeboard when laden (Bateman, 2010; Pristrom et al., 2013) (Table 5).

Type	2013	2014	2015	2016	2017
Accommodation Barge	–	–	–	1	–
Bulk Carrier	55	55	80	52	58
Cable Ship	–	–	1	–	–
Cement Carrier	–	1	–	–	1
Container	58	28	30	10	23
Dhow	1	–	–	–	3
Dredger	–	–	–	1	–
General Cargo	17	14	15	11	12
Heavy Lift Vessel	–	–	–	4	–
Heavy Load Carrier	–	1	–	1	–
Hopper Dredger	–	–	1	–	–
Landing Craft	1	–	–	–	–
Livestock Carrier	1	1	–	–	–
Offshore Processing Ship	–	1	–	–	–
Ore Carrier	–	–	1	1	–
Passenger Ship	–	1	1	–	–
Pipe Lay Barge	–	–	1	4	–
Pipe Layer Crane Vessel	–	–	1	–	–
Refrigerated Cargo	2	–	1	1	2
Research Ship	–	2	–	2	2
RO-RO	1	2	–	–	–
Supply Ship	5	3	2	4	8
Support Ship	–	1	–	1	2
Tanker Asphalt/Bitumen	3	4	–	1	1
Tanker Bunkering	–	2	1	–	1
Tanker Chemistry/Product	52	80	62	304	42
Tanker Crude Oil	39	24	20	11	18
Tanker LNG	–	1	–	1	3
Tanker LPG	9	13	4	20	13
Trawler/Fishing	2	3	2	1	1
Tug/ Offshore Tug	10	7	10	14	11
Vehicle Carrier	–	2	1	2	–
Wiper Barge	–	1	–	–	–
Wood Chips Carrier	–	–	2	–	–
Yacht	–	–	1	–	–
Total at year end	284	245	244	164	188

Table 5. Types of Vessel attacked (2013~2017).
Source: ICC International Maritime Bureau 2017. https://www.icc-ccs.org/icc/imb

Commonly, when conducting an attack, pirates use two or more small high speed (up to 25 knots) boats with AK 47 rifles and pistols which are carefully coordinated to attack commercial ship (Fig. 1.). When approaching the commercial ship, they will use a long lightweight hooked ladder to climb the side of ship and occupy the ship.



Fig.1. (a) piracy boat; (b) piracy boat
Source: Witherby Publishing Group (2011)

In order to defend against pirate attacks, ships can be equipped with razor wire around the deck or use a water spray to block the pirate's boat. Also, since the bridge is similar to the brain of the ship, steel bars are always used to protect the bridge whilst sailing in high risk area (Fig. 2).

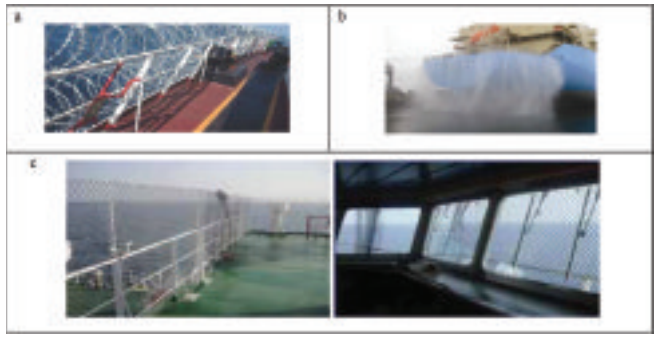


Fig. 2. (a) metal spike; (b) water spray; (c) protective metal mesh for the side and rear bridge windows.
Source: Witherby Publishing Group (2001)

2.2. Defence strategies criteria

There are many defence strategies used for pirate attack, we summarized three criteria and 10 sub-criteria based on past studies.

2.2.1. International conventions and policies

Up to now, many international conventions and policies have been developed and implemented in attempts to strengthen maritime safety and security, such as International Safety Management Code (ISM), International Convention for the Safety of Life at Sea (SOLAS), Port State Control (PSC), International Ship and Port Facilities Security Code (ISPS), and so on (Mukherjee, 2007; Bateman, 2010; Hallwood and Miceli, 2013; Pristrom et al., 2013; Weihai, 2017). The International Maritime Organization[7] and the International Maritime Bureau[8] have regularly collected information on piracy and suggested effective defence polices for global shipping operators and other related stakeholders (Kundsen and Hassler, 2011). For example, generally speaking, each shipping international company must develop its own ship security plan. The captain and all the crew are required to understand its operation procedure and contents. Also, in order to analyze dynamic pirate activities and develop effective defensive strategies, international maritime security organizations (e.g. the Security Center, Horn of Africa[9]) regularly collect piracy related information and have developed anti-piracy guidance for industry and shipping companies. However, Yang et al. (2013) suggest anti-piracy policy making should contain more proactive elements. Practically, maritime security service can include private security companies who organize armed personnel on board and naval (air) escorts (Weihai, 2017). Here, sub-criteria include ship security plan, piracy information collection and analysis, navy patrol protection participation, and armed guards on vessel.

7 http://www.imo.org/en/Pages/Default.aspx
8 https://www.icc-ccs.org/icc/imb
9 http://eunavfor.eu/the-maritime-security-centre-horn-of-africa/

2.2.2. Defence strategies in different high-risk areas

In order to defend against a variety of potential piracy attacks, it is argued that the captain's maneuvering and management ability are key since captains must effectively handle all emergency incidents and take appropriate decisions (e.g. ship speed, steering, etc.) (Weihai, 2017). Also, shipping companies usually evaluate high risk areas (e.g. the Gulf of Aden, Arabian Sea, Northern Indian Ocean and the Strait of Malacca) and arrange safe sailing routes and schedules for shipping services (Pristrom et al., 2013). Furthermore, for each shipping company, it is essential that the captain and all crew must clearly understand security procedures and operate protective equipment and respond to piracy incidents. Here sub-criteria include the captain's maneuvering and management ability, sailing planning and schedule, and the crew's response ability.

2.2.3.Ship's hardware and software

In order to identify or deter piracy threats, a qualified ship must be equipped with hardware and software facilities, such as communication systems (e.g. automatic identification system, radar signal, etc.) and physical barriers for ship protection (Witherby Publishing Group, 2011; Pristrom et al., 2013; Weihai, 2017). Bateman (2011) shows that many seafarers have served in sub-standard vessels and are exposed to a higher risk of being hijacked by pirates. Therefore, strengthening a ship's construction and ensuring it has the necessary hardware and software are vital to avoid and prevent piracy attacks. Here sub-criteria include communication facilities, physical barriers for ship protection, and ship alarm facilities. The above criteria and sub-criteria from the literature review can be summarized, as shown in Table 6.

Criteria	Sub-criteria	Description	Reference
International Convention and Policy	Ship security plan	Well organized ship security plan for shipping companies	Roe (2008); Bateman (2010); Fawcett (2010); Witherby Publishing Group (2011);
	Piracy information	Shipping companies and international	
	collection and analysis	organizations search and analyze piracy's activities and present effectively defence policies	Hallwood and Miceli (2013); Pristrom et al. (2013); Weihai (2017)
	Navy patrol protection participation	Navy conduct patrol service and avoid piracy attack in high risk areas	
	Armed guards on vessel	Shipping companies hire armed guards on vessel and vessel safety protection enforce	
Defence strategies during various sailing areas	Captain's maneuvering and management ability	Captain use ship maneuvering skills (e.g. ship speed, steering, etc.) and leadership management ability to avoid piracy attack	Witherby Publishing Group (2011); Pristrom et al. (2013); Weihai (2017); Maritime Security Centre, Horn of Africa [10]
	Sailing planning and schedule	Adequate sailing schedule design and time planning to guide ship moves non-piracy attack area	
	Crew's response ability	Crew can effectively implement various ship protection plans and procedures (e.g. establishing a safe muster point or secure citadel) during high risk area (e.g. Navy and the Guard of Hormuz to the North, IRTC and 78°E.)	
Ship's hardware and software	Communication facilities	Using communication facilities (Radio, automatic identification system (AIS), VHF(Very high frequency)/SSB(Single-Sideband Transmit), CCTV) to identify any specific threat and provide ship position report to maritime safety units (e.g. UK Maritime Trade Operations (UKMTO) in Dubai, The Maritime Security Centre – Horn of Africa (MSCHOA))	Herbert (2003); Witherby Publishing Group (2011); Weihai (2017); Maritime Security Centre, Horn of Africa [11]
	Physical barriers for ship protection	Using physical facilities to increase the height and difficulty to prevent piracy's potential attack and boarding (e.g. razor wire, the use of water cannon). Providing additional protection to budget issues	
	Ship alarm facilities	Using alarm facilities (e.g. lighting, dummy objects) to deter piracy attack	

Table 6. Summary of criteria and sub-criteria

3. Methodology

The methodology for any Fuzzy Analytic Hierarchy Process (FAHP) is always situated in the middle of the standard procedures for most research projects in that the research problem is first identified and the literature is then reviewed to identify key areas for investigation. Similarly as with most standard research procedures, the analysis is then followed by discussions and conclusions. The actual FAHP procedure itself consists of 4 key stages: firstly the combination of a standard Analytic Hierarchy Protocol (AHP) and Fuzzy Theory to identify key criteria from the literature for a questionnaire. Following this the questionnaire is designed and pre-tested before being rolled out to key participants. The next stage is to administer the questionnaire to the key participants and, following the collection of effective questionnaires, to analyze these effective questionnaires to prioritize the criteria and sub-criteria. This prioritization reveals the key criteria for any discussion and conclusions to be drawn for stakeholders. We describe these four key method stages in more detail here below but first we visually represent the overall process of the research for summary and clarity here (with the four method related stages in bold) in Figure 1: Stages of an FAHP approach:

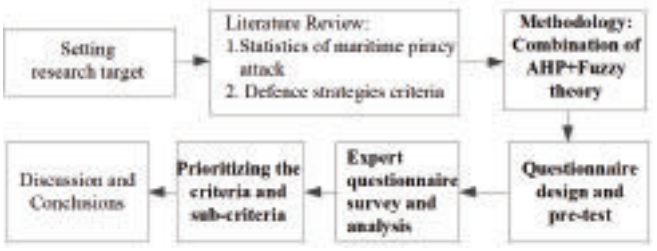


Figure 1: Stages of an FAHP approach

3.1. Justification of the Fuzzy Analytic Hierarchy Process (FAHP)

In this paper, the decision to develop piracy defence strategies for shipping companies involved the consideration of four influential criteria. From the perspective of the international shipping industry, such a decision should be taken at a corporate or strategic level and be based on a group decision. The fuzzy analytic hierarchy process (FAHP) is a highly effective technique for analyzing multi-criteria decision making (MCDM) problems and has been widely used in many fields, such as shipping (Tseng and Kevin, 2018), logistics (Fu et al., 2015), management science (Ahmed et al., 2016), and others. Using this technique, fuzzy linguistic variables and associated fuzzy triangular numbers can be used to make comparisons between the influential attributes and consequently provide effective solutions to vague and uncertain problems in decision making (Zadeh, 1965; Saaty and Vargas, 2012). Therefore, FAHP is selected as the most appropriate technique to analyze the piracy defence criteria decisions contained herein. Ultimately, this method can be justified because we combine fuzzy theory with the AHP method (Saaty, 1980). Subsequently, fuzzy comparison matrices can be effectively applied and mitigate against the weaknesses of traditional AHP that result from AHP assigning and utilizing exact numerical values in the judgement of comparisons, which inevitably produce imprecise results when applied to ambiguous problems (Chang, 1996).

10 http://www.mschoa.org/
11 http://www.mschoa.org/

3.2. FAHP model construction

Based on Saaty (1980) and Chang (1996), the AHP stepwise algorithm used in this paper is shown as follows: Step 1: Constructing an AHP model

Drawing on the previous literature review (see Table 6), an AHP model with three criteria and 10 sub-criteria is developed, assuming criteria and sub-criteria are independent.

Step 2: Evaluating the weights of different hierarchies
The main steps are described as follows:

A reciprocal value is assigned to the inverse comparison.

$$a_{ij} = \frac{1}{a_{ji}}$$

where a_{ij} denotes the importance of the ith (jth) element.

Pairwise comparison in AHP is made in the framework of a matrix, and a local priority vector can be derived as an estimate of relative importance associated with the elements (or components) being compared by solving the following equation:

$$A \times w = \lambda_{max} \times w$$

where A is the matrix of the pairwise comparison, w is the eigenvector, and λ_{max} is the largest eigenvalue of A (Satty, 1980). Therefore, A is consistent if, and only if,

$$\lambda_{max} = n.$$

The consistency index (CI) of a matrix is given by

$$CI = \frac{\lambda_{max} - n}{n-1}$$

The consistency ratio (CR) is obtained by comparing the CI with the random inconsistency (RI) values, each of which is an average random consistency index computed for very large samples. The judgments in the comparison matrix are said to be consistent and therefore the relative priority vector estimation is accepted if the CR value is less than 0.1. The CR value is calculated as follows:

$$CR = \frac{CI}{RI}$$

Step 3 Calculating fuzzy numbers

Zadeh (1965) presents a fuzzy set as a class of objects with a continuum of grades of membership ranging between zero and one. A Triangular Fuzzy Number (TFN) is defined as three points and denoted as (l, m, u). The parameters l, m, and u represent the smallest possible value, the most promising value and the largest possible value, respectively, as shown in equation (5):

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-l}{m-l}, & l \le x \le m \\ 1, & x = m \\ \frac{u-x}{u-m}, & m \le x \le u \\ 0, & l \ge x \ge u \end{cases}$$

Step 4: The fuzzy positive reciprocal matrix
Suppose Ã is a fuzzy positive reciprocal matrix and can be expressed in the form:

$$\tilde{A} = [\tilde{a}_{ij}]$$

where the n elements of this matrix $\tilde{a}_{ij}$, represent the pairwise comparison between criterion *i* and *j* using fuzzy numbers, and is shown as follows:

$$\tilde{a}_{ij} = 1, \quad \forall i = j$$
$$\tilde{a}_{ij} = 1/\tilde{a}_{ij}, \quad \forall i \neq j$$
$$i, j = 1, 2 \ldots . n$$

Step 5: Calculating the fuzzy weights

According to Buckley (1985), the fuzzy weights of each criterion in the fuzzy positive reciprocal comparison matrix are obtained by utilizing the geometric mean method. The geometric mean of the fuzzy comparison value of criterion *i* to each other criterion is expressed as follows:

$$Z_i = (a_{i1} \times a_{i2} \times \ldots . a_{in})^{1/n}$$
$$\forall i = 1, 2, \ldots . n$$

The fuzzy weight of the ith criterion is represented by a triangular fuzzy number, and is computed as follows:

$$W_i = Z_i \times (Z_1 \times Z_2 \times \ldots . Z_n)^{-1}$$
$$\forall i = 1, 2, \ldots . n$$

Step 6: Defuzzification

Defuzzification can locate the best non-fuzzy performance (BNP) value based on the centre of the area or centroid (Van Leekwijck and Kerre, 1999; Tseng and Cullinane, 2018). This step can conduct the transformational process from fuzzy triangular values into non-fuzzy values.

Step 7: Normalisation and synthetic analysis

In order to compare the relative importance attached to each of the evaluation criteria and sub-criteria, normalization and synthetic analysis are carried out. First, normalization is used to construct an overall priority rating. Then, a synthetic analysis is undertaken using this priority rating. The global weights are synthesized from the second level down by multiplying the local weights by the corresponding criterion in the level above and adding them for each element in a level according to the criteria affected.

3.3. Questionnaire measurement

To validate the measures of the questionnaire content, during 1-10 April, 2018, 10 field experts were invited to pilot study and refine the questionnaire, through measures such as improving its wording and readability. The questionnaire survey respondents included shipping operators and academics who understood maritime piracy issues well in Taiwan.

4. Results

Before sending the questionnaire, the backgrounds (e.g. working experience and professional ability) of potential respondents were reviewed and they were contacted to ensure they could participate in the study. A total of 22 questionnaires were administered by mail with postage-paid return envelope to 22 respondents (including 15 shipping operators and 7 academies) on 21 April, 2018. By the cut-off date (5 May, 2018), 22 questionnaires had been received. For each sample, the consistency index (CI) and consistency ratio (CR) were individually tested to confirm the consistency of its pairwise comparison matrix. The results indicated one questionnaire with CI>0.1 and CR>0.1 was highly inconsistent (Saaty, 1980) and was consequently discarded. Therefore, the overall response rate was 95.5% (=21/22). The profiles of the 21 respondents' characteristics (including 14 shipping operators and 7 academies) are shown in Table 7. It can be seen that most of the respondents were senior experts and most of them had 11 years (or more) working experience in shipping field at least, thus strengthening the reliability of the research findings.

Type	Number	Percentage	Type	Number	Percentage
Shipping Operators			Academy		
Gender					
Man	14	100.0	Man	7	100.0
Female	0	0	Female	0	0
Total	14	100.0	Total	7	100.0
Age (years)					
Less than 30	0	0	Less than 30	0	0
31~40	0	0	31~40	0	0
41~50	10	71.4	41~50	1	14.3
51~60	4	28.6	51~60	6	85.7
above 61	0	0	above 61	0	0
Total	14	100	Total	7	100
Type	Number	Percentage	Type	Number	Percentage
Shipping Operators			Academy		
Job title			Job title		
Vice president or above	0	0.0	Professor	1	42.9
Section director	2	14.3	Associate Professor	6	57.1
Captain	12	85.7	Assistant Professor	0	0.0
Total	0	0.0	Total	7	100.0
Chief engineer	0	0.0	Education level		
Others	0	0.0	Ph. D.	7	100.0
Total	14	100.0	Master	0	0.0
Company Type			Total	7	100.0
Container Ship	7	50.0	Seniority		
Bulk Ship	7	50.0	Less than 5	0	0.0
Total	14	100.0	6~10	1	14.3
Seniority			11~15	4	57.1
Less than 5	0	0.0	16~20	2	28.6
6~10	0	0.0	21-25	0	0.0
11~15	6	42.9	Total	7	100.0
16-20	7	50.0			
21-25	1	7.1			
Total	14	100.0			

Table 7. Characteristics of respondents.

The analysis results of FAHP are shown in Table 8. All the consistency ratio (CR) values are less than 0.1 and meet the consistency test. The results indicate that international convention and policy (0.475) is the most important criteria, followed by defence strategies when sailing in particular water areas (0.320), and ship's hardware and software (0.205). With regard to attributes, ship security plan (0.309), crew's response ability (0.377), and communication facilities (0.379) were perceived to be the most important sub-criteria with respect to each of the international conventions and policies, defence strategies when sailing in particular water areas and ship's hardware and software, respectively. Regarding the global weight, the results reveal that the three highest most important sub-criteria were ship's security plan (0.147), crew's response ability (0.121), and piracy information collection and analysis (0.117), respectively.

Criteria	Weight	Sub-criteria	Local weight	Global weight	Rank
International convention and policy	0.475	Ship Security Plan	0.309	0.147	1
		Piracy information collection and analysis	0.245	0.117	3
		Navy patrol protection participation	0.237	0.113	4
		Armed guards on vessel	0.209	0.099	6
Defence strategies during various water areas	0.320	Captain's maneuvering and management ability	0.325	0.104	5
		Sailing planning and schedule	0.297	0.095	7
		Crew's response ability	0.377	0.121	2
Ship's hardware and software	0.205	Communication facilities	0.379	0.078	8
		Physical barriers for ship protection	0.296	0.061	10
		Ship alarm facilities	0.325	0.067	9

Table 8. FAHP analysis results

5. Discussion and Conclusion

Maritime piracy is an extremely important international safety and security issue. This paper has described current statistical information (e.g. attack location, attack type, types of violence to crew, type of vessel attacked, etc.) on piracy attacks based on the data from the International Maritime Bureau and revealed useful defence strategies for ships against piracy attacks. During 2013~2017, major piracy attack areas were Indonesia and Nigeria (Table 2). The major type of piracy attacks were in the form of boarding, followed by attempted boarding, Hijack and Attempted Hijack (Table 3). Taking crew hostage was the most common strategy used by pirates, followed by kidnapping, injuring, threats and assault (Table 4) and attacks can be extremely violent and traumatic (Africa News, 2018) and cost huge amounts of money. In yerms of the most commonly attacked ships, tanker chemistry/product and bulk carriers were more easily attacked (Table 5) than other ship types due to their slower speeds, lower crew proficiency and lower freeboard levels when laden (Bateman, 2011). Such acts can be extremely traumatic for crew, and their success is often facilitated by companies' use (whether through necessity or not) of sub-standard shipping (Bateman, 2011). Given the vast area that is considered high-risk for piracy, and the nature of shipping company schedules meaning ships would not be travelling in convoy (Fawcett, 2010), it is not possible for continual naval or military escort to be provided. Indeed, even when reporting to MSCHOA a vessel's entry into the high risk area, and even when giving daily reports on a ship's progress to UKMTO, if ships are attacked, it may not be possible for help to be sent. As guidelines on Best Management Practices for Protection against Somalia Based Piracy note, "Naval/Military forces will endeavor to respond rapidly to ongoing acts of piracy.

However, because of the very large distances across the High Risk Area a Naval/Military response may not be possible (Witherby Publishing Group, 2011, p 47). Further, given the increase in piracy in times of economic crisis, the ability for state aid to improve social conditions in such countries from where piracy originates is highly unlikely (Baniela and Ros, 2012). Ultimately, at present it is therefore left to ships themselves to do what they can to protect themselves. Yet, they may be unsure what others consider to be the optimum or primary approaches to adopt to do so. It is this aspect that this paper has focused on, both to reveal key criteria for ships themselves, but also for shipping companies and policy makers.

Drawing on 21 effective expert questionnaires, this paper prioritized the key criteria and sub-criteria of piracy defence in the shipping companies. The research findings can be used to inform and assist with any review and revision of current international security policies and constructing more well ship security plan reports. In particular, effective conventions and policy implementation are considered key to reducing potential security issues. In order to enhance the ship's safety, various safety criteria can be used in various strategic management stages. For example, before sailing, ships should effectively evaluate a safe transit corridor which is recommended by international organization (e.g. IMO). When sailing in the high risk area, necessary safety facilities (e.g. automatic identification system, etc.) should be checked and confirmed. Given the results here, it is arguable that priority be given to security plans and to training of crew in response and retaliation (cf. Weihai, 2017) as well as to overall policies on information gathering and response. In this context, although Navy patrol protection and participation may be unfeasible given the distances and areas involved (cf. Fawcett, 2010), enlisting the Navy to help in training crews could be an effective solution.

When facing a piracy attack, captains could be trained to effectively manoeuvre to avoid piracy approach and conduct leadership management ability (e.g. announcing emerging call for help (e.g. UKMTO), arrange crews to be safely confined in cabins or citadels quickly, use metal spike, water spray, protective metal mesh, etc.). After any piracy attack, it is suggested to review the sailing planning and provide improvement strategies for revising the content of ship security plan and necessary safety operation procedures, both for future training and also to provde information about pirates' techniques and approaches. Such information should also be disseminated to the international organizations (e.g. IMO and IMB) to state the details of the piracy attack and treatment processes to inform their approaches and policies. The collected information can be used for database analysis and improving safety towards any potential piracy attack issues.

We note here, however, that although these issues were ranked as being the top 3 and thus are arguably ones that were accorded the highest priority, this does not mean that other factors such as alarm facilities and physical barriers should be ignored. Rather, they should all be given attention, but that the first three are the one perhaps those that should be given the most attention.

With regard to how these results and outcomes can be used by either companies or policy makers, there are, we argue, a number of measures. As noted above, training programmes are arguably key, as are the integration of such training in policies. Undoubtedly, such initiatives would not be free, but the issue of the cost of training we argue needs to be contextualised alongside the costs to companies of the loss of ships through piracy, and also, we would argue, reduced insurance costs for those ships with proven records of crew training and ships plans. Companies therefore, could justify the cost of any training to shareholders and boards both through recourse to the results of studies such as the present one, but also use such training to argue for reduced costs to insurers. Indeed, any avoided pirate attacks, whilst always hypothetical in cost, do save significant amounts incurred from any actual attacks.

Notably, whilst the research outlined here was focused towards identifying what ships (and their companies) can do in the face of piracy, it also has potential implications for policy makers. We argue that the above results can help underpin arguments to policy makers and governments to either encourage or to legislate for greater training and planning to avoid piracy attacks. Whilst it may on the one hand be prohibitively expensive (and unpopular) for policy makers to stipulate that companies cannot sail in areas of high piracy without certain training, if policies were introduced that set aside funding for such training this would arguably reduce the losses incurred from piracy. Here, such losses are not simply economic, they are also human and social, and it is the latter type that policy makers can, we argue, be justified in pushing forward policies that may seem unpopular at first. On a higher International level as well, more investments in information gathering and responses to piracy are justified and would help defend against piracy in line with the opinions of the experts interviewed here that prioritised information gathering.

Regarding future research directions, other quantitative methods should be used to analyze related topics. For example, game theory could be used to investigate hostage, ransom and insurance issues. Also, in-depth qualitative interviews with crews who have experienced piracy attacks or attempted piracy attacks would complement this research and explore strategic emergency response issues in their real practical contexts.



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Transport

Two research approaches study into drivers' perspectives: What do professional drivers think about their profession?

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PURPOSE OF THE PAPER

A shortage of qualified and available professional drivers within the Freight Transport, Distribution and Logistics (FTDL) sector is becoming an area of increasing concern in Ireland, and across the European mainland. Current vacant driving roles accompanied with expected drivers of change in demand for professional drivers in the forthcoming years represent a significant challenge to the ongoing prosperity of the Irish economy. Brexit embodies just one driver of change in the demand for skilled personnel and although employment growth is expected within the sector, increased vacancies are anticipated (Expert Group on Future Skills Needs, 2015). Throughout Europe, driver retirement and a poor image of both the working environment and career path available to drivers represent the key contributors to vacant driver roles within the industry, with age-related insurance issues, lack of experience stemming from the absence of significant apprenticeship schemes and the costs of obtaining a license also significantly hampering recruitment efforts (Expert Group on Future Skills Needs, 2016) (European Parliament, 2017). Furthermore, Sweeney (2013) suggested that the "people dimension" has generally been neglected with improvement initiatives focused solely on technology or information systems and states that people are a vital aspect of supply chain management in terms of building relationships and development. Consequently, there is a need for studying into driver's perspectives on their profession. The purpose of this paper is to explore the issues experienced within the the Freight Transport, Distribution and Logistics sector with regard to recruiting and retaining. The paper aims to address the issues causing the drivers' shortage, and analyse the issues and job retention.

REVIEW OF RELEVANT LITERATURE

With the growth of global supply chain and recent trends in improved automation, logistics and freight transport will automatically be hike in the need for drivers (McKinnon et al., 2017, p27; Wrenn 2017). Organizations are increasingly relying on drivers for on-time deliveries, as now in many sectors deliveries are viewed as an extension of assembly line with materials replenished utilizing a just-in-time methodology. This synchronization of deliveries with production and distribution has been facilitated by the flexibility and speed of road transport (McKinnon, 2006). The entry–level logistics roles have lower pay and lower status than entry–level positions within other industries, creating an unattractive position for skilled workers (McKinnon et al., 2017). Reports produced by the European Parliament (2017) indicated that drivers within the freight transport industry across Europe feel the quality of various aspects of their role have deteriorated in recent years including the standard of their working environment, income levels, the amount of non-standard and standard working hours and the skilled work involved, creating issues in terms of driver retention.

Drivers Turnover

It is noted that significant driver turnover within an organisation often adversely affect a firm's ability to be competitive due to the expensive recruitment processes incurred, equipment downtime and the disruption caused to delivery services (Min & Emam, 2003). Academic literature regarding driver turnover is highly contrasting, with several different aspects of the role presented as the key contributing factor to drivers leaving their positions

The variety of aspects of role as the central factors behind driver intention quit have been identified in the previous studies, for instance, the age and education levels of drivers (Beilock &Capelle, 1990; Min &Emam, 2003), relationship with manager (Keller&Ozment, 1999); working conditions and job security (LeMay et al.,1993; Stephenson & Fox, 1996; Suzuki et al., 2009); the occupational stressors experienced within the role (De Croon et al., 2004). Safety hazards (Viscelli, 2018); and and personal risk (Costello & Suarez, 2015; Douglas & Swartz, 2016). LeMay et al. (2013) stated that drivers feeling they have been misled about what the role entails can contribute to driver turnover.

Furthermore, Suzuki et al. (2009) noted that drivers are more likely to leave their position in the direct aftermath of an event which negatively affects their satisfaction in their role. The research of Lambert et al. (2001) echoed the point made in various academic articles based on wide-ranging disciplines that job dissatisfaction is a factor which has a direct correlation with employee turnover intention. (Hardigan & Sangasubana, 2010; Alsaraireh et al., 2014).

Employee Behavioural Models

Maslow's hierarchy of needs is an employee behavioral theory which details how individuals satisfy personal needs in the context of their work (Gawal, 1997). Herzberg (1959) developed a two-dimensional model of factors contributing to employees' attitudes towards work, referred to as either hygiene factors or motivators. These hygiene factors include interpersonal relationships, salary, job security, operating

conditions, administrative practices within the organisation and benefits provided. The factors referred to as motivators are those which serve to bring about the improved job satisfaction and performance which employers seek as a result of satisfying the employee's needs for self-actualization within their role.

Hackman & Oldham (1980) developed a framework known as the job characteristics model which serves to identify how particular job characteristics affect employee attitudes, including job satisfaction. Many of the criteria identified within this paradigm align with motivators developed by Herzberg, pinpointing facets of the role of the HGV driver, which could be reviewed in an attempt to create greater job satisfaction. Within the job characteristics model, five core features are detailed which contribute to how fulfilling and meaningful an employee's work is; task identity, task significance, autonomy, feedback and skill variety. Within this report, employee behavioral models developed by Maslow (1943), Herzberg (1959) and Hackman & Oldham (1980) provide the central academically-recognized frameworks for analysis of employee satisfaction and motivation.

In regard to job satisfaction levels of professional drivers, Richard et al (1994) claimed that attitudes towards their environment and other personnel particularly dispatchers, top management, other drivers in the company and the recognition systems in place held a significant role in influencing extrinsic job satisfaction amongst heavy goods vehicle drivers whereas time available to spend at home and additional mileage had a noticeably weaker influence, contrary to prior assumptions. Recently-hired drivers also have been found to represent a different challenge for managers in maintaining employee satisfaction, and must be given greater consideration in order to reduce turnover rates (LeMay et al., 2009).

Drivers Retention

HGV drivers encounter many challenges within their daily operations, stemming from their duty to satisfy the needs of their own organisation, shippers and receivers whilst maintaining safety standards and abiding to extensive regulations (Kemp et al., 2013). Several studies have developed the link between HGV driving as a career and particular health issues such as back disorders, heart disease, obesity, diabetes and respiratory issues (Dahl et al., 2009; Jensen & Dahl, 2009; Angeles et al., 2014).

As noted by Min & Emam (2003) no stand-alone measure is sufficient in reducing turnover due to the complexity of the issue. This can be attributed to the fact that drivers, or any employees are not homogenous in regard to their expectations, needs and beliefs (Taylor et al., 2010). Williams et al. (2011) proposed a segmented-view of drivers as a strategy for retention with drivers categorized by their demographic and the degree of importance they deem different aspects of the role to hold. Given the unique segments developed, employee retention schemes can be established based on the conflicting primary concerns of drivers. Taylor et al. (2010) also outlined the validity of a segmented approach to driver retention, in this case in terms of owner-operators specifically, indicating a "one-size fits all" approach to tackling driver turnover is unlikely to render successful results.

Psychological capital is a relatively new wide-ranging concept, as described by Luthans et al. (2007) 'individual's positive psychological state of development', characterized by high-self efficiency, maintaining optimism, and perseverance in reaching goals. Schulz et al. (2014) indicated that psychological capital amongst drivers correlates strongly with job satisfaction and commitment to their organisation, further outlining the role psychological components play in maintaining driver employment rates where often relationships can seem solely focused on monetary incentives. The findings of Schulz, Luthans & Messersmith (2014) represented an opportunity to recruit and retain high performing drivers stemming from a greater understanding of psychological capital.

Driver Support Initiatives

As the physical health of drivers remains an area of concern within road haulage, Boyce (2016) stated that greater care should be given to driver wellness particularly so that the current workforce of drivers are given the greatest opportunity to perform to the best of their abilities given the already strained driver resources available, suggesting promoting healthy-eating initiatives and smoking cessation as methods of reducing health problems. Research regarding health promotion schemes for HGV drivers shows that these initiatives are well-received and garner tangible positive results in the form of improved body mass index (BMI) ratings, reduced blood pressure and cholesterol or increased consideration from drivers given to exercise and balancing their diet (Holmes et al., 1996; Olson et al., 2009; Sorensen et al., 2010; Sendall et al., 2016).

Literature regarding initiatives to limit the psychological issues encountered by HGV drivers is somewhat limited and requires further research although improving driver job satisfaction by reducing the stressors encountered has been identified as an area to consider (Da Silva-Junior et al., 2009; Shattell et al., 2012).

Academic literature regarding driver shortage is highly contrasting, with several different aspects of the role presented as the key contributing factor to drivers leaving their positions. Within this paper, employee behavioral models developed by Maslow (1943), Herzberg (1959) and Hackman & Oldham (1980) provided the central academically-recognized frameworks for analysis of employee satisfaction and motivation.

RESEARCH APPROACH

This research followed a two-stage methodology carrying out a large scale survey and conducting in-depth semi-structured interview. A quantitative approach to research entails employing strategies of inquiry such as questionnaires or surveys to gather data on programmed instruments, which produce statistical data (Cresswell, 2003). Quantitative research targets larger samples than qualitative research in order to produce generalizable results (Zikmund et al., 2013). Quantitative data can be categorized into categorical data, which is descriptive and ranked, or numerical data, which is continuous and discrete (Saunders & Lewis, 2012). Saunders et al (2009) indicated that errors in sampling and measurement are significant risks when solely implementing quantitative research approaches that can lead to inaccurate

results. Qualitative research is research which addresses objectives through techniques which allow the researcher to generate in-depth interpretations of phenomena without relying on numerical data, focusing on unearthing new insights and inner meanings (Zikmund et al., 2013). As qualitative data can refer to any non-numerical or un-quantified data, qualitative data can range from short responses to open-ended survey questions to transcripts of in-depth interviews (Saunders et al., 2009). Sekaran & Bougie (2010) outlined the difficulties that can arise within qualitative data analysis as there are relatively few well-established guidelines for this analysis in comparison to quantitative methods. Furthermore, qualitative data analysis can commence after only some of the data is collected due to the non-linear processes of drawing conclusions from the data and the repeated sampling and data collection methods, which may be involved (Sekaran & Bougie, 2010).

Having considered the limitations and advantages of implementing either approach, a two–stage method research strategy was selected, utilizing both quantitative and qualitative approaches independently to conduct this exploratory research. This particular multiple method research approach was selected due to the associated benefits of triangulation and aid interpretation. Triangulation refers to the use of multiple independent sources of data to validate research findings whereas aid interpretation refers to the use of qualitative data as a tool to elaborate on the quantitative data collected (Saunders et al., 2009).

Furthermore, SPSS was applied to test the relationships between the causing factors contributing to driver's shortage and job retention. Thematic analysis was conducted to analyse the data. This is a foundational method for qualitative analysis, and is an accessible and theoretically flexible approach to analyses qualitative data (Lee and Lings, 2008).

SUMMARY OF ANALYSIS

Saunders & Lewis (2012) identified questionnaires as an efficient method of collecting data about a constant list of questions from a large number of respondents. For this reason, a questionnaire was developed to be administered to professional drivers employed within the FTDL sector to gauge the perspectives of these drivers towards their profession. An analytical and descriptive questionnaire which considered all relevant facets of driver's perspectives to their roles was developed for the purpose of collecting quantitative data for analysis. These questionnaires were distributed both individually and within groups when possible. All questionnaires were distributed face-to-face, administered to drivers. 130 questionnaires were administered to the national drivers and international drivers in December 2018 and January 2019 in the Republic of Ireland. 115 questionnaire were collected in February, 2019. Four of the questionnaires were not fully completed. After data coding and data screening, 111 questionnaires are useful. The rate of Completed Questionnaires is 97%. The research was conducted using 111 questionnaires and data analysis with SPSS.

Thematic analysis was conducted to analyse the data. This is a foundational method for qualitative analysis, and is an accessible and theoretically flexible approach to analyses qualitative data (Lee and Lings, 2008). Braun and Clarke (2006) stated that thematic analysis provides a flexible and useful research tool which potentially can provide a rich and detailed, yet complex, account of data. In addition, it provides methods of analysis that should be applied rigorously to the data. It can be used to further interpret various aspects of the research topic. As thematic analysis does not require a detailed theoretical and technological knowledge of approaches, it is a more accessible form of analysis. However, because thematic analysis is a flexible method, the researcher needs to be clear and explicit about objectives; what the researcher says they are doing needs to match up with what they are actually doing. Thus, the theory and method needs to be applied rigorously (Braun and Clarke, 2006).

Following transcription of the interview materials, analysis in this paper focused on what the interviewees explained about themes, these themes are given below and capture key findings from the data in relation to the research purpose:



FINDINGS AND DISCUSSION

Data collected through questionnaires found that 44% of Drivers choose this career because they like driving, 19% of drivers choosing this career as they believe it is secure employment. Native English speaking drivers working much more hours than the non native English speaking drivers. A drivers as an employee is working much more hours than a driver as an owner/operator. Around 82% of respondents are working 41-60 hours per week, majority of these drivers are working overtime (week days and weekend days). Interestingly, 16% of the drivers are working over 60 hours per week. 10% of the drivers are working less than 40 hours. Surprisingly, majority of drivers are working over time which is 70% of the drivers working over time between 40-60 hours. It is important to note that the vast majority of the current samples are mature male adults - in their mid 40s to mid 50s.

Through the cross case tabulation analysis in SPSS, the research found that 33% of the drivers, they working over 60 hours per week for salary reasons. According to the data analysis, National deliveries drivers can be paid by kilometres, and number of deliveries. In contrast, for international deliveries, the drivers can be paid by hours and salary. Majority of the drivers completed 4-8 deliveries per day. Remuneration of drivers is an area mentioned by all interview participants when discussing elements of professional driving which are detrimental to recruitment and retention. When

the topic of shortfalls in recruitment arises, the level of pay and benefits provided to drivers was frequently the first area identified by participants. These finding further support much of secondary data which outline insufficient pay as a repelling aspect of the profession, with several sources noting poor pay as an aspect of the role as a key contributor to driver turnover (LeMay et al.,1993; Stephenson & Fox, 1996; Suzuki et al., 2009; Expert Group on Future Skills Needs, 2015).

Majority of participants agreed that driving roles generally attracted those who appreciated the freedom involved with driving for a living or those who enjoyed driving. Hackman & Oldham (1980) note the importance of some level of employee autonomy in maintaining job satisfaction, much of which has been removed within professional driving according to participants. Furthermore, findings generated through the primary qualitative research in terms of driver recruitment, training programmes and institutional support provided to drivers raise several areas of concern when taking into account the behavioural theories (Hackman & Oldham, 1980).

From the participants surveyed, 44% stated they became drivers due to their affection for driving whereas less than 13% detailed that they chose the profession due to benefits of the role (salary, flexible hours) which could be described as 'hygiene factors' (Herzberg et al., 1959). Hackman & Oldham (1980) note the importance of some level of employee autonomy in maintaining job satisfaction.

A range of occupational stressors was prevalently referred to throughout the interview process, outlining several factors of the role, which contribute to a negative professional experience for drivers. A collection of elements of the position, which conclusively negatively contribute to the overall experience of a professional driver. As all researched areas recognize several aspects of the role as occupational stressors. In addition to the issues addressed in greater detail in this paper, pressure to fulfil on-time deliveries, rigorous regulations and extended time spent on the road are identified within both facets of primary research and within the secondary data reviewed as adverse aspects of the profession (Shattel et al., 2010; Passey, et al., 2014; Sousa & Ramos, 2018).

Because of long hours away from home, social and psychological factors have a significant influence on their job satisfaction. All participants make reference to the loneliness which can be experienced by drivers. Abiding to increasingly strict regulations, irregular work schedules and the previously mentioned unfavorable views of the public towards the roles are other areas identified through data collection as unsatisfactory elements of the profession. Mentioned frequently by interview participants was how drivers are perceived and treated both by those within freight transport and logistics operations and by members of the general public, noting a need for drivers to be treated with more respect and dignity. The importance of recognition of efforts made by management in retaining drivers, citing making simple gestures to show appreciation to employees which contribute much to their business as hugely significant. The finding is more in keeping with literature Maslow (1943) recognized the role fulfilment of an individual's self-esteem needs plays in human motivation, identifying experiencing a lack of respect and not being recognized as a unique individual as central to feelings of dissatisfaction (Herzberg et al., 1959).

Most of the participants feel that very little regard is given to their health as no facilities are provided at service stations for exercise, no education is provided to them in how to maintain a balanced diet and no institutional support is provided to promote positive mental health. Driver Wellbeing need to be acknowledged and addressed. Despite the widespread knowledge and numerous publications outlining the detrimental effects working as a driver can have on both the physical and mental health of drivers. Many research findings illustrated that very little initiatives in educating or supporting drivers in these matters were provided (Dahl et al., 2009; Jensen & Dahl, 2009; Shattell et al., 2012; Angeles et al., 2014). Furthermore, the data analysis found that there is a relationship between drivers age group and job satisfaction, and between the length of working as a professional HGV drivers and job satisfaction. A borderline significant trend relationship between training/professional development and job commitment was found. Older drivers were also found to have greater commitment to the position and experience greater satisfaction within their duties, a positive relationship exists between the length of time working as a professional driver and commitment to the role. This is supporting the theory proposed in multiple academic journals that driver demographic is the central factor behind driver turnover rates (Beilock & Cappelle, 1990; Min & Emam, 2003).

CONCLUSION

Within the overarching topic of driver shortage, challenges encountered by drivers in regard to operational and social aspects of their role, the key contributors to driver recruitment and retention and how different aspects of the profession may effect a driver's motivation and satisfaction within their position have been analyzed and discussed in this paper.

Several aspects of the driving profession can be pinpointed as issues which negatively influence retention within their profession. Respect afforded to drivers in all aspects of their duties, the perceived status of driving roles, the insufficient standard of facilities provided to drivers and operational burdens frequently experienced can all be considered to be hindrances in creating gratifying operating conditions. Furthermore, a lack of opportunity for progression and advancement is an area earmarked as an administrative aspect of the role, which repels potential entrants with stricter emphasis on regulations noted as an aspect making the role less appealing than it once was.

As regards the main contributions, this paper addressed the issues causing the driver's shortage and analyzed the relationship between these issues and driver's retention through conducting two stages research methods with regard to exploring drivers' shortage within FTDL sector. Such research contributes significantly to FTDL sector, it also provides theoretical and practical knowledge in order to attract and retain a sustainable labor force of drivers. By uncovering the factors contributing to the drivers shortage, this study contributes to the gap which it is one of the very few concerning "people dimension" in logistics and supply chain management studies (Sweeney, 2013). In other words, it contributes to the lack of understanding on HGV driver's perspective on their profession from the view of logistics and supply chain management. This research also answers a call for future research on a better professional status needs to

be developed (McKinnon et al, 2017). Despite much evidence that initiatives promoting driver wellbeing in terms of physical and mental health are generally well-received and garner positive tangible results, very little support or education is provided to drivers in this regard. Considering the well-documented psychical and psychological health issues drivers may experience due to the nature of the profession, this is an area, which requires greater attention (Shattell et al., 2012; Angeles et al., 2014).

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Truck platooning: The future?

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Introduction

The arrival of (semi-)autonomous vehicles is an opportunity to improve people's lives and to protect the environment. These vehicles support the sharing economy concept and are environmentally friendly. They also contribute advancing the sustainable development agenda (UN, 2015). One of the application areas of (semi-)autonomous vehicles is "platooning" which is the linking of two or more trucks together to create a train, using Internet of Things (IoT) and automated driving support systems (EU, 2016). Truck platooning can be considered as road trains that uses an advanced technology. And, it refers to trucks connected to a group of trucks. Other definitions also use the term vehicle-to-vehicle communication, since this how vehicles can communicate and drive in one platoon.

The future of transportation is seamless mobility where all modes and vehicles are fully connected into a single network of information exchange. Connected and autonomous vehicles can transform the transportation system to make it safer, greener and cheaper. Truck platooning technology can be used to control the position of following road vehicles, permitting the group to operate in a very closer range (less than a meter). This would lead to fuel consumption improvements in the rest of platoon. A simple truck platooning representation is illustrated in Figure 1. In this basic illustration, four trucks are forming a platoon and traveling together on a motorway.



Figure 1: A basic illustration of truck platooning

The European Union only began to pay attention to advanced vehicle technology systems for transport vehicles after 2004, but since that time EU has increasingly focused on such advanced systems (EU, 2018). In the last decade, the EU has given more attention to automated and intelligent driving systems, and some countries have shown a strong belief that this is the future of transportation. In the United States, as autonomous vehicles gain acceptance, changes to traffic rules and laws that reflect the impact new advanced technologies will have on highway network are under consideration at every level (NACFE, 2016). This holds true for truck platooning as well, certain states allowed to use limited use of public roadways for real-world testing of truck platooning technology.

The purpose of this paper is to provide an insight and example into how platooning can improve the transport industry, particularly for the United Kingdom (UK). The truck platooning requires a different transport planning approach than classical solutions. The assumptions of this new technology are challenging and interesting for both the academia and the industry. The primary research methods for this study are to gather secondary information on truck platooning technology and implement operational research techniques for further investigation. More specifically, we look at the base problem where vehicles need to be brought from other locations before the start of journey. It is important to pull trucks to the same (origin) location so these vehicles can start their journey together.

As a potential research direction, the (re-)location of assets is an interesting area to provide transportation planners with high quality of decisions during the planning of platooning routes. Multiple freight requests are needed to be planned for different time periods, and the planners should consider several other constraints so that trucks can start from the same origin. The objective of the proposed problem is to minimise the total costs (and emissions) and the number of decisions that are taken by the planners (i.e., enhancing span of control over a large transport network) and offer rapid and high-quality suggestions to them. Thus, planners should be able to investigate, evaluate and finally choose the most optimised plan during the planning. The prosed problem also helps matching of freight to pulled unit, monitoring empty running, and finding alternative ways for assignment of shipments to routes.

The contributions of this paper are two-fold. First, we study a new transportation problem that is applicable for truck platooning. Second, we present an example case study to highlight the potential benefits. The content of the paper is structured as follows. The next section provides a brief literature review. The following section provides the background information related to the problem. Then, we present a case study and conclusions and future research directions are presented in the last section of the paper.

Literature review

This section provides a brief literature review on truck platooning, including its development in the UK. Most of studies surveyed include the case studies conducted in various countries. Related articles are found on Google Scholar, Emerald Insight, Science Direct, Web of Science, EBSCO, and IEEE Xplore. After reviewing the relevant literature on the mentioned databases, a word cloud illustration is prepared in R and presented in Figure 2.

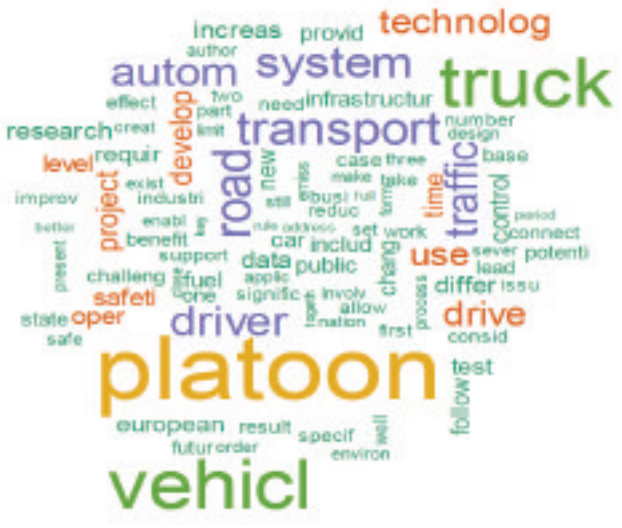


Figure 2: An illustration of world cloud from selected articles on truck platooning

Figure 2 shows us that the literature on truck platooning is focusing on mostly technical and legal aspects of it. Infrastructure and technology-related terms widely appear in the literature, even in case studies. Interestingly, there is not much discussion on environmental aspects. We know that there are several environmental advantageous of platooning, but it seems that the focus on literature is at least for now focusing on other aspects. Another related analysis is also provided in Figure 3. We show the thirty mostly used words in selected academic publications. Due to the page limitation, we only present a limited analysis and do not present the selected literature.

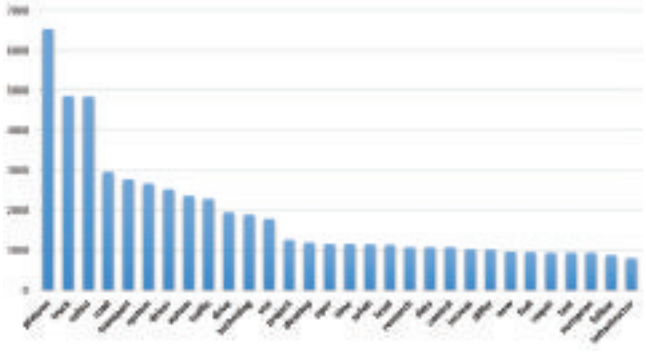


Figure 3 Frequently used words in the literature on truck platooning

We can learn from the literature that control, system, time, speed, traffic, technology, driver are the biggest concerns for truck platooning. Based on the above-mentioned analysis, we can also highlight that a possible implementation of (semi-)autonomous technologies is to combine several trucks together to form platoons, which are predicted to bring opportunities in terms of safety (e.g., casualty reduction), fuel efficiency (e.g., smart driving), emissions (lower air pollution and CO2e emissions), and congestion (RICARDO-AEA, 2014). In 2015, 793 billion passenger kilometres were recorded and 201

billion of domestic freight was moved within the UK (Department for Transport 2016). The numbers are the highest volume ever recorded and there are tremendous opportunities with the use of autonomous vehicles to overcome increasing environmental burden of transportation by providing more empirical evidence and new arguments.

The near future of truck platooning is promising for the UK (EPSRC, 2018). For example, the UK is planning to allow road tests of fully driverless cars by the end of 2019 (Financial Times, 2018). DHL is expecting to see the use of (semi-)autonomous vehicles in freight industry in the next decade (DHL, 2016). In the long-term autonomous vehicles will have the biggest impact in the freight industry. This will allow logistics companies to work as an integral part of the supply chain (e.g., all stakeholders of a supply network will be connected via this technology). Decision making itself will become more automated. It is therefore important to look at this technology closely and understand how it can affect the UK logistics industry before it's too late. There are several case studies in the literature; percentage values from selected countries are shown in Figure 4.

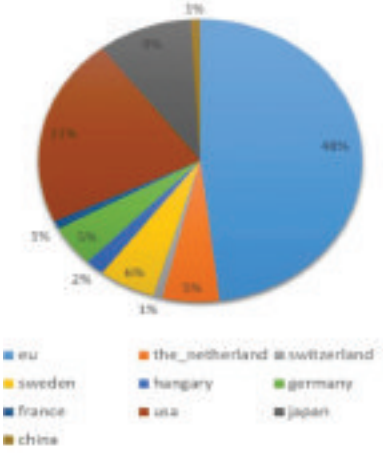


Figure 4: Case study applications

Figure 4 tells us that there are many countries focusing on truck platooning from the EU. It is expected to see that the next ten-year period will fasten the development of this technology on roads especially in these countries.

One of possible applications of platooning technology is to improve the repositioning of trucks in the network. This is especially important since there is a high uncertainty with regards to transport demand. Platooning could be an alternative solution to move assets in the network and respond the demand the fastest way possible using the main road (highways) of the transport infrastructure. The next section presents the investigated problem.

Problem description

This section introduces the problem. Generally, in practice, transport requests are assigned to routes according to time windows and destination. Then, a route is assigned to an available truck. In many cases, more than one truck is needed to complete the transportation of freight between a given origin and destination. It should be noted that a route can also include one or more stops. Consequently, when there are many shipments that are going to the same destination, truck platooning can be useful

practice to reduce the transportation costs while coordinating all transport activities. Before the start of journey, it is important to allocate the required number of trucks to the same origin. The problem at hand deals with an allocation of trucks to the same location in the network. The following assumptions are considered while defining the problem.

- Truck and trailer are considered together, and this combination represents a single entity in platoon.
- Freight demands are deterministic and each of them corresponds to one full truck load (i.e., one TEU).
- Travel time between two locations is proportional to distance and known in advance. Service time (loading/ unloading) in each location is equal to zero.

The problem requires several important parameters, and these are listed as follows.

- Time horizon (only the number of time periods). Each of time periods correspond to a specific time interval in the rolling horizon.
- Set of locations of trucks and demand points,
- Travel time between locations, always expressed in time periods,
- Available vehicles in each location (beginning of period and the ones that may appear later because of maintenance etc.)
- Loading limitations (types of commodities e.g. box, cooler, tilt)
- Cost of departure for loaded vehicles
- Cost of departure for empty vehicles
- Cost of staying idle in one location
- Number of full loads need to be moved from one location to another

The outputs of the problem are as follows.

- Number of trucks in a platoon to departure from an origin to a destination location on a specific time period,
- Number of empty vehicles to departure from an origin to a destination location on a specific time period,
- Number of needed other trucks on a specific time period,
- Number of trucks staying idle in locations for each time period.

The objective function of the model is the minimisation of total transportation costs, including the movement of trucks -- empty and full load -- and carbon dioxide emissions. The proposed model has the following constraints. All assets must be covered and considered in the network. Transport demands must be satisfied while considering loading limitations and time windows. Conditional constraints should be included to ensure that each vehicle is only used if a truck needs to be located, otherwise it needs to wait at the current location until there is a new shipment. Due to the page limitation of the paper, the linear mixed-integer programming formulation could not be provided. In the next section, we present a case application for the investigated problem.

Case application

A small-sized transport problem has been considered in this section. The case study has been formulated as a linear mixed-integer programming formulation and solved with CPLEX solver.

The benefits that can be derived when the problem is solved include cost savings, quick solution (compared to manual solution by the planner), consideration of travel times, enhanced control on network, reduction of emissions (due to connected travel along the journey), and on time performance since time windows of freight requests are considered.

The output of the case study will determine the allocation and distribution of empty trucks (repositioning in anticipation of future demand), full and idle trucks in the network. The decisions are based on matching of freight to pulled unit (loading limitations), travelling times between locations (multiple origin - destination), and transportation costs between locations (i.e., empty, load, and idle).

To demonstrate the case study, the following scenario is designed. The specific inputs of the case study include four different locations, called A, B, C and D; travel time between these four locations (one period equal to two hours) and three different types of trailers and four different types of commodities. The relationship between these variants is determined from the following table. In this scenario, the number of available vehicle-trailer is not enough to cover the demand and empty running will be needed from other locations in order to serve all transport requests. Time periods and travel times between locations are provided in Table 1.

Period	Time
1	0-2 hours
2	2-4 hours
3	4-6 hours

Traveling times				
	A	B	C	D
A	0	2	3	1
B	2	0	3	1
C	3	3	0	3
D	1	1	3	0

Table 1: Case data (defined time periods and traveling times)

From Table 1, we can see that there are three time periods and each period correspond two hours duration. We can also see traveling times between locations in the right side of table. Traveling times are assumed to be symmetric between locations. The following table presents the number of trailer types and demand (one TEU) from each location to each destination.

	Trailer type		
Commodity	1	2	3
1	1	0	0
2	1	0	1
3	1	0	1
4	0	1	0

From	To	Commodity	Period	Demand
A	B	2	1	3
A	C	4	1	2
A	B	1	2	4

Table 2: Details on commodity and freight demand

Table 2 can be interpreted as follows. For example, at time period one, there is a demand for three trucks that will carry commodity type two from location A to location B. At time period one, five vehicles should have already been loaded and leave the depot. Available trucks exist only in location A and D, and the number of available trucks is the followings.

Location	Trailer type 1	Trailer type 2	Trailer type 3
A	2	2	3
B	0	0	0
C	0	0	0
D	3	0	0

Table 3: Truck availability of each type

After solving the problem, we obtain the following optimal solution. We note that since the case problem is very small, the solution time with CPLEX solver takes only a few seconds.

	From	To	Trailer type	Period	Demand
Empty running	D	A	1	1	2
Loaded running	A	B	3	1	3
	A	C	2	1	2
	A	B	1	2	4

Table 4: An optimal solution found for the case study

The number of vehicles on the network is enough and the model makes the right allocation for the use of platoons (if there is more then one truck is needed). Empty running is always cheaper than using another truck (i.e., charter), thus the model suggests two vehicles of type one to depart from D at period one. These assets will satisfy the demand that occurs in A at time period two.

Based on this small case application, we can see that there are several benefits, including greater fuel economy due to reduced air resistance, reduced congestion, substantially shorter commutes during peak periods, and efficient repositioning of trucks in the transport network. Our preliminary results show that the new technology can be an alternative solution to improve the reliability of the transportation since trucks will travel together. This will improve the reliability of the transportation. It also provides economic and environmentally friendly planning solutions.

Conclusions and future research directions

This paper has studied the truck platooning by providing a possible application from an operational research perspective. The proposed quantitative approach is especially relevant and has a great potential to be implemented by industries. For example, one of possible applications of platooning technology is to focus on repositioning of vehicles within the network. This is especially important since there is a high uncertainty with regards to transport demand. Platooning could be an alternative solution to move physical assets in the network and respond the demand the fastest way possible.

Changing customer preferences and innovative logistics concepts lead to smaller batch sizes, higher transport volumes and shorter delivery times, resulting in new challenges for transport operations. However, increasing road traffic negatively impacts the environment and increases the risk of disruptions, thus affecting transport reliability. The truck platooning technology can provide a major step forward in reducing emissions as well as bring significant improvements to the planning of transportation activities.

The benefits of truck platooning can be considered in three areas. These are financial, technical and environmental. For example, financial benefits include platoons have the potential to make the logistic operations more efficient and optimise the labour market, platooning is a cost-saver (as lower fuel consumption means lower fuel costs), which currently make up 30% of total operating costs of a truck, and for transport companies, platooning means also a safer, more efficient flow of their freight. Technical benefits include platooning enables the supply network to be optimised from a higher

perspective and allowing for more predictive driving of trucks on the road (i.e., proactive vehicle maintenance). Environmental benefits are platooning results in a lower fuel consumption, with less braking and accelerating, truck platooning has the potential to reduce CO2e emissions, and platooning reduces congestion by improving traffic flows and reducing tailbacks.

The practice of truck platooning is about to emerge in the next decade, but governmental and business participation in the UK is still limited and the effectiveness of the system remains unexplored. An exploratory study can contribute to the literature by developing a body of knowledge on truck platooning in the UK context.

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The Development of a performance measurement system for road freight transport

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1. Introduction

Driven by the rapid growth of regional and global trade, just in time inventory practices and sustained economic growth, there has been in recent years a significant increase in the quantities of goods transported by road, and hence an upsurge of the number of the companies specialized in transporting cargoes via road (Zhang, Qin, He, Ye, & Ni, 2015). While freight transport plays a key role in economic development and employment growth, the sector also contributes to several negative externalities such as congestion, pollution and accidents (Deakin, 2014; Mckinnon et al., 2010).

Another development that has brought changes in the freight transport in recent years are advances in technology such as: Telecommunications and Information Technologies (IT) which includes: mobile phones applications for managing road freight transport and their effects in facilitating the movement of cargoes; Intelligent Transportation System (ITS) such as: smarter vehicles, highways monitoring systems and New systems like: alternate fuels and vehicles for ground transportation (Deakin, 2014; Yoshimoto et al., 2005).

Recently, new technologies have been used practically to the management of some different road freight transport problems such as traffic congestion, air pollution, fuel use, and accident risk, both for passenger and freight transport (Li and Yu, 2017). Moreover, road freight transport companies and users benefit too from the new road freight transport technologies adopted like: travel cost reduction, increasing safety and reducing travel (Deakin, 2014). The aforementioned development in transport operations also have social implications (UN Economic and Social Council, 2009). It has been argued that technology can, to some extent, help mitigate the social, economic and environmental impacts of freight transport while contributing to sustainable future. However, previous studies lack integrating the three main aspects of sustainability (economic, social and environmental) embedded with technology serving them in order to overcome the road freight transport problems (Lindh and Rudeke, 2018). Accordingly, to overcome this gap it is highly recommended that integrating different types of technologies and adopting ICT with sustainable pillars should enhance significantly the road transport sector's sustainability performance and lessen road freight transport problems and it's negative impacts (Tob-ogu, Kumar and Cullen, 2018).

Hence, this paper will propose an integrated road freight transport performance measurement system through the lens of sustainability by highlighting the main challenges faced by the road freight transport sector and the contribution of technology.

2. Literature Review

Previous studies have highlighted the importance of road transport in the movement of freight (Penteado et al., 2012; Zhang et al., 2015; Engstrom, 2016). However, little attention has been paid to rules and regulations in the road freight transport sector, along with low safety standards as transporting freight by road across boarders causes conflict between different rules and regulations in each country where adjusting various rules and regulations is very complicated (Lindh and Rudeke, 2018). The long hours and less-than-ideal working conditions that most truck drivers in many developing and emerging countries have to work are a significant concern that impacts economically on individuals, companies and society (Isler, Starkey and Sheppard, 2011); and socially traffic accidents, working conditions and gender equality (Engstrom, 2016).

Moreover, pressure on road transport infrastructures in certain countries increased and therefore spread the negative effects such as: emissions, noise, congestion, fuel consumption and economic losses (Santos, Limbourg and Carreira, 2015). Also, the road transportation infrastructure development has historically relied on guidelines that minimized the initial cost, emphasized traffic mobility with minimal consideration for the social and environmental needs (Jha, Ogallo and Owolabi, 2014) and road freight transport is considered as a main source of congestion too as it reduces the available capacity for passenger movement (Zhang, Fan & Zhu, 2015). Romain Pison (2018) highlighted that the road transport dominance in the freight sector leads to various concerns such as journey time unpredictability, high logistics costs, congestion and high levels of pollution and greenhouse gas emissions. In addition, the time consumed to travel from one point to another is not only impacted by unpredictable customs procedures, but by other factors as well such as congestion in and around urban areas.

As highlighted above, the last decades have witnessed the implementation of new technologies which changed the development of transportation in general. These include Intelligent Transportation Systems such smart cards, on-board diagnostics and information systems, and smarter highways, transit, automobiles, logistics systems, and other information

systems (Tob-ogu, Kumar and Cullen, 2018). Over the upcoming two decades, emerging new technologies for road freight transport will

continue to develop, and could improve transportation systems in many ways, such as, electric, hydrogen, or hybrid electric-petroleum vehicles may be launched that would significantly reduce emissions and fuel features of the fleet, and possibly pose challenges regarding finance and system operations. In order to enhance the feasibility and accessibility of a range of pricing opportunities for road use, parking, and transit fares, smart card technologies are highly recommended (Yoshimoto et al., 2005). While, monitoring and information systems could allow travellers to estimate trips time and pick routes in order to be able to avoid congestion and reduce trip duration. The advanced traffic management systems applications are highly efficient on maximizing road capacity considerably by enhancing safety and concerning other elements like: pedestrian comfort. Thus, adopting technologies in transporting freight by road should lead to increasing developments in safety, capacity, and convenience on long term (Deakin, 2014).

This paper attempts to develop a road freight transport performance measurement system through the lens of sustainability comprising the main problems faced by the road freight transport and including the main performance measures used to measure these problems where technology contributions will be embedded to serve the three pillars of sustainability. This will assist the road freight transport companies in measuring and enhancing their performance.

3. Research Method

The demand on road transport for carrying cargoes from one point to another has increased dramatically. For example, in Europe, road freight transport has increased by nearly 40% over the last twenty years, consequently, the number of truck movements has increased at a very high rate. Road freight is one of the main selection for freight transportation in Europe with market share in the EU27 increasing from 73.7% in 2000 to 75.6% in 2011. This is because of the flexibility offered by road freight transport for door to door delivery as well as overall economic competitiveness, but also due to the changes in production values witnessed over the last decades (Santos, Limbourg and Carreira, 2015). Consequently, negative impacts have been generated which affect human, environment and society. Accordingly, it has been recommended that by applying and adopting various type of technologies, these problems should be reduced and sustainability could be achieved.

Hence, this section will review the main problems facing the road freight transport sector. As it is observed from most of the previous studies conducted in road freight transport performance, there is still a gap on applying a road freight transport performance measurement system through the lens of sustainability. Public and private road freight transport sectors are well aware of its impact on the company's performance, the whole economy and the environment. In the next sections the paper will illustrate the previous studies that have been conducted in this area upon which the developed framework will be presented.

3.1. Technology in the road freight industry

Technology should play a vital role in facilitating processes, reduce the negative impacts on environment through lessening gas emissions, enable managers, cargo owners and drivers to find cargoes, trace them and also minimize working conditions, where it can be a good tool which can assist in achieving sustainability in road freight transport sector (Li & Yu, 2017). Moreover, technology is considered as an important tool that should serve the three main dimensions of sustainability. For sustainable development, information and communications technology (ICT) has been recognized as an important enabler (Kayisire and Wei, 2016). For example: mobile phones, internet of things (IOT), big data, radio frequency identification (RFID) and geographic information systems (GIS) are considered as ICT tools that have been implemented to assist sustainable development all over the world. The application of ICT tools that encourage sustainable travel are recognised in the literature. Researchers have highlighted time saving e-ciencies from the ICT application (barcoding, decision support systems) to carrier operations, have enhanced the overall service providers and users experience (Sternberg et al., 2014). Other studies have connected competitiveness and safety to the implementation of ICT tools such as: GIS navigation and on-board computers (OBCs) to support transportation. Still, the proof for this link between ICT and sustainable transport in Africa is lacking, even with the importance of road transport as a main UN sustainable development indicator and the high socioeconomic costs linked with transportation in Africa (UN, 2016). For example: Africa has been recognised as the highest risks of road transport casualty with more than 26% of road accidents happening in Africa (UN Economic and Social Council, 2009; World Health Organisation, 2015). Porter (2014) stated that the distinctive nature of many African countries because of the human and freight mobility services consumption happen at the same time (Tob-ogu, Kumar and Cullen, 2018).

3.2. Congestion Problem

Khanal (2012) suggested that congestion problems impact both environmental and economic performance of road transport, as it has direct negative impact on the environment by increasing pollution and economically through increasing operating cost and reduce productivity improvements. Congestion problem not only has direct impact on both environmental and economic performance but also has an indirect effect on social performance as it causes increased stress level for drivers and road users (Demir et al., 2015). Boussier et al. (2011) agreed that congestion leads to inefficient economic performance and logistical systems. While Grote et al. (2016) point of view is that congestion play a direct role on harming the environment and the surrounding areas. For Ruli (2016) congestion not only impacts the environment but also it has a great impression on the social pillar as congestion problem lead to increasing driver's stress. Meng & Liu (2012) persisted that congestion problem influences the three pillars of sustainability and stands against achieving it. Accordingly, it is worth mentioned that congestion is considered as a main issue facing the road freight transport performance which not only has a direct impact on the economic aspect of sustainability but also the environmental aspect. Accordingly, it has been observed from the above discussion that congestion is a main issue that impact the road freight companies not only economically but also environmentally where different performance measures can be used to measure its impact on companies' performance.

3.3. Road Infrastructure and Maintenance

Road infrastructure and maintenance is considered as a main dimension under both aspects (economic and environmental) that affect the road freight transport performance measurement through the lens of sustainability. However, different performance measures are used in measuring its impact under each aspect. For example, Schoenmaker et al. (2016); Linxue et al. (2015); Tong et al. (2015) stated that road infrastructure and maintenance impact the road freight transport performance from an economic perspective. While Goh et al. (2014); Meng (2015) persisted that road infrastructure and maintenance impacts road freight transport performance economically and environmentally. Hence, road infrastructure and maintenance should be considered as a dimension in both economic and environmental aspects of the developed road freight transport system by using various performance measures to observe their impacts.

3.4. Driver's Training and Qualifications

Lee et al. (2013) stated that driver's training and qualifications influence the social aspect as it increases the stress level for drivers (Kemp et al., 2013). Beanland et al. (2012) observed that driver's training and qualifications are considered as the main dimension under the social aspect of sustainability which has a great impact on road freight transport overall performance as they are the main sources dealing with the road networks and freight. Accordingly, driver's qualifications and driver's training are the main dimensions under the social aspect when developing a road freight transport and different performance measures can be used to measure their performance. Hence, the following figure conclude the developed road freight transport framework through the lens of sustainability where the three main aspects of sustainability and the dimensions under each will be presented where the technology will be the main aspect which will serve the three aspects. Accordingly, the research will mainly focus on how to make the technology embedded to serve them?



Figure 1: Road freight transport system through the lens of sustainability.

4. Conclusion

The main challenges are facing road freight transport from different perspectives such as economic, social, environmental and technological aspects, need to be identified as they will play a key role in making freight transport more efficient and environmental friendly (Ruesch, Schmid, Bohne, Haefeli, & Walker, 2016). Accordingly, this paper has highlighted the main problems associated with road freight transport based on previous studies conducted on congestion problem, infrastructure maintenance, driver's qualifications and training and the resulting impact on accessibility and mobility, gases emissions, cost, time, stress level and accidents. A road freight transport system has been concluded where the main aspects of sustainability and the dimensions under each where presented.

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Feasibility of Inland Water Transport in the Humber Estuary and East Yorkshire, UK

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Introduction

This paper assesses the potential of moving freight by using Inland Waterway Transport (IWT) in the Yorkshire region, reversing the recent decline in IWT usage in response to the long-term (2050) low carbon emission requirement which is predicted to increase the price of road transport in the next few years (European Commission, 2018). The capacity of the Aire & Calder Navigation has increased over the years, with current plans to accommodate Euro Class II or container barges, so providing a significant route from the Humber ports to Leeds. The efficiency of a logistics supply chain can be assessed in terms of reduced carbon emission with different optimization strategies rather than a fixed freight-by-road fee. The investigation of a green logistics supply chain in the Yorkshire and Humber region has been reviewed in this paper. Conclusively, the outlook of inland navigation appears promising, wherein issues on infrastructural gaps and institutional support are addressed. This study has been commissioned to establish the current use of non-road modes of transport to and from Yorkshire and the Humber along with their future potential and challenges. The study is intended to explain how this use would change in subsequent years, the scope for its increased use in the future and the conditions required for that to take place. The relevance of such an overview to the future role of specific IWT-related sites will be discussed.

Case Description

IWT freight transport has considerable potential for reduction of CO_2 emissions. Whilst detailed figures for CO_2 emissions depend upon a wide range of variables, it is generally accepted that emission for IWT freight is approximately one third of that for road freight. For example, Figure 1 shows specific emissions for different freight modes (European Environment Agency, 2017).

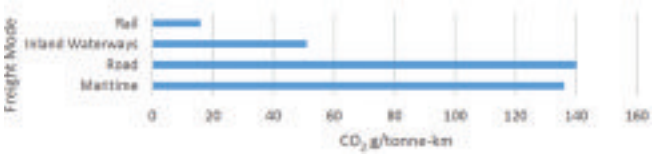


Figure 1: Comparison of CO_2 emission of different freight modes (European Environment Agency, 2017).

Whilst most studies focus on exhaust emissions, recently non-exhaust emissions have increasingly become a concern. Although hydrogen and electric engine reduce exhaust emission, the non-exhaust particulate emissions are caused by road traffic. Road wear, brake and tyre wear cause particulate emission, dust and soot, which may be more than that from the exhaust emission (Penkała, Ogrodnik & Rogula-Kozłowska, 2018). The cost of such emission reduction should not neglected in this comparison.

The potential for the IWT mode of freight transport has been unquestioned over the years and it forms a significant fraction of freight movement in many countries across Europe. Figure 2 presents the 2017

EU-28 statistics for IWT Tonnage–Km in various European countries, arranged in decreasing order of IWT million-tonne-kilometre (Eurostat, 2017). The figure shows that Germany, Netherland, Romania, Belgium and France have the five highest Tonne- Km IWT amounts of cargoes. Further analysis of the statistics would reveal that, whereas the statistics for Germany and the Netherland have remained substantially constant over the years 2014 to 2017, for the UK the corresponding figures are not only much smaller but also show significant decline as shown in Figure 3. According to the review of recent studies the modal share of IWT has gradually declined due to poor maintenance, lack of dredging, terminal facilities and improved road network resulting in fierce competition from road transport. However Yorkshire has a significant inland water network comprising the Humber Estuary and connected canal network, which is more densely distributed than the average in UK. Some studies indicate that the modal share of IWT in the UK is lower than the average for European countries, currently at 99.5 Mt-Km (Eurostat, 2017) of the total cargo. The IWT traffic estimation is based on the report of CRT organisation.

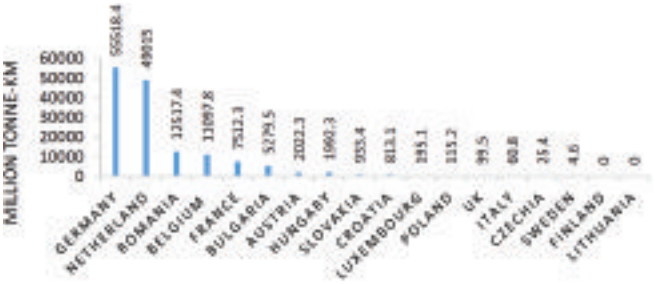


Figure 2: Comparison of Inland waterway freight volumes across Europe for 2017 (Eurostat, 2017).



Figure 3: UK Inland waterway freight transport volume showing decline over 2014-2017 (Eurostat, 2017).

Waterways may be categorised by the dimensions of cargo vessels which can be accommodated. The commercial waterways forming the focus of our investigation are classified under s.104 of the Transport Act 1968-4 (IWA, 2018), totalling 564km in length. These are smaller waterways than Principal inland freight waterways but some have significant freight potential for barge traffic as well as seagoing traffic. They comprise mainly non-tidal rivers and canals (beneficial for improving fuel consumption efficiency) while generally accommodating vessels of between 350 and 1000 tonnes payload, although a few are smaller. Within the UK the available navigations are the Aire & Calder Navigation, Calder & Hebble Navigation (part of), Sheffield & South Yorkshire Navigation, New Junction Canal, Gloucester & Sharpness Canal, Crinan Canal, Caledonian Canal, and part of the rivers Ouse (Yorkshire), Trent, Lee, Severn and Weaver (IWA, 2018).

The IWT system, like any other form of transportation, provides for the movement of freight traffic, although slow in turn-around. Whilst road freight is currently perceived to be cheaper, the inherent advantage of IWT lies in its capacity to move bulk cargo in large volumes. When the tonnage per cargo exceeds 1000 tonnes, IWT costs become comparable to the road only freight cost (Praveen & Rajakumar, 2015). However, monetary cost should be considered along with environmental cost and IWT is potentially a way to make greener transport, ie reducing CO_2 and NOx gas emission.

Hence, a major thrust needs to be given to this sustainable means of transport. Simultaneously, the government should act as a facilitator to attract private sector participation, especially in development of transhipment facilities, maintenance of boats or provision of new boats such as Euro Class II barges, terminals and wayside facilities along the waterway. An example of government intervention is provided by the IWT Policy of the Indian Union Government which provides a vessel building subsidy of 30% for ship owners and 100% tax exemption to investors in this sector along with a further tax exemption of 30% for the next five years (Praveen & Rajakumar, 2015). An optimal mix of road, rail and IWT will provide an efficient transport infrastructure. Even the projected improvement of roads may not reduce the congestion levels significantly. It necessary to encourage the private sector to use IWT, ultimately providing more economical and environmentally friendly competition for road transport.

Scope of the Study

This study addresses the potential for increased use of IWT freight in the Yorkshire and Humber region of the UK. 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 one million tonnes of freight per annum are carried although this figure represents a significant decline from around 4.5 million tonnes in the early 1990s. 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 (Santén et al, 2018). Figure 4 shows where the IWTS-project has chosen to focus, within the UK, on the Aire & Calder Navigation as it connects the industrial conurbation of Leeds, Bradford and Wakefield through to the Humber Estuary, via Goole. There are 11 locks along the 34 mile length of the Aire & Calder navigation, whose maximum boat size dimensions are: length 61m, width 2.5m and headroom 3.6m. Hence, the inland waterways in the area has the possibility of short-sea connections with mainland European ports including Rotterdam and Amsterdam (Santén et al., 2018). In order to overcome the barriers for more efficient barge movement and move towards an aspiration of 200,000 tonnes p.a. of bulk cargo into Leeds in 2020, the UK Canal and River Trust (CRT) has announced an in-principle agreement with West Yorkshire Combined Authority (WYCA) for £3million in funding to construct the Inland Port of Leeds at Stourton, subject to planning permission. The longer-term ambition is for 8 million tonnes p.a., but this would need additional investment of around £10 million to eliminate bottlenecks to facilitate Euro Class II /Container barges and expand into other services such as fast-moving consumer goods (FMCG) and Containers (Canal & River Trust, 2019).

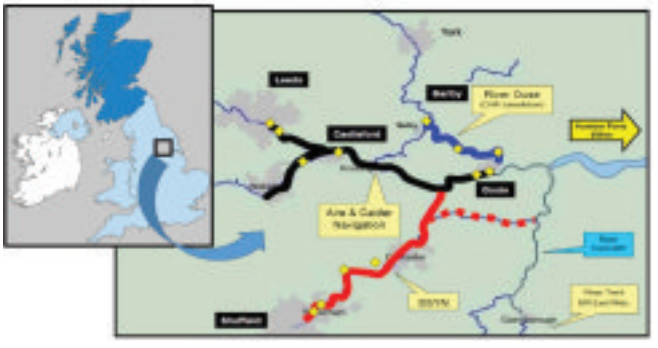


Figure 4: Location of Aire & Calder Navigation showing connection with Humber Estuary (Santén et al., 2018)

UK-wide traffic carried by barge or sea going vessels on the inland waterways network has recently increased by 8%, mainly due to a 30 per cent increase in goods moved by the River Thames attributable to increases in the movement of oil products and of dry bulk (Lessons from the Thames, 2016).

Also, while investments in this sector have not equalled those in rail in early years and road in more recent times, there are proposals for investing in this sector. The current study endeavours to investigate the commercial viability of IWT in order to facilitate such investments.

A key driver for the reduced environmental cost of IWT freight is the reduction of HGV loads. For example a single 500-tonne Euro Class II barge is equivalent to twenty 25-tonne HGVs. The above 200,000 tonne aspiration would result in 8000 fewer road vehicle movements whilst a projected 500,000 tonne movement to IWT by 2023 would save 20,000 HGV movements and produce a CO_2 saving of 100 tonnes per year.

Methodology of the Study

This paper presents a survey which has been made of published literature and statistics on IWT in Europe and UK in order to understand the historical development, the existing status of freight movements and the investments in the sector and includes a summary of the major recommendations and actions. There is a need for coherence within the competitive transport environment: where shipping companies and customers can transfer cargo to IWT, finding it economical to transport goods in a particular mode; where carriers are able to meaningfully invest in the organisation and services for this purpose and finally where government and other agencies may have a regulatory or facilitating role. Workshops, visits and interviews have been directed with various players in the inland waterways sector. These include wharf and barge owners and operators in the region around the mentioned inland waterways as well as the Canal and River Trust (the Inland Waterways Authority for the UK).

Geographically and economically, the River Humber and the Manchester shipping transport system contribute to road traffic congestion and queues for unloading cargoes that came from Humber ports to Manchester. It can be seen that the traffic is considerable which makes the road-only freight unreliable and inefficient. Figure 5 illustrates two typical abnormal and oversized loads which may be better transported by IWT.



Figure 5: Abnormal and oversized cargo traffic make the road freight unreliable but it is appropriate to load by IWT.

Table 1 represents the navigation system and relevant size of the boats, maximum tonnes of goods capabilities or future possibilities of the IWT, the equivalent lorry load compared to the barge size and the goods types.

Navigation	Max Vessel Size m	(Tonnage)	Equivalent Lorry loads per vessel	Cargo presently
Aire & Calder (barge)	61	600	21	General Goods
Aire & Calder (shipping)	110	3,000	107	General Goods
Calder & Hebble	17	75	3	N/A
South Yorkshire	70	700	25	Oil
Stainforth & Keadby	19	100	4	N/A
Selby Canal	24	100	4	N/A
River Ouse (shipping)	120	3,000	107	General Goods

Table 1: Composition of cargo move waterway IWT and future cargo waterways in Yorkshire (Tonnes) (CRT, 2019).

According to the Table1, the mentioned freight above, and comparison of CO_2 emission in road freight and IWT, see Figure 1, the amount of the CO_2 reduction due to one trip (from Humber port toward Stourton, Leeds along Aire & Calder navigation) would be about 920.00 gCO_2 /tonne regardless to other dangerous gas due to road transport.

Prospects for increased usage of IWT

Several Yorkshire and Humber navigations (namely the Aire & Calder, Calder & Hebble, Stainforth & Keadby, Selby Canal and River Ouse) may be considered for the feasibility of the CO_2 reductions for low carbon emission freight. The Aire & Calder navigation can form part of a connection between the east and west coasts of the UK, although there is no realistic prospect of a complete east-west IWT link since although the canals exist they cannot support the projected freight volume. Historically, location of industrial activity has been influenced by logistical convenience of water transport possibilities, at a time when road and rail networks were not so well developed. At the present time, the geographical origin of goods flows has no such constraint and therefore optimal use of IWT requires improved trans-shipment facilities to connect with rail and road links.

Prospects for increased usage of IWT include not only bulk freight but also connections to last-mile services.

Although the time-to-transport is part of the cost function, the slow route via the inland waterways can be a possibility as a storage i.e the power stations along the navigation can arrange the fuel arrival time by the IWT just for usage rather than storage (pipeline effect).

For IWT, the typical cost of vessels has to be added to the costs of the subsequent mode of low CO_2 emission transport which may have to be used to achieve the end to end requirement of IWT.



Figure 6: Mokum Maritime full-electric barge (BESTFACT, 2015).

The waterway freight should be able to move seamlessly and be compatible with other last mile freight offers such as ebay shop to other modes, eg train and taxis. See for example Figure 6, which presents an urban cargo operation in Amsterdam using electric barges of modified size (20m length, 4.25m width, 85m3 load capacity) (BESTFACT, 2015). The short distance IWT in our proposed region could be viewed as urban freight!



Figure 7: Last mile freight by electric bike (Eurostat, 2017).

Figure 7 shows a further possibility for low carbon emission last mile freight. It is an electric bike taxi IWT (Eurostat, 2017).

Parcel delivery is a further opportunity to use IWT to connect to special canal-side post offices, offering free last mile green transport. This is a new sector that has some possibilities in a free post and package service to complement on-line sales.

Optimisation in support of continuous improvement

Optimisation of supply chain efficiency can take place on a number of levels. In order to promote the use of IWT, not only monetary cost but also environmental cost needs to be considered (green logistics). In order to verify any improvements, a significant monitoring data collection is required and it is vital to arrange to monitor the improvement of the logistic system continuously otherwise the system would fail to remain competitive.

Several issues need to be considered for computation of the logistics problem solutions. Various different algorithms can be chosen but there are several variables that should be considered including cost, time and location as well as CO2 emission. Reverse Logistics (RL) could also be included (Quesada, 2003).

A P-Median solution can solve an algorithm for locations (Daskin & Maass, 2015) of a reverse logistics system and the cost issues due to high investment for reverse logistics. The cost issue of reverse logistics (Wang, Zhou & Ren, 2010) may not be ignored in the future (Genchev, 2009), due to the contribution of the optimum logistics chain and global challenge. Due to a different assumption for choosing the variables in a single procedure algorithm the errors can be significant. Therefore, multiple solutions are needed to make a heuristic technique for a multi-objective algorithm.

Conclusions

Further detailed study is required to emphasize the freight flow mapping, and identify what cargoes are currently coming into the Humber Ports (Hull, Goole, Immingham, Grimsby and Immingham), which are the cargoes that can continue feasibly their journey by water even short journey.

An appropriate model is a key issue for operational requirements and constraints into something the computer can understand and use in algorithms. The proof of the flexibility of the options due to different variables needs to be shown by clear results. In the context of optimised model may further expand the study needed to operate and control by expertise to support the data and control the changes while providing the cost of technology and operational improvement.

A significant amount of carbon emission is caused by transport systems and statistics suggest that the transport-related contribution will increase in the future.

Transport infrastructure investment should focus on improved intermodal facilities to facilitate access to IWT.

Initial investigations have concerned the applicability of IWT in terms of costs, volumes and connectivity.

Additionally, it is impossible to ignore future growth of cities and calls for integrated investments. To increase interconnection with other transport modes, IWT issues need consideration. These include faster vessels, unified pricing and targeted subsidies in the area.

Activities that are underway to improve the functionality of IWT in the Yorkshire & Humber region include development of the Inland Port of Leeds. This development includes the building of a new wharf facility at Stourton and the target to deliver 200,000 tons p.a. of bulk cargo into Leeds from 2020, as well as actions to eliminate bottlenecks to facilitate Euro Class II / Container barges through Bullholme Lock.

It is essential to have the most efficient transport managing and automatic data capturing, a continued green optimised supply chain and logistics technology.

Air quality improvement would be cost effective and, although not easy, there is an increasing number of companies providing green supply chains and autonomous logistic systems.

Acknowledgement

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