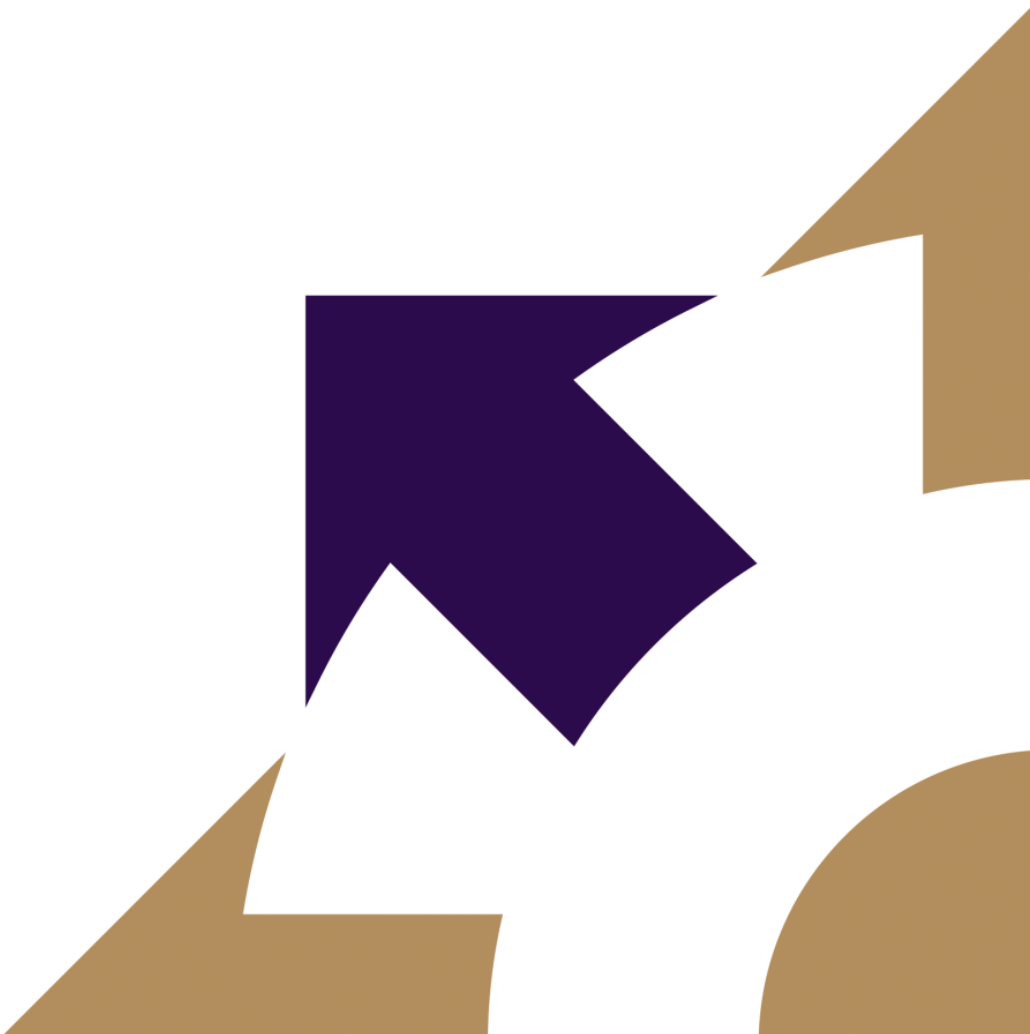
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Autonomous Vehicles in Logistics

Flying Maggots – A novel solution to an ongoing problem

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Purpose: Whilst there is a growing body of research which discusses the use of Remotely Piloted Aircraft Systems (RPAS) to transport medical supplies, almost all reported cases employ short range aircraft. This paper considers the advantages and challenges inherent in the use of Long Endurance aircraft (LE-RPAS) to support the provision of medical supplies to remote locations – specifically 'medical maggots' used in maggot debridement therapy (MDT) wound care.

Research Approach: After introducing both LE-RPAS technology and MDT, the paper first reports on the outcomes of a case study involving eleven semi-structured interviews with individuals who either have experience and expertise in the use of LE-RPAS or in the provision of healthcare to remote Aboriginal communities in Western Australia. The insights gained from this case study are then synthesised to assess the feasibility of LE-RPAS assisted delivery of medical maggots to remote Indigenous communities.

Findings and Originality: The paper offers an assessment of the feasibility of the use of LE-RPAS to transport medical maggots. In doing so, it highlights a number of infrastructure and organisational challenges that would need to be overcome to operationalise this concept. Whilst the particular context of the paper relates to the provision of medical support to a remote location of a developed country, the core benefits and challenges that are exposed relate equally to the use of LE-RPAS in a post-disaster response or in the provision of medical support in a remote location of low-middle income countries (LMICs). To this end, the paper offers a high level route map to support the implementation of the concept.

Research Impact: The paper demonstrates how the use of LE-RPAS to support remote Indigenous communities offers the potential to deliver healthcare at reduced cost compared to conventional approaches. The paper also underlines the potential benefits of the use of MDT to address the growing wound burdens in remote communities. Finally, the paper expands on the existing discussion of the use of RPAS to include its capability to act as the delivery mechanism for medical maggots.

Practical Impact: The paper offers a novel approach to the efficient and effective provision of medical care to remote Australian Aboriginal communities which, in particular, reduces the need to travel significant distances to obtain treatment. In doing so, it emphasises the importance in gaining acceptance of both the use of MDT and also the operation of RPAS noting that these have previously been employed in a military, as distinct from humanitarian, context.

Introduction

The State of Western Australia (WA) is extremely sparsely populated with isolated communities frequently located at some distance from the single North/South highway. Thus, for example, the Federal Constituency of Durack (which covers much of the North of the State) has an area of some 1,629,858 sq km – approximately the area of France, Germany, Spain and Portugal combined – but has only just under 100,000 registered electors (AEC, 2016). WA is also home to the third highest number of Aboriginal Australians, and of these, 41% live in remote areas (Shahid et al., 2016). Furthermore, Aboriginal Australians living in rural and remote communities are far more likely to suffer from injury, skin infections and chronic disease, than non-Aboriginal Australians (AIHW, 2016). Thus, the timely and efficacious treatment of wounds presents an ongoing challenge for which Maggot Debridement Therapy (MDT) is one potential solution.

In parallel, there have been considerable recent advances in the use of Remotely Piloted Aircraft Systems (RPAS) as a means of delivering supplies in both a commercial and humanitarian context (Tatham et al., 2017). Whilst much of the publicity has related to their use by companies such as Amazon and Domino's, a number of case studies relating to the movement of medicines by RPAS have recently been published by Swiss Mine Action (FSD). These reports are part of a two year project to determine if, how, and under what circumstances RPAS can add value to humanitarian operations in disaster areas (Soeliso et al., 2106).

Aim

With this introduction in mind, the aim of this conceptual paper is to review the benefits and challenges inherent in the use of LE-RPAS to transport medical maggots for the treatment of wounds in remote communities. To achieve this, the paper will integrate three lines of investigation: (1) the benefits and challenges relating to the use of MDT in disaster, development and remote area medicine; (2) the potential for the operation of LE-RPAS (as distinct from RPAS in general) in the provision of humanitarian aid; and (3) a qualitative case study exploring the feasibility of using LERPAS to make emergency medical deliveries to the Aboriginal community of Bidyadanga in the North West of WA.

Maggot Debridement Therapy

MDT typically employs the larvae of the green bottle fly Lucilia sericata to remove dead or dying tissue from a patient's wounds, thereby controlling infection and stimulating regeneration and wound healing. Although MDT was very popular in the 1930s and 40s, the convenience of modern antibiotics led to a post-WWII decline in its use. However, since the late 1980s there has been a renaissance (Whitaker et al., 2007), and this has resulted in maggot production facilities being developed in various countries including the USA, Europe, Africa and Australia.

From a clinical perspective, there is clear evidence of the efficacy of MDT in the treatment of wounds from a broad number of causes (Sherman et al., 2007) but, in addition, MDT has a number of nonmedical benefits as a treatment regime. In particular, it can be applied and managed by nurses, thereby allowing surgeons and physicians to focus on other tasks – a key consideration in the aftermath of a disaster when the number of patients vastly exceeds the assistance that is available, or when the distances are such as to limit the ability for doctors to visit their patients on a regular basis (Stadler et al., 2016).

The maggots themselves are bred in sterile conditions and then transported in sealed containers before being applied directly to the wound and retained via a securely fastened netting or inside porous mesh bags that permit feeding but retain the maggots within, thus making the treatment more convenient. After use the maggots must be disposed of in line with World Health Organisation (WHO) guidelines. It is a prerequisite for the use of MDT that the treatment is acceptable to patients on emotional, cultural, social and religious grounds. In relation to the general acceptability of MDT, research by Spilsbury et al. (2008) indicates that there is no evidence of wide-spread patient resistance toward MDT. Moreover, if there is a need for halal or kosher medical maggots there are production methods that cater for such niche markets. Finally, trials undertaken by the Walter Reed Army Institute of Research indicate that medical maggots are able to withstand conditions found during military evacuation and transfer flights (Peck et al., 2015), and thus there is no a priori reason why they should not be transported as part of the payload of an RPAS mission. Remotely Piloted Aircraft Systems

Firstly, the use of the terminology 'Remotely Piloted Aircraft Systems' (RPAS) reflects the nomenclature adopted by the International Civil Aviation Authority and is, therefore, preferred to alternatives such as 'Unmanned Aerial Vehicles' (UAVs) or 'Drones'. Furthermore, when referring to the aircraft (as distinct from the overall system), the acronym RPA (or RPAs) will be used.

RPAs range from small rotary wing platforms to high end aeroplanes such as the USAF Global Hawk that is the size of a small executive jet. However, their key feature is the ability to be flown by an operator who remains on the ground at a distance from the aircraft itself. RPAs can employ either fixed or rotary wings (or a combination thereof), and be powered by fuel or battery driven engines – as a result their endurance varies from minutes to hours, with a summary of three exemplars shown in Table 1.

	Rotary Wing RPA	Fixed Wing RPA	Hybrid RPA
Exemplar	DJI Inspire	Aerosonde Mk 7	Latitude HQ -160B
Endurance	15-30mins	10+hrs	15hrs
Cruising Speed	70-80kph (40-45kts)	90-110kph (50-60kts)	70kph (40kts)
Ceiling	4,500m (14,750ft)	4,500m (14,750ft)	4,268m (14,000ft)
Wingspan	0.559m (1.63ft)	3.6m (5.6ft)	3.81m (12.6ft)
Overall Length	0.559m (1.63ft)	1.7m (5.6ft)	2.44m (8ft)
Max gross take-off wt	4.6kg (10.14lb)	25kg (55lb)	43kg (95lb)
Max payload weight	1.7kg (3.74lb)	4.5kg (10lb)	5.44kg (12lb)
Launch	Vertical	Catapult/from roof of a 4*4	Vertical
Landing	Vertical	Belly landing or catch net	Vertical

Table 1. Rotary, Fixed Wing and Hybrid Exemplar RPAS

Literature Review

A review of the literature was undertaken based on Kunz and Reiner's (2012) methodology in which the following databases were searched: ABI/INFORM Complete, Business Source Complete and Web of Science for academic journals. The review was carried out in two phases, the first of which was focused on the use of RPAS in a disaster response, and the second in respect their potential use in support of medical activities. The starting point for the search timeframe was based on the first reported use of RPAs in a humanitarian context which took place in the aftermath of the 2005 Hurricane Katrina (Tatham, 2009).

Use of RPAS in Disaster Response

This phase of the search identified 57 relevant papers. Of these a significant proportion were devoted to the methods to improve the actual operation of the RPAS and their associated sensors or the use of micro/miniature RPAS, and whilst such research is clearly of importance, it is outside the scope of this paper. More relevant contributions were found within a number of papers which will be considered in more detail.

Firstly, OCHA (2014) surveys the recent use of RPAS and its analysis suggests that: "One promising area is delivery of vaccines or other small medical supplies…" (p. 8). However, it goes on to note that "… the range limits on small UAVs (perhaps 40km) would make them unviable where villages are too widely spaced like much of the DRC [Democratic Republic of the Congo]" (p. 8). This latter observation captures an important theme that emerges from the literature in which, as far as the author has been able to ascertain, discussion around the use of RPAS in a humanitarian context generally, and in relation to their potential use for the delivery of medical supplies, only considers small RPAs similar to the DJI Inspire (the capabilities of which are summarised in Table 1).

A more detailed example took place in Papua New Guinea in which multi-rotor RPAs (similar to the DJI) were used to collect tuberculosis sputum samples and transfer them to a central testing laboratory (Soeliso et al., 2016). The report from this trial recommended that "…platforms should be hybrid designs, automatic and very simple to use with a minimum range of 60 km and a minimum payload capacity of 1 kg." (Soeliso et al., 2016, p. 37).

The American Red Cross (2015) undertook a comprehensive review of the potential of RPAS in a disaster response context. Their report concludes that: "Aerial drones [RPAS] are one of the most promising and powerful new technologies to improve disaster response and relief operations. … When a disaster occurs, drones may be used to … deliver needed supplies and equipment … among many other potential applications." (p. 4). The final important source is the website of the UAViators organisation which supports a community of practitioners who are striving to develop improved ways of using RPAS to support those affected by disasters. Not only does this website contain a large number of case studies but it also provides a set of Operational Guidelines (UAViators, 2016) which are currently under consideration by the UN, IFRC and NGO communities, and which are recommended for use by OCHA (2014).

A particularly important theme emerging from the literature relates to the ethical aspects of the use of RPAS which reflects their migration from their original role as a military weapons (i.e. armed 'drones'). This element of the challenge is summarised by Soesilo and Sandvik (2016) who offer the results of a survey of humanitarian organisations, donors, UN agencies, national governments, private business and other respondents. Whilst the response rate is not provided, the survey is elicited 194 inputs during the period 15 Nov 2015–15 Jan 2016, the result of which can be summarised in the authors' observation that: "A majority of survey respondents [66%] expressed confidence that drones have the potential to strengthen humanitarian work … while a significant minority [22%] viewed the use of drones in humanitarian work unfavourably." (p. 3). In particular, the survey respondents emphasised the ability of RPAS to support material delivery; whilst on the negative side, the core concerns were related to their association with military applications and their potential to increase the 'distance' between the beneficiaries and the aid workers.

Use of RPAS in Medical Response

The second phase of the literature review focused on the potential use of RPAS in a medical context and although this search uncovered 230 papers, only 8 were relevant. At the macro level, the paper by Schroeder and Meier (2016) envisage a scenario in which trained medical workers identify the needs in remote communities and arrange for the supply of appropriate medicines etc. by RPAS, with commensurate savings of time and cost. This, as will be seen in Section 6, is precisely the arrangements that have been studied in the field element of this research.

A similarly strategic discussion is offered by Sachan (2016) who summarises the current use of RPAS for the delivery of medicines etc., although the author cautions that the movement of such materials must reflect their relative fragility. This paper discusses a 'proof-of-concept' trial undertaken by the United Nations Population Fund in which contraceptives were delivered by RPAS to a remote part of Ghana using short range RPAs. The paper by Haidari et al. (2016) reviewed the economic and operational value of RPAS to transport vaccines in low and middle income countries. These authors used a simulation model of the WHO's immunisation programme in Southern Mozambique and the results indicate that not only did the use of an RPA (rather than the traditional multi-tiered land transport system) improve the availability from 94%->96%, but it also reduced the cost/dose by 20%.

Thiels et al. (2015) address the potential use of RPAS to transport medical products to hospitals, mass casualty events and offshore locations in the event of critical demand. The authors' research provides a conceptual analysis of the associated benefits and challenges in the use of a short range multiple-rotor RPA. The research concludes that "the use of UAVs would be a viable mode for the transport of medical products in times of critical shortage" (p. 108), and that the costs are likely to be significantly lower than those of conventional medical transport.

The Medical Supply Chain to Support an Indigenous Australian Community

Overview of the Case

The case study described in this section of the paper considers how the use of LE-RPAS might mitigate the challenges posed in the timely provision of medical care to members of the Aboriginal community of Bidyadanga. It is located 180km by road from the nearest town with a hospital (Broome), although the direct distance to Broome is only 90km. The community has a population of some 750, and the local health clinic has 10 staff (1 manager, 5 Aboriginal health workers and 4 registered nurses (RN)). In addition, it is supported by twice weekly visits by general practitioners who fly to the community by plane. The clinic also operates a bus service that takes patients to Broome on a daily basis, and this bus is also used to collect medicines as required. The regular journey time is 1.5 hours each way, but the route is both unreliable and extremely dangerous in the wet season due to flooding and road degradation.

The scenario used to ground the case study was that of a patient suffering a medical condition in which rapid (<2 hours) administration of medication is necessary. Thus, the concept envisages an initial assessment of the patient's condition at the clinic, after which the medicinal requirements are transmitted to Broome Hospital. An RPA is then despatched by a qualified operator, received at the clinic in a designated landing zone with support from a trained operator located at the clinic site. An RN unloads the RPA payload and administers the medicine to the patient. The RPA then returns to Broome Hospital.

As discussed above, existing RPAs cover a spectrum of capabilities that reflect a balance between weight, endurance and the mode of control. However, the case study scenario requires that the RPA flies some 180km (round trip) plus a safety margin. This results in the need to employ an LE-RPAS such as the fixed wing Aerosonde Mk 4.7 or the hybrid Latitude HQ i60B. Given the context of a remote community with limited availability of technical aircraft handling skills, the latter presents a less risky option as it minimises the infrastructure requirements. Furthermore, the ability of the Latitude to operate VTOL (it requires a clear area of diameter 5m) would increase the operational flexibility whilst minimising the airfield to hospital/clinic transit times. The Latitude also has a greater payload, and has thus been selected as the exemplar platform for the purposes of this case study.

Interview protocol

The research underpinning this element of the paper was undertaken in mid-2016 and consisted of 11 semi-structured skype-based interviews, the details of which can be found in Table 2.

	Position With Organisation	Organisation Type
Interviewee A	Communications Manager	Federal Government
Interviewee B	Chief Executive Officer	Research Organisation
Interviewee C	Manager	RPAS Commercial Operator
Interviewee D	Manager	RPAS Commercial Operator
Interviewee E	Operations Manager	Emergency Services
Interviewee F	Operations Manager	Emergency Services
Interviewee G	Station Officer	Emergency Services
Interviewee H	Operations Manager	Medical Organisation
Interviewee I	Care Provider	State Government
Interviewee J	Operations Manager	Medical Organisation
Interviewee K	Health Support Worker	Medical Facility

Table 2. List of Interviewees, their Organisations and Roles.

Summary of the Perceived Challenges

Interviewees with expertise in the technological aspects of RPAS operations were very supportive of the proposed use. Furthermore, successful trials have been undertaken by the Melbourne Fire Brigade which, in turn, have informed similar trials in both New South Wales and Queensland. Based on these, Interviewee H indicated that the key challenges are related to the need for the appropriate infrastructure as well as the restrictions imposed by the Australian Civil Aviation Safety Authority (CASA) regulations. In terms of the actual operation of the RPAs, the scenario used in this research was perceived to be relatively straightforward with a vertical launch, a transit some 90km in a straight line, vertical landing, and a similar return flight.

The Latitude RPA weighs 45kg and is, therefore, classified as a 'medium' aircraft under the CASA regulations. Consequently, specific approval would be needed to cover: (a) Operating in Beyond Line of Sight (BLOS) mode; (b) Operating within 3nm of an aerodrome (Broome airport); (c) Night time flying and (d) Operating within 30m of people. However, interviewees with relevant industry experience were of the view that there would be a reasonable expectation that the use would be approved due to the nature of the project's intent and its Area of Operation.

The whole issue of the acceptability of the use of RPAS has been summarised above, with one of the major concerns over the benign use of RPAS reflecting its potential to increase the 'distance' between the aid workers and the beneficiaries. In a similar way, it was made clear by Interviewees I and K that it would be essential to engage with the community through a partnership that was able to draw on the trusted and established relationships that the Bidyadanga Clinic has developed. More broadly, the overall operation of the RPAS was not perceived to create major challenges. Whilst it is assumed that the process would be managed and controlled from Broome by licensed operators, the Clinic itself would require a number of staff able to receive and despatch the RPA. Their role would include ensuring that the land/launch area is clear of hazards (including people), unloading/loading the RPAS (a relatively simple operation), conducting any pre-flight checks and then liaising with the Broome operators to initiate the return flight.

Flying Maggots

The field research reported in this paper has focussed on the challenges/benefits associated with the use of LE-RPAS to transport urgent medical supplies to support patients located in a remote community of WA. In parallel, however, the aim of this paper has been to extend the research to include consideration of the transport of medical maggots, and the aim of this section is to integrate the two streams of research.

From a transport perspective, medical maggots are fragile living organisms that are heat-sensitive, require oxygen and adequate humidity. Thus the key requirements are that they should be kept in a secure container that will (a) maintain the internal temperature in the range 6-25oC; (b) maintain adequate humidity inside the sterile primary container; and (c) provide sufficient ventilation either via excess air within an air–tight system or via air inlets that continue to provide protection and temperature control. The key outstanding issue relating to the successful use of MDT remains the acceptability of MDT to the particular community. Prior research into the use of medical maggots indicates that there is no evidence of wide-spread patient resistance toward MDT but this cannot be automatically assumed for remote Aboriginal communities, or for the healthcare workforce servicing these communities. Therefore, information programs for healthcare professionals and patients would need to be a core component of any MDT implementation irrespective of the mode of transport for medical maggots.

Operationalising the Use of LE-RPAS to Transport Medical Maggots

The above analysis of the benefits and challenges surrounding the use of LE-RPAS as the means of transporting medical maggots clearly suggests that there are no insuperable challenges to the implementation of the concept. However, its operationalisation will, inevitably, require some investment, and the following steps represent a proposed way forward:

Step 1. Select a pilot location to act as a 'pathfinder'. The selection would be based on: (a) The prevalence of wounds in the community that are amenable to MDT; (b) Timely access to laboratoryraised medical-grade maggots; (c) The willingness of local wound care providers to use MDT, and the patients to accept this treatment; (d) The extent to which the community is supportive of the use of RPAS as a means of providing swift and effective transport for medical supplies including medical maggots and (e) The geography and topology of the chosen location both in terms of the need for LERPAS services to that location as well as the safe operation of the aircraft.

Step 2. Representatives of the pathfinder community together with RPAS experts in the various domains (the aircraft operations; air traffic control; risk management, etc.) should collaborate to undertake the following activities: (a) Establish appropriate air traffic control protocols to enable RPAS operations; (b) Capture base-line data that will enable the downstream impact analysis; (c) Conduct appropriate training and education at all levels to facilitate the RPAS operations and (d) develop (as necessary) appropriate payload containers that will ensure the delivery of high-quality viable medical maggots during all environmental and weather conditions.

Step 3. Conduct live operations on a limited basis in order to evaluate and improve the above people, process and technology-related requirements for safe, effective and efficient RPAS use in support of medical supply chains. Thereafter, and assuming that the trial proves both efficient and effective, the use of RPAS to support MDT could be expanded to include other countries and scenarios.

Summary

In summary, it is perceived that the use of LE-RPAS has significant potential to support the logistic processes underpinning the provision of MDT in remote locations. However, a number of important hurdles remain before the concept can be operationalised. Key amongst these are the development of an air traffic control regime that supports (rather than constrains) the RPAS use, together with the required people and process-related mechanisms. Importantly, whilst the paper reflects the authors' analysis of the existing literature in the HL, RPAS and MDT fields, it has been amplified by the insights developed from a series of interviews with key informants whose spheres of expertise have covered a broad range of issues relating to the use of RPAS. It is also important to note that the whole area of RPAS operations is moving extremely quickly, and the lessons identified, and associated developmental activity, are likely to benefit the efficient and effective operation of LE-RPAS.

It is argued, therefore, that the next critical step in understanding the reality of the potential for LERPAS to support the transport of medical maggots is to undertake a field trial in a benign environment through which the reality and magnitude of the challenges can be better understood. Assuming a positive set of results in such a trial, this would enable a more robust plan to be developed and costed, and the resultant proposition given due consideration by governments and the global humanitarian assistance community.

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THE APPLICATION OF UNMANNED AERIAL VEHICLES IN MANAGING PORT SECURITY IN KUWAIT

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Introduction

Unmanned Aerial Vehicles (UAVs) also known as drones have proliferated since the improvements in the weight and power of batteries and electric motors. UAVs are now common among hobbyists as well as in use by commercial organisations involved in survey work as well as film and photography. UAVs are now beginning to be deployed more in the monitoring of safety and security and this study aims to reveal the extent to which UAVs can be deployed to enhance security, but with a focus on maritime ports.

Literature Review

Types of UAV

There are numerous types of UAVs and drones currently in operation. From nanodrones, microdrones and minidrones, which are widely available for purchase by civilians, to small range and long-range medium altitude and long endurance (MALE) and high altitude and long endurance (HALE) drones, which are typically employed by military forces. All these vehicles have some similarities, such as the lack of humans aboard them and the ability to be controlled via radio/infrared communication. The ranges, weights, payloads and altitudes of these vehicles also vary. In terms of altitude, they can fly between heights of 30 metres and over 10 km. In terms of endurance, their power units offer flight times of between 12 minutes and over 24 hours. In terms of payload, their maximum take-off weight ranges between 0.4 kg and more than 3 tons (Dougherty, 2015).

Talas (2016) states that the current regulations that exist for the commercial flying of UAVs differ from nation to nation. The regulations for the commercial flying of UAVs in the UK are governed by the Civil Aviation Authority's (CAA) Unmanned Aircraft System Operations in UK Airspace: Guidance (March 2015). The guidance, also known as CAP722 states that UAVs operating in the UK must meet at least the same safety and operational standards as manned aircraft. UAVs are classified into three categories: those which weigh up to 20kg; those which weigh between 20kg and 150kg; and those which weigh more than 150kg.

In the UK, drone hobbyists are not required to register their UAVs and nor do they need operating permission from the CAA or a pilot qualification. Furthermore, drones must not be flown within 50 metres of people or over or within 150 metres of any congested area or of an organised open-air assembly of more than 1000 persons. The drone must be flown in visual line of sight so that direct, unaided visual contact can be maintained with the aircraft which is sufficient to monitor its flightpath in relation to other aircraft and persons on the ground. The drone must remain within 500 metres horizontally and no more than 400 feet vertically from the operator. If a drone operator

wishes to fly within 50 metres of people or 150 metres of a congested area then prior permission must be obtained from the CAA. Similarly, for all commercial UAV flights the CAP 722 regulation states that permission must be obtained from the CAA prior to any flight (Talas, 2016). Where UAVs are deployed for commercial purposes, it is necessary for the pilot to have undergone training for at least the basic national UAS certificate for small unmanned aircraft (UAV Academy, 2016).

In a port, a UAV could be deployed on regular perimeter checks to assess any fence-line breaches or to overfly buildings to check that roof access doors have not been left open. Furthermore, checks can be made from the air on any restricted areas in the event of the failure of another detection system, such as CCTV cameras.

Classification of UAVs in Terms of Autonomy

In order to determine what the best choice of UAV technology would be for the purpose of ensuring port surveillance, it is necessary to examine the existing technology in terms of autonomy. Huang (2010) describes how the levels of autonomy are categorised from zero (UAVs devoid of any autonomy) to 10 (fully autonomous UAVs). The evaluation in this study will be constructed around the needs of the port supervision authorities and counter-terrorist forces as well as around the financial and technological resources available in Gulf countries. Higher degrees of autonomy might be not only more expensive, but also unnecessary for the tasks implied in port supervision. This means that first, it is necessary to establish the tasks and activities for which UAVs are required and what type of vehicles and systems are best suited to these tasks. Secondly, the possibilities posed by individual technologies have to be evaluated, in order to determine all the goals that a type of vehicle/technology can be selected for.

Port Security Threats

Researchers (Pinto and Talley, 2006) indicate a series of threats currently associated with US ports' security among which they mention: containers with smuggled nuclear and chemical weapons, mines placed on ships that can disrupt the use of shipping channels and pirate vessels that can be set to destroy bridges or other important landmarks. Parfomak and Fritelly (2007) add examples to Pinto and Talley's list (2006) thus proving that there is a large range of potential risks to be considered. Due to this consideration, these threats and the increased probability associated with their incidence are constantly scrutinised by specialist marine war and terrorism underwriters, who evaluate these risks as well as the costs associated with them. Talas (2010), another researcher interested in identifying the different type of security incidents associated with ports, elaborated on a list of potential security incidents, drawing on the suggestions formulated by Parfomak and Fritelly (2007). The fact that these potential incidents are similar for different port facilities indicates that they represent realistic potential threats for all ports across the world. The list compiled by Talas (2010) encompasses: bombs introduced by a person on foot, by a car, or by a truck; an attack with a biological agent directed at the port conducted either on foot or by vehicle, mining of the port infrastructure and attack by suicide vessels.

Talas (2010) points out that before the 9/11 incident the most important port security threats were considered those related to organised crime and drug smuggling. However, since September 2001, terrorist attacks have become the main concern when it comes to security risks associated with ports (Talas, 2010). Raymond (2006) indicated that these facilities are characterised by features that make them particularly vulnerable to terrorist

attacks, pointing out their considerable extent and the fact that ports can be easily reached both by sea and by land. These access options make it difficult for them to be protected by the same security measures as those corresponding to airports. Further security-related vulnerabilities are described by Bichou (2004): ports' interaction with cities and tourist attractions.

Researchers have considered (Nincic, 2005) terrorist groups which are known to display different levels of maritime expertise. While these should not be ignored, neither should be the observation made by Raymond (2006) according to which port security threats should not be reduced to those potentially posed by groups who have already conducted maritime terrorist attacks. Talas (2010) argues that port security risks can also be associated with the security labour force (i.e. manpower shortfalls and security guard violations such as unauthorised copying and distribution of security passes) and to operational aspects corresponding to security systems (i.e. IT systems, CCTV camera unit failings, alien detection of scanning devices etc.). The failure of existing security systems or other existing vulnerabilities must also be included on the list of port security risks (Juttner et al, 2003). One relevant example in this respect is that of the suspected al-Qa'eda member who was transported in a container to an Italian port (Raymond, 2006).

Potential to Be Exploited by Terrorist Organisations

The constantly growing market in commercial UAVs raises concern among specialists (Dedrone, 2016) who perceive the increased risk posed to security. The fact that UAVs are largely available for virtually anyone increases the possibilities for them to be misused for reconnaissance and surveillance missions underpinned by criminal intentions. The level of development which permits these devices to carry elaborate imaging equipment and consistent payloads generates additional reasons for concern. The price of this equipment is another feature which renders them highly available for the general public. Moreover, it is highly probable that the rapid expansion of the market will push the prices to decrease even further. Specialists in the field (Synergia, 2016) point out that there are already UAVs available for under €900 that can transport a payload of approximately 1 kg, that can fly for at least 5 km, and that have full GPS. If the UAVs are equipped with both GPS systems and autopilot, then they can be used to fly independently according to pre-established routes.

According to Synergia (2016) the following categories can be mentioned as representing some of the security risks generated by UAVs:

Reconnaissance and surveillance – UAVs could be used to identify potential targets or to conduct surveillance missions to inform their operator of the actions undertaken by different individuals from private, public or military establishments. The increased number of civil UAVs purchased by the general population makes it difficult to rapidly establish whether such a device is operated for recreational use, in order to support news-gathering and other similar activities, or if it serves criminal intentions.

Smuggling – since UAV models are created so as to permit them to carry significant payloads, one of the existing concerns is that these vehicles could be used for the transportation of illicit goods. There have been events which motivate these concerns; most of them intended to introduce different materials into prisons (Russon, 2013, Mullany, 2015) or to transport drugs across borders (Berger, 2015).

Kinetic attack – this type of threat is also related to UAVs' ability to carry a payload. The nature of the payload correlated with the intentions of those operating the vehicles determines the nature of the risk they pose. If the payload is made up of guns or explosives which are managed so as to be flown into people or structures than such an attack may result in loss of life or material loss. The list of potential targets is virtually unlimited, but it needs to be pointed out that these could include important and strategic infrastructure (Finn, 2011).

Methodology

As part of the research, both primary and secondary data were collected. The primary data collection involved both qualitative and quantitative methods. Primary data was collected using an online survey issued to 66 port-related respondents and from five semi-structure telephone interviews, taken from a voluntary subset of the survey respondents.

The main research question proposed is:

RQ1 How can UAVs be effectively utilised to enhance port security?

In order to address the main research question, it was necessary to explore some additional themes, such as: what are the key security threats that a port faces; the extent to which a UAV can become a security threat; the efficacy of UAVs in complementing existing security measures; the extent to which UAVs can be seen as a health and safety risk; and whether UAVs should be registered with the appropriate aviation authority. It is these additional themes which were reflected in the content online survey.

Results and Discussion

A total of 66 respondents participated in the survey. The data were collected using online tools (SurveyMonkey.com) while taking into account relevant ethical considerations. The first question was concerned with the field of expertise of the respondent. Table 1 summarises the responses received:

Table 1: Respondents' field of expertise

Field of Expertise	Responses
Port security expert	14.1%
Port security equipment supplier	3.0%
UAV expert	12.1%
UAV equipment supplier	6.1%
Port official	16.2%
Customs official	6.1%
Other governmental organisation official	22.2%
Other non-governmental official	20.2%

As shown in Table 1 the majority of the respondents were governmental organisation officials. Only 12.12% of the respondentss were UAV experts, while 6.06% were suppliers of UAV equipment. 14.14% of the respondentss were port security experts, which increases the reliability of the data they provided. The next question referred to the respondents' familiarity with UAVs, with the results in Table 2.

Table 2: Familiarity with UAVs

Familiarity with Unmanned Aerial Vehicles (UAVs)	Responses
Very familiar	28.6%
Fairly familiar	44.4%
Slightly familiar	21.8%
Don't know	3.2%

As the results show, only 28.6% of respondents indicated that they were very familiar with the devices in question. 44.4% of respondents declared that there were fairly familiar with the device, while 21.8% said they were slightly familiar with UAVs. Only two respondents (3.1%) claimed they did not know anything about this type of aerial vehicle. The third question of the survey is "how serious do you consider the threat from UAVs to port security?" As shown in Table 3, 74.6% of the respondents considered that the threat UAVs pose to port security is either serious (38.1%) or very serious (36.5%). Table 3: Seriousness of threat from UAVs

Severity of threat from UAVs to port security	Responses
Very serious	36.5%
Serious	38.1%
Mildly serious	20.6%
Not at all serious	1.6%
Don't know	3.2%

As observed in the literature (Talas, 2010), before 9/11, the most significant threats to port security were drug smuggling and organised crime. However, after those attacks, terrorism became a significant threat. Bernard (2015) argues that one of the most significant current threats to port security comes from cyber-attacks, which could be conducted by terrorist groups using unmanned aerial vehicles. As identified by Dedrone (2016), UAVs may have certain weaknesses that could be exploited by terrorist organisations. Synergia (2016) argued that UAVs can be used for reconnaissance and surveillance, smuggling, or even electronic attacks. Also, it was identified in the literature that UAVs have a capacity to transport small loads of up to 1 kg across a pre-established route using a GPS signal (Dedrone, 2016). This could enable terrorists to transport explosive devices into secure areas of the port. Therefore, the primary data that indicate UAVs may pose a serious security threat are consistent with the findings of the literature.

The fourth question is "Please rank accordingly the risk of UAVs in terms of a security threat where 1=highest risk and 5=lowest risk." The results are shown in table 4. The majority of the respondents indicated that the highest risk is that of an act of terrorism: 39.7% of the respondents indicated the highest risk. Furthermore, 20.6% of the respondents also indicated that there is a higher risk of illegal surveillance using UAVs. This is consistent with the findings of the Synergia (2016) report, which claimed that UAVs can be used to identify potential targets or conduct surveillance missions that would help the user access information that would have otherwise been unavailable to them. The report also indicates that the increased popularity of these devices with the general population, which has led to an increase in demand and purchase of UAVs, makes it difficult to know whether the purpose of such purchases is recreational use or if the buyer has criminal intent. It is interesting to observe from Table 4 that the respondents considered that there is a limited risk to using a UAV to smuggle weapons into the secure areas of the port, considering the fact that Dedrone (2016) claims the UAVs would be able to transport a small explosive device (approximately 1 kg) into secure locations.

Table 4: Security risks from UAVs

	1=highest risk				5= lowest risk
Security Threat	1	2	3	4	5
Smuggling arms and ammunition	7.9%	20.6%	27.0%	14.3%	28.6%
Illegal surveillance	20.6%	11.1%	25.4%	30.2%	11.1%
Smuggling of contraband	15.9%	27.0%	11.1%	27.0%	17.5%
Act of terrorism	39.7%	19.1%	22.2%	9.5%	7.9%
Other unauthorised act	14.3%	20.6%	12.7%	17.5%	33.3%

The fifth question is “In your opinion how effective could the deployment of UAVs in a port facility complement existing security measures?” The deployment refers directly to the monitoring requirements as prescribed in the ISPS Code, namely the monitoring of the ship-port interface; port areas; and ships stores (Table 5)

Table 5: Effectiveness of UAVs to complement existing security measures

ISPS monitoring requirement	Very effective	Effective	Less effective	Hardly effective	Not at all effective	Don't know
Monitoring the ship-port interface	57.1%	27.0%	12.7%	0.0%	1.6%	1.6%
Monitoring port areas	66.7%	25.4%	4.8%	0.0%	1.6%	1.6%
Monitoring ships stores	23.8%	27.0%	28.6%	9.5%	4.8%	6.4%

Despite the security risks that the respondents identified in relation to the use of UAVs, Table 5 demonstrates a confidence that UAVs can be used to increase port security. Sixty-six per cent of the respondents believe that UAVs can be effective in monitoring port areas that do not benefit from surveillance. Furthermore, 57.14% of the respondents also considered that UAVs could be very effective in monitoring ship-to-port interfaces. Synergia (2016) found that the UAVs available for civilians have different functions that enabled the users to control the specific capabilities of the device, such as speed, flight time, or reaction to different weather conditions. Also, different models of UAVs allow for various altitudes or distances of flight, making them rather flexible in covering large areas as far as surveillance is concerned.

The sixth question is “In your opinion should it be mandatory for UAV ownership to be registered with local or state authority?” (Table 6).

Table 6: Mandatory registration of UAVs with a local or state authority

Answer choices	Responses
Strongly agree	73.0%
Agree	17.46%
Neutral	7.94%
Disagree	0
Strongly disagree	1.59%

As we can see from Table 6, the majority of the respondents (73.02%) strongly agree with the registration of ownership with the local or state authorities. As the Synergia (2016) report showed, the number of civilian users of UAV devices is increasing, and the authorities have no possibility of determining the purpose for which the UAVs are being purchased. This increases the risks associated with the use of UAVs by civilian users; however, the authorities could not breach the right to privacy of a person, only their right to use a device that can potentially be employed with criminal intent. Nevertheless, the registration of such a device would associate the owner with a specific device identified by a unique serial number. This can both increase the safety of the device user and make it easier for the authorities to identify the owner of a device who intended to use it to commit a criminal act. Only one respondent expressed a strong disagreement with the registration of UAV ownership.

Conclusion

The study has revealed some interesting findings regarding the application of UAVs in port security with a view to enhancing security and complimenting existing security regimes. It is also noted that the presence of UAVs can themselves be perceived to be a threat to port operations, hence the high proportion of respondents looking for UAVs to be registered with a local or state authority. There is scope for the study to be extended to include a wider geographic area and also to address other nodes in the supply chain beyond merely ports.

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Customer Service

ENABLING A CUSTOMER-CENTRIC SUPPLY CHAIN THROUGH 3D PRINTING: AN AEROSPACE CASE STUDY

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Introduction

Today's world is experiencing a "New Industrial Revolution" which is re-shaping the supply chain (SC) landscape (Christopher, 2016). The New Industrial Revolution is characterized by the use of digital manufacturing technology, the search for value co-creation through a strict customer-centric orientation and a highly networked environment (Anderson, 2012). These trends have emerged in response to the increased rate of dynamism, volatility, turbulence, globalization and growing customer demands (Christopher and Holweg, 2011).

One key aspect of the New Industrial Revolution is the growing use of Additive Manufacturing (AM) technology. Three-dimensional printing (3DP) is the best known AM technology, within the broader context of Digital Direct Manufacturing (Holmström and Partanen, 2014; Gibson, Rosen and Stucker, 2015). AM is a topic that has gained increasing attention both from a theoretical and a managerial perspective, especially linked to the Supply Chain Management (SCM) discipline and in particular in a service supply chain context (Hanseth and Lyytinen, 2010). In fact, supply chains are no longer governed by a "Goods Dominant Logic", but they follow a "Service Dominant Logic" (Lusch, 2011). Under this logic supply chains provide a value for the customer that is co-created by all the SC members oriented toward a customer-centric approach (Potter, Towill and Christopher, 2015; Bogers, Hadar and Bilberg, 2016).

The enormous potential of 3D printing to transform the way in which products are produced is evident (Berman, 2012), but little research has focused on discovering the implications of this disruptive innovation on supply chain management (Tuck, Hague and Burns, 2007; Christopher and Holweg, 2011). Likewise the implications for supply chain management of the service dominant logic are little understood (Karpen, Bove and Lukas, 2011; Holmström and Partanen, 2014) and in particular the role of the supply chain in the value co-creation process (Bogers, Hadar and Bilberg, 2016). For the purposes of this paper we have posed one main research and two sub-questions:

Main RQ: How does 3D printing enable Supply Chain customer-centricity?

Sub1RQ: How should the network be configured in order to enable customer-centricity?

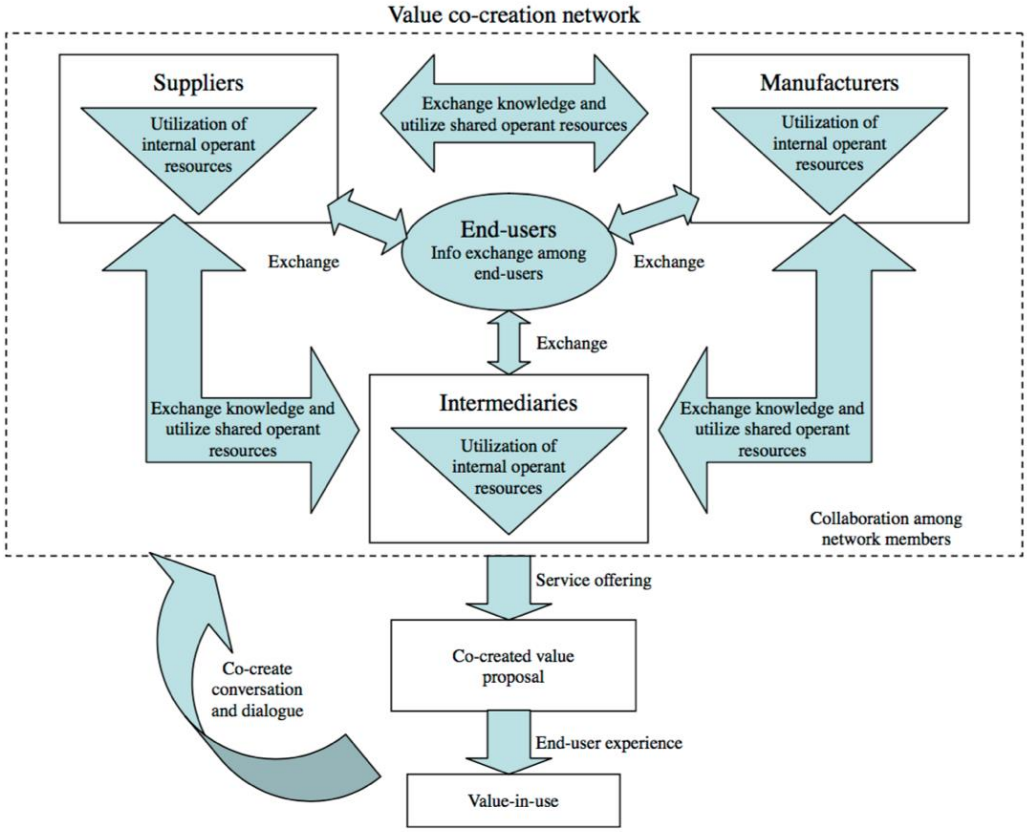
Sub2RQ: What are the sources of value co-creation made possible through the 3D printing process?

Theoretical background

In the New Industrial Revolution the customer gains a centrality in all the activities undertaken by the Supply Chain (Potter, Towill and Christopher, 2015). The customer changes from "passive audience" to an "active player" (Prahalad and Ramaswamy, 2013) co-creating the product and even all the services that it needs (Bogers, Hadar and Bilberg, 2016). Consequently, all the business partners are interrelated to a far greater extent in a closely networked supply chain. The traditional supply chain business model is no longer valid, based as it was on the maximization of efficiency through the production of large volume and the exploitation of capacity (Christopher, 2016). In today's world these models, based on the economies of scale, are not able to cope with the rate of volatility, change, variety and customization that is required. Instead customer-centricity emerges as a new orientation to meet the dynamism of this new environment.

The "Service Dominant Logic" (SDL) implies that value is created through the interaction of the supplier and the customer through a process known as "co-creation". The idea behind co-creation is that companies should seek to embed themselves in their customers' value chains; in other words they should actively seek to explore with customers how new sources of value can be developed. Such an idea implies a high level of customer engagement and a recognition that 'one size doesn't fit all', suggesting that greater levels of customisation of the product/service offer will be required. Under the SDL, supply chains are recognized as value co-creation networks (Tokman and Beitelspacher, 2011). These networks exchange, deploy and coordinate resources (Flint and Mentzer, 2006), improving the knowledge growth among all the members of the supply chain. The model of Tokman and Beitelspacher (2011) explains how the value is co-created by the entire network (Figure 1). The co-created offer is realized by the interconnection of actors, who share knowledge and utilize operant resources, to provide value for end-users. The complete process, from raw material providers to end-users, generates a dynamic and multi-part dialogue which increases collaborative value-creation behaviours (Tokman and Beitelspacher, 2011).

Figure 1: Illustration of a value co-creation network



Source: Tokman and Beitelspacher (2011).

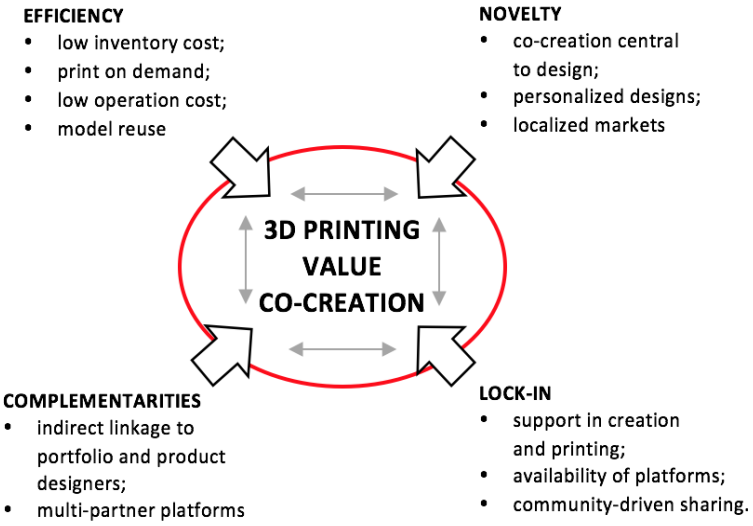
The use of advanced manufacturing technologies and additive manufacturing in particular allows a direct contact with the customer, who is included in the first phase of the productive process (e.g. design and prototyping of products) (Holmström and Partanen, 2014).

Additive Manufacturing (AM) has been defined as "the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies, such as traditional machining" (ASTM Standard). This technology is also known as direct manufacturing or 3D Printing and it allows the production of physical objects layer-by-layer using three dimensional computer aided design (CAD).

3DP can potentially enhance the possibilities for the co-creation of value between the supplier and the customer through its flexibility and the relatively low cost of frequent and/or late design changes. In fact, this new manufacturing method enables a high level of production flexibility making a significant impact on the wider supply chain (Sasson and Johnson, 2016). 3DP also unlocks design potential (Stratasys, 2016) and enables even the most complex design geometries to be incorporated without special tools and equipment (Gibson, Rosen and Stucker, 2015). Designs can be shared between entities in the SC and modified without significant additional cost (Berman, 2012). Likewise, the product is more homogeneous with greater metallurgical uniformity and is more robust and lighter. Further advantages are the elimination or simplification of production stages and improvements in recycling and waste. 3DP will also often lead to shorter lead times thus reducing inventory holding, obsolescence and

shortages (Holmström and Partanen, 2014), packing and packaging (Berman, 2012), assembly work, and the need to develop the production process at the product development stage (Gibson, Rosen and Stucker, 2015), setup costs, and changeover time (Tuck, Hague and Burns, 2007).

With this in mind and building on the work of Bogers, Hadar and Bilberg (2016) and Amit and Zott (2001), we suggest a framework that highlights the main sources of value co-creation through a 3DP process in a customer-centric supply chain. The sources of value co-creation can be identified as: efficiency, novelty, lock-in and complementarities. Efficiency refers to the possibility of decreasing inventory costs, print on demand, reduced operations costs and reusing the model design. The second element is novelty. This results from co-creation in the design process, personalization of designs and the localization of markets. Lock-in refers to the possibility for strengthening the bonds with customers through such things as providing support in design creation and printing, availability of platforms and shared resources. It enables the creation of customer loyalty by making it easy to repeat



or modify applications in future transactions. The last issue is complementarities. They include indirect linkage to portfolio and product designers and multi-partner platforms. These are the union of products and services that increase the perceived value in use for the customer. Figure 2 summarises the framework.

Figure 2: Sources of value co-creation through 3D printing process

Source: own elaboration, adapted from Bogers, Hadar and Bilberg (2016) and Amit and Zott (2001)

This process of value co-creation can be contextualized in a broader framework of a value co-creation network (Tokman and Beitelspacher, 2011) which we previously introduced. Here a manufacturer and its supplier utilize internal operant resources and they exchange knowledge and employ shared resources. The end-user shares information with both of them. In this model 3DP is an enabler of value co-creation.

Case study

3D printing is reshaping supply chains in every industry and its applications are broad (3D System, 2016; Stratasys, 2016). In the aerospace industry traditional manufacturing methods have required specialist tooling and machining which are often slow and wateful. AM now provides the prospect of 'printing 'high quality, complex aircraft parts in less time and at lower cost.

The Trent XWB-97 is the most technologically advanced engine using additive manufacturing techniques containing the world's largest-ever 3D printed object (Goehrke, 2015). At the moment this 3D printed component has not yet been incorporated into the production run of the XWB-97 but successful ground and flight tests have been completed providing significant information as to the possibilities of manufacturing such industrial parts of that magnitude in the future in aerospace sector using 3DP. The XWB-97 programme started in 2013 and Rolls-Royce is the exclusive engine supplier for the Airbus A350 XWB and has invested tens of millions of pounds in its Derby site to make it the centre for Trent XWB production. It is the highest thrust engine ever certificated, capable of the highest operating temperatures and using the most advanced cooling systems ever designed for a civil engine (Howie, 2015). It is the most fuel efficient civil aircraft engine in the world (Derby Telegraph, 2015), using lighter materials to reduce weight. In order to achieve this result, Rolls Royce created a specific network of actors comprising the Manufacturing Technology Centre (MTC), Sheffield University, Arcam AB and Rolls Royce themselves.

The objective of the case study was to explore the ways in which 3DP enables supply chain customer-centricity. The main research question was: How does 3D printing enable supply chain customer-centricity? Moreover, two sub-research questions are posed in order to gain a better understanding of the problem: How does the network reconfigure itself in order to enable customer centricity and what are the sources of value co-creation made possible through the 3D printing process?

Research methodology

We followed a qualitative approach appropriate to industry investigations using exploratory, inductive single case study analysis (Ellram, 1996; Yin, 2013). This choice is justified by two main considerations. First of all, the 3DP theme has recently emerged in the literature and for this reason case study approach is generally recommended as a suitable research design for theory-building (Eisenhardt, 1989; Yin, 1989). Secondly, a single case design was applied as is appropriate for network research in many situations (Yin, 2003).

The case study is based on a triangulation of different data collected through extensive desk research, information gained by meetings with experts in the aerospace industry using semi-structured interviews and records of members of the supply chain analysed. This data was supplemented with information drawn from conference proceedings, progress reports, articles, company presentations and organizational charts. This research approach enables a detailed comprehension of the supply chain and of the different actors. Meetings were held with technical and industry experts including academic sand managers from across the supply chain. The semi-structured interviews lasted one hour on average and were focussed on gaining a better understanding of the specific network and the role of 3DP in the aerospace sector.

Analysis

The Trent XWB-97 was created specifically for the Airbus A350 civil aircraft and uses lighter materials to reduce weight and to increase fuel efficiency.

In order to meet Airbus' stringent requirements regarding the performance of the engine, Rolls Royce created a specific network of actors involving: Arcam AB, a specialist designer and producer of additive manufacturing machines; Sheffield University, an early user of these machines with extensive experience of additive manufacturing; and the Manufacturing Technology Centre (MTC), a UK government supported initiative which draws on a diversity of sources of knowledge and expertise in advanced materials science and technology. They jointly formed a team of experts who are responsible for the co-created 3D printed 1.5 metre diameter titanium component, which contains 48 aerofoil-shaped vane parts which are themselves produced by additive layer manufacturing (ALM). The ALM process involves building ultra-thin layers of metal powder, which are melted using a laser or electron beam heat source.

The team quickly developed a close working relationship where knowledge was openly shared and their combined competencies enabled a more rapid response to the challenges presented by the Airbus contract. Between them the team had a span of knowledge and experience that was probably unique. All parties made specific contributions to the project and they all gained something from it. Table 1 below summarises the exchanges within the team and the contributions made and the insights acquired under the four categories of efficiency, lock-in, novelty and complementarities (Bogers, Hadar and Bilberg, 2016).

Rolls Royce

Actor's contribution

Lock-in: customer's guidelines, quality assurance, assessment of parts' integrity

Complementarities: linkage to portfolio and product design

Novelty: more time for co-creation, local market knowledge

Actor's acquisition

Manufacturing efficiency: reduction of lead times of 30%, more time for design and development phases

Novelty: product and process characteristics, recycled powder, flaws' classification, operation practice & set-ups, complex geometries and multiple machine to machine variation

Arcam AB

Actor's contribution

Process efficiency: precision and process robustness, tool-less technology, increased performance machines

Product efficiency: new design possibilities, light-weight components, functional aspects (cooling, heating or filtering characteristic)

Service efficiency: team for design and production phases, courses for engineers

Novelty: quality of product free of residual stress

Lock-in: team of experts for production, ensuring optimization of machine performance, designing and production phases, provider of courses and machines

Complementarities: added services for technology

Actor's acquisition

Novelty: constant improvement of machines and techniques

Lock-in: tight relationship with all members

Sheffield University

Actor's contribution

Product efficiency: product properties

Process efficiency: development of ALM techniques

Lock-in: programme of testing, chemical research, quality assurance

Complementarities: specific research department

Actor's acquisition

Novelty: new research on powders and materials characteristics

MTC

Actor's contribution

Process efficiency: large volume and repeatability

Complementarities: cloud multiplatform

Lock-in: closer connection with university and its expertise in additive manufacturing, the analysis of powders, manufacturing the parts and providing the final analysis

Actor's acquisition

Novelty: repeatability of the process, new research on powders and materials characteristics

Table 1: Contribution and acquisition of each actor during 3D printing process

Source: own elaboration, from Bogers, Hadar and Bilberg (2016) and Amit and Zott (2001)

Rolls Royce actively contributed to the project establishing guidelines and assessing parts' integrity and quality before assembling the component (Nathan, 2015b). The collaboration through this team of experts allowed Rolls Royce to acquire new knowledge on recycled powder, classification of flaws, operation practice and set-ups, complex geometries and multiple machine to machine variation. All this understanding shed light on the industrial viability of AM technology and future possibilities for Rolls Royce in the aerospace sector (Nathan, 2015b). The 3DP project shortened manufacturing lead times by more than 30% compared to the same process using traditional methods (Nathan, 2015b), and it allowed more time for designing and developing the component (Nathan, 2015a).

Arcam AB was the provider of the AM technology. Its machines were designed for cost-efficient production and they enabled the building of large components with precision and process robustness. They were tool-less technologies permitting minimal lead time and costs. (Arcam AB, 2016). In addition, the advanced process produced light-weight components with a buy-to-fly ratio close to 1 – the buy-to-fly ratio compares the cost of an item with its impact on the amount of fuel required to fly the aircraft. The product's design was improved for weight reduction and functional aspects such as cooling, heating or filtering characteristics. All these issues increased the overall quality and the product itself was free of residual stress. Arcam AB supported the production through a dedicated team of engineers, ensuring optimization of the machines' performance, through the design and production phases. The collaboration brought benefits to the company as Arcam AB established a tight relationship with all the actors involved, gained better knowledge and capabilities, including possibilities for improving the efficiency and quality of their machines (Arcam AB, 2016).

The Department of Materials Science and Engineering at Sheffield University was able to help develop a more sophisticated product made with radically improved resource efficiency and gained a deeper knowledge of the possibilities of AM in the aerospace sector, improving expertise and identifying opportunities for further research. Thanks to their past experience with Arcam machines, Sheffield University developed ALM techniques through a programme of testing, research and quality assurance, providing a fundamental research work in chemical analysis and powder sources that allowed a strong underpinning to development activities (The University of Sheffield, 2015). The University of Sheffield carried out the initial research on the process and material behaviour with subsequent piloting at the Manufacturing Technology Centre in Coventry.

The MTC provided a means to bridge the gap between university-based research and the development of innovative manufacturing solutions, in line with the Government's manufacturing strategy (MTC, 2016). MTC supplied a cloud multiplatform to connect partners involved in the process for design and specificities of product and process. MTC engineers contributed to the 3D printing process by analysing powders, and manufacturing parts and providing analysis (Nathan, 2015b). They brought the project to the next level, testing scalability and repeatability of the process. In addition, the project helped MTC to develop methods for working with large volumes of powders.

Discussion and conclusion

The case study provides an illustrative example of how the use of 3DP can enable supply chain customer-centricity through a specific form of collaboration that allows value co-creation among all the members. Our first subsidiary research question was 'How should the network be configured in order to enable customer-centricity' and the case study provides some pointers.

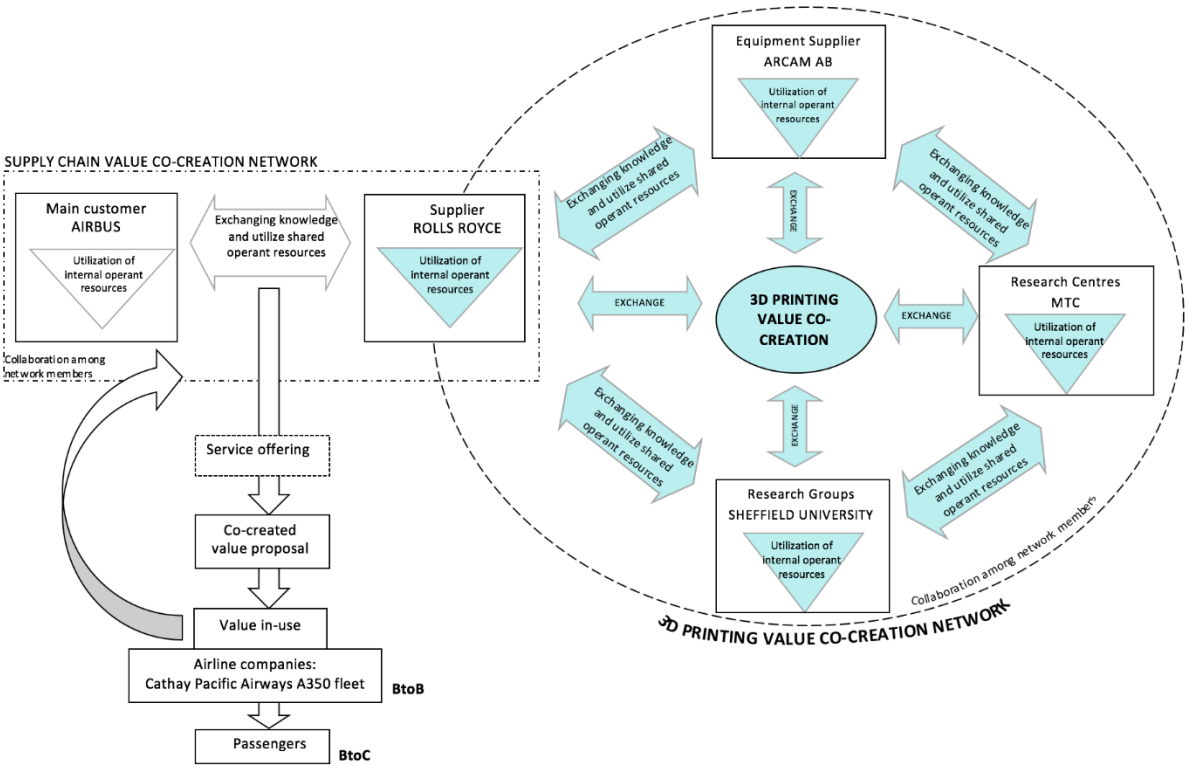


Figure 3: 3D printing value co-creation network

Source: own elaboration, from Tokman and Beitelspacher (2011);

Bogers, Hadar and Bilberg (2016) and Amit and Zott (2001)

The focal company – who had a direct relationship with the main customer - gave directives, organized the project, shared relevant data, and assessed the integrity and quality of the final component. The provider of the machines provided service and technological support. The university supplied research, test and quality assurance, while the MTC provided the link with all manufacturing processes, connecting members and testing scalability. 3DP enabled the realization of a particular form of collaboration, a team of experts, using 3DP to co-create a unique value for the end-customer. Regarding the second subsidiary research question, some specific sources of value emerged during the analysis of the value co-creation process. The case study research suggests an adaptation of the Bogers, Hadar

and Bilberg (2016) and Amit and Zott (2001) frameworks in order to furnish a deeper understanding of specific characteristics of 3DP technology in a supply chain. By using 3DP value co-creation is enhanced as the product is printed on demand in accordance with the real time needs of customers and also inventory and operation costs are reduced. In addition, it emerges that lead times are substantially shortened, saved time is redirected into design and development phases and product functionality can be significantly improved. Another source of value co-creation is novelty. The 3DP process allows co-creation during the design phase and designs are tailored to customer requirements. Moreover, markets can become localized through a specific form of collaboration for directly sharing information and knowledge. Complementarities are an additional source of value co-creation. This aspect recognizes the importance of integrative connections between members during a collaborative process. 3DP permits linkage to a portfolio of product designers according to parameters and guidelines given by the main customer. It leads to usage of multi-partner platforms and to the integration of different members' actions in a unique process. The fourth source of value co-creation is lock-in. The case study revealed that where there are mutually beneficial outcomes all parties remain committed to the value co-creation process. Community platforms facilitate the sharing of knowledge across the network and as well as enabling rapid changes at any point in the value-creation process thus creating a spirit of joint enterprise. Figure 4 highlights the main elements of each of the four sources of value co-creation: efficiency, novelty, lock-in and complementarities.

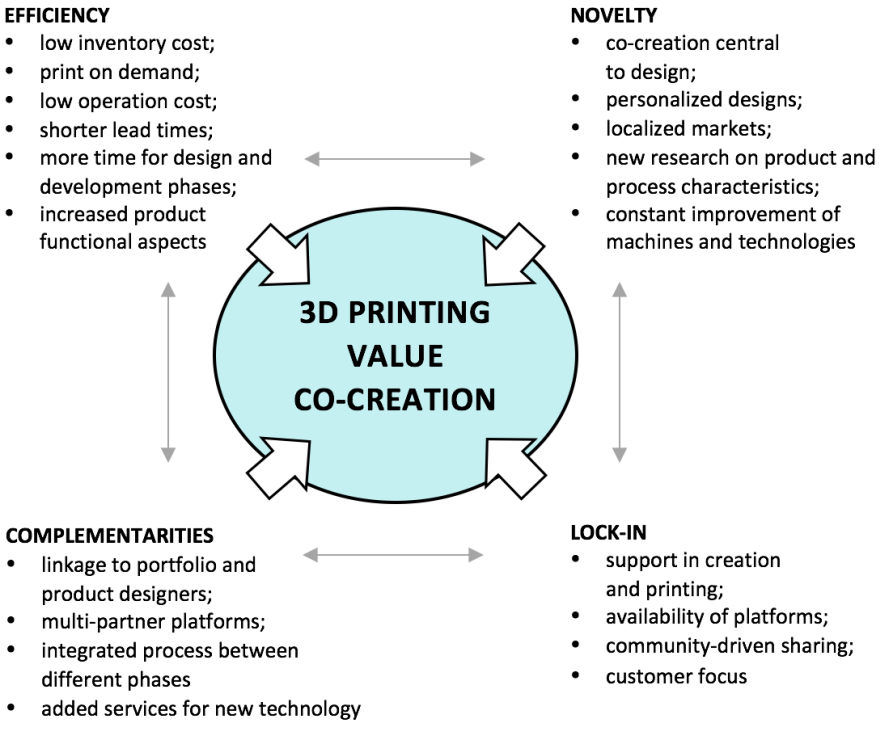


Figure 4: Sources of value co-creation through 3D printing

Source: own elaboration, adapted from Bogers, Hadar and Bilberg (2016) and Amit and Zott (2001)

In conclusion, the case study has shown how 3DP can enable supply chain customer-centricity by transforming the end customer's guidelines and requirements into solutions that deliver unique value. A specific form of collaboration was employed that reshaped the network and permitted the realization of unique co-created value for the end customer.

From a theoretical standpoint the case study confirms how the co-creation of value across a network can be facilitated by the adoption of a customer-centric stance. This is the basis for the modified framework we present, based on the original model of Tokman and Beitelspacher (2011). We further augment this approach by adopting the concepts developed by Bogers, Hadar and Bilberg (2016) in which efficiency, novelty, complementarities and lock-in are posited as the sources of value creation across a network. Taking a managerial perspective, the study highlights the potential role of 3DP in enabling the creation of a customer-centric approach to supply chain management. Furthermore, by developing a collaborative approach across a network of knowledge providers, the value creation process is enabled and enhanced.

One obvious limitation of the study is that the research is based on only a single case study in a specific industrial sector. Ideally further research should be based on multiple case studies and different ways through which a company using 3DP can enable customer-centricity. Clearly AM is in its infancy and our understanding of its potential is still developing (Howie, 2015). However, at the same time an exciting area for further research and development – particularly in the context of supply chain management – is now emerging with potentially significant payoffs.

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INVESTIGATING SUSTAINABLE GREEN AIR TRANSPORT (SGA) IN EGYPT; A SWOT ANALYSIS OF CAIRO INTERNATIONAL AIRPORT COMPARED WITH DUBAI INTERNATIONAL AIRPORT

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1. Introduction

Aviation is one of the world's most important contributors to the advancement of modern society. (Morten, 2015). It contributes about 2% of global greenhouse emissions and supports 8% of the world economic activity (Sarkar, 2012).It has the role of improving and enhancing the community development by providing jobs, skills and opportunities. As any other industries, aviation industry has an environmental impact which should be taken into consideration to minimize its negative impact on the environment to the minimum.

Aviation recorded high occupancy rates of 65% to 70% compared with those of road and rail transportation (Neal, 2015). Air transport entirely covers its infrastructure costs. Unlike road and rail, it is a net contributor to national treasuries4 through taxation. The world's 900 airlines have a total fleet of nearly 22,000 aircraft. They serve some 1,670 airports through a route network of several million kilometers managed by around 160 air navigation service providers. It was recorded that aviation industry supports nearly 63 million jobs all over the world and supports the global GDP by 2.7 trillion (Gill, 2016).

According to Schafer and etal. (2009), they found that air transport is faster in growth compared with the automobiles. They found that the travel growth of passengers by automobiles is expected to be more than double from 2010 to 2050. Although this increases, air transport is still the faster in growth. The concept of green air transport is closely linked to the reduction of emission level in the atmosphere. Recently, there is growing trend towards air safety and environmental health. This paper is discussing the concept of sustainable green air transport system by focusing on the recent achievements in the aviation industry regarding this concept in respect of the new innovative technologies combined with emission mitigation efforts towards sustainable growth of air transport industry. Also, this paper represents the main achievements done regarding green air transport in Dubai International Airport comparing with Cairo International Airport in order to determine the main barriers behind implementing such concept in Egypt.

2. Literature Review

2.1 Sustainable Air Transport

The Core Concept of Green Airport Green airports have become one of the top priorities in the nation, primarily due to federal, state, and local initiatives. Green airports can be defined as a holistic approach of how airports could be managed to ensure to the integrity of the Economic viability, Operational efficiency, Natural resource conversation, and Social responsibility of the airport. Bartolotti and Siniscalo (2014) mentioned the main benefits that will return on the state if we applied green airport design through the following:

Initial Cost Saving: By reducing infrastructure cost, material use, savings in construction waste disposal and savings from downsizing mechanical equipment. Reducing Operating Costs by lowering energy costs, reducing water costs and ensuring greater durability and increasing its depreciation rate. Environmental Benefits: Through decreasing the global warming impact, and minimizing local and regional water pollution.

2.2Trends of International Airport towards the sustainable green aviation industry

2.2.1Green Aviation Technology

Biofuels –the third generation biofuels are characterized as fast growing algae to provide a drop-in fuel substitute. 2. Advanced composites – The future composites will be lighter and stronger than the present composites which the airplane manufacturers are just learning to work with and use. 3.Fuel cells - Hydrogen fuel cells will eventually take over from jet turbine Auxiliary Power Units (APU) and allow electrics such as in-flight entertainment (IFE) systems, galleys etc. to run on green power. 4. Wireless cabins – The use of Wi-Fi for IFE systems will save weight by cutting wiring - leading to lighter aircraft. 5. Recycling - Initiatives are now underway to recycle up to 85% of an aircraft's components, including composites - rather than the current 60%. By 2050 this could be at 95%. 6. Geared Turbofans (GTF) - Already under testing, GTF could prove to be even more efficient than predicted, with an advanced GTF providing 20% improvement in fuel efficiency over today's engines. 7. Blended wing body aircraft - These flying wing designs would produce aircraft with increased internal volume and superb flying efficiency, with a 20-30% improvement over current aircraft. 8. Hydrogen-powered aircraft - By 2050 early versions of hydrogen powered aircraft may be in service - and if the hydrogen is produced by clean power, it could be the ultimate green fuel. 9. Advanced air navigation - Future ATC/ATM systems based on Galileo or advanced GPS, along with international co-operation on airspace, will allow more aircraft to share the same sky, reducing delays and saving fuel. 10. Quiet aircraft - Research by Cambridge University and MIT has shown that an airliner with imperceptible noise profile is possible - opening up airport development and growth. 11. Open-rotor engines - The development of the open-rotor engines could promise 30%+ breakthrough in fuel efficiency compared to current designs. By 2050, coupled with new airplane configurations, this could result in a total saving of 50%. 12. Electric-powered aircraft - such as UAVs are already in service. 13. Solar-powered aircraft - After UAV applications and the Solar Impulse round the world attempt, solar-powered aircraft could be practical for light sport, motor gliders, or day VFR aircraft. Additionally, solar panels built into the upper surfaces of a Blended-Wing Body (BWB) could provide additional power for systems (Agarwal, 2012).

2.2.2Green Infrastructure Technologies

1. Electric/hybrid ground vehicles – Use of electric, hybrid or hydrogen powered ground support vehicles at airports will result in reducing the carbon footprint and improve local air quality. 2. Multi-modal airports - Future airports will be connected with other modes of transport to connect passengers seamlessly and quickly with other destinations and encouraging them to depend less on cars. 3. Sustainable power for airports - Green airports of 2050 could draw their energy needs from wave, tidal, thermal, wind or solar power sources. 4. Greener helicopters - Research into diesel powered helicopters could reduce fuel consumption by 40%, while advances in aircrafts edges design will cut the noise. 5. The return of the airship - Taking the slow route in a solar-powered airship could be an ultra 'green' way of travel and carve out a new travel niche in 'aerial cruises', without harming the planet.”

Through these technological, operational and infrastructure innovations, the aviation industry has acted to reduce mankind's environmental footprint. With the necessary commitment and the already-existent willpower, it sets an example for other, more polluting industries (Agarwal, 2012; Aerospace International, 2009).

2.3 Challenge Facing the Sustainable Green Airports (SGA)

However the main benefits that can be gained when transferring an airport to a green airport, still there are a lot of barriers and challenges that are representing as barriers for airports in order to be green. Agarwal (2010) determined that High cost, Lack of Funding, Improving Efficiency Airport Operation, Lack of Sustainable Concept Awareness and lack of staff Experience. While Capegimini (2012) stressed on the mechanical and technical barriers in terms of Poor Management Support, Harmful Air Emissions from Aircraft Engines and the obstacles facing the innovation of designing green planes.

3. Research Method

This study can be described as basic research by investigating the sustainable air transport in Egypt by conducting a comparative study with Dubai International airport and to determine the main challenges facing Cairo Airport in terms of the sustainable air transport.

This research follows the qualitative data approach as qualitative data are characterized by their richness and value through the ability of the researcher to explore a subject or a phenomenon in as real a way as possible (Saunders etal, 2012). Bartunek and Seo (2013) and Saunders et al. (2012) characterized the qualitative research approach as the interaction between individuals to imply the social properties, rather than separate the phenomenon, from the individuals in its construction. Qualitative data was gathered depending on a set of semi-structured interviews targeting general managers and operators at Cairo International Airport as a case study to discuss the actions taken to apply green transport within the period of study.

The main aim of these set of interviews is to investigate the main caused preventing the green concept to be applied in Cairo airport and to discuss the possible solutions for these causes or problems. A comparative study is conducted between Cairo airport and Dubai airport through SWOT analysis which is an analytical tool used to identify the strengths, weaknesses, opportunities and threats facing Cairo airport and same as Dubai Airport.

Dubai International Airport has been chosen as it is the primary airport serving Dubai, United Arab Emirates and is the world's busiest airport by international passenger traffic. It is also the 3rd busiest airport in the world by passenger traffic, the 6th busiest cargo airport in world, the busiest hub for the Airbus A380, and the busiest airport in the world operating with two runways only (Sahoo, 2017). The investigation held on Dubai Airport helped in describing and explaining the main major global standards for going green followed in order to reach the sustainability of air transport. Cairo Airport has been chosen as it is the initial airport and the busiest Airport in Egypt and serves as the primary hub for Egypt Air and Egypt Air Express as well as several other airlines. It is the second busiest airport in Africa after O.R. Tambo International Airport in Johannesburg (writer, 2016).

4. Results and Findings

4.1 Dubai International Airport SWOT Analysis

According to previous survey doing by several researchers on Dubai international airport so we can mention Dubai international airport SWOT analysis as follow:

Strength:

Dubai airport have big wide international connection with a lot of countries around of the world. Also, Dubai airport designed to contain high technology and modern hubs as well as good innovation strength and up to date to all the new trends in world aviation such as aircraft or operations. Furthermore, Dubai airport has great reputation with the international airlines companies inside the country and around the world. As well as they using high technology inside and outside the facility which made it from the highest developed Airport Cities (Bitelmal, 2010).

Weakness:

In the weakness which face Dubai airport is not the increasing of capacity but to manage demand by channeling it to off peak times or to alternate sites. The rationale underlying all these approaches is that capacity and demand must somehow be brought into equilibrium in order to prevent or reduce delay (Townsend, 2015).

Opportunity:

Dubai airport have collaboration with many airlines and partners around the world to transport passengers and cargos from strongly emerging regions. Also Dubai made link between the international trains with the airport to make it easier on the passengers. Furthermore, Dubai airport continue improving supply chain innovation and sustainability in all operation and management inside the airport as well as its international activities in sustainability and green environment (Bitelmal, 2010).

Threats:

Dubai airport is considered from top rank airports in the world so the competition from other airports inside Dubai and airports around the world take place. On other hand the Threat of terrorism effect negatively on the airport's operations as well as unexpected European innovation and the intensified security requirements needed and travel procedures.

4.2 Cairo International Airport SWOT Analysis

According to the set of semi-structured interviews held with the top managers of operations of the Cairo Airport and with the airline companies located inside the airport, the following SWOT analysis could be concluded:

Strengths:

In our investigation there are some of strength points that Cairo has to going green, this point such as high growth rate in Egypt which increase demand on airports all over Egypt generally and Cairo international airport especially.

Another point of strength is that existing distribution and sales network considered as strength point because of the number of existing of suppliers and sales networks and distribution centers of Cairo international airports for customers to be satisfied and to go green.

Weakness:

According to our investigation in Cairo international airport we noticed that the weakest point that Egypt face during the application of green concept is the lack of investments in research and development that restricted from knowing the new technology and trends in global green aviation around the world.

Opportunities:

Cairo international airport have great opportunity in growing the economy as well as increase the awareness demand for sustainability of the environment by investing and building projects that funded by the government to achieve the growing of the economy. Furthermore, the globalization of the market will take into the consideration of the major opportunities for Cairo international airport in the transport of the passengers and cargo around the world. Regarding the airports expansion, Cairo airport is subjected to a comprehensive scheme of airport modernization according to international standard, in addition to contracts with private sectors are signed under a BOT concept for infrastructural development.

Threats:

There are some threats that facing the government and Cairo international airport which is the technological problems and how the employees will deal with it if they are not qualified or not training well to solve these problems. Furthermore, the economy in Egypt is in recession and this will lead to tax changes, increase in labor cost and financial capacity. Furthermore, Trade restrictions and tariffs Political instability will take into consideration.

5. Discussion

This research found that Cairo International Airport is making an environmental awareness and management efforts as an integral part of its growth strategy. Cairo Airport sets its environmental goals in compliance with local, international environmental legislation and the civil aviation guidelines to ensure the best practice of the civil aviation industry in Egypt and the environmental issues with all is different branches. In addition, Cairo Airport Company (CAC) has proved after the expansion of terminal three and the expansion held in terminal 2 that it was the best environmental and economical solution for the expansion (http://www.cairo-airport.com/environment.asp).

Another aspect that Cairo Airport is committed to be a green sustainable airport, it is now certified by ISO 9001/2008 in the quality management system in 2016. It is certified by the Swiss Company (SGS) after ensuring that the airport is performing according to the International standards (http://www.egypt-business.com/News/details/1634-Cairo-airport-is-now-certified/54592).

The renovation of terminal 2 at Cairo Airport is considered a major indicator that this airport is taking all the needed measured towards the sustainability. It adopted green building practices for modernization through implementing a sustainable airside design by maximizing savings in the use of natural and existing resources and material durability. This expansion aims at reducing the taxi distances and times in order to reduce air and water pollution from

combustion process. It also aims to reduce the number of passengers' vehicles by assigning a convenient shuttle service to reduce the traffic congestion and air and water pollution. Minimizing the use of electricity is one of the major contributions of the renovation of terminal 2 by using natural light for illumination and the use of the daylight dimming control system with high efficient energy lamp providing the electrical power consumption. This will help in reducing the CO2 emissions. The design of the new building is designed according to the international standards to ensure the reduction of noise level resulting from the operation, take-off and landing of aircrafts.

It is also operated with insulated glazing system providing thermal efficiency and prevents unnecessary heat/cool transfer. The expansion also adopts non-toxic materials in its interior materials and resources which has a positive impact on the environment and health. The renovation of terminal 2 through minimize gas emission by establishing air quality monitoring stations in order to make the airport has a minimum significant impact on the surrounding residential area.

On the other hand, there is some major problem that prevents the efficiency of terminal 2 performances and minimizes its green operation which lies in the lack of investment, lack of the green technology and lack of making new project that will facilitate the operation with the passengers at the peak time. In addition to the poor level of Service including space, time and distance, comfort and convenience, performance standards, reliability and effectiveness in addition to the delay processing, long waiting time and facility and equipment lack of performance.

On the other hand, the government and the Egyptian authority takes on their behalf the efforts and responsibility of dealing with such disasters like the natural disasters and terrorist attacks…etc. that leads in many times to very late of response due to the lack of resources, experience, good preparedness and a major cause of the deficiency in efficiency performance at Cairo international airport. Comparing with Dubai International Airport as shown in the table below, it was found that Cairo airport is going on its way to be a sustainable green airport (SGA), however the problems mentioned above. Lack of investments, the devaluation of the Egyptian pound, the current status of the Egyptian economy in addition to the existing war in Egypt with terrorism are considered the major obstacles and barriers preventing Cairo Airport to be a sustainable green airport, at least at this specific period of the economic recession compared with Dubai Airport. It was found that Cairo and Dubai airports are somehow similar in strength points as well as opportunities but Cairo Airport is facing more difficulties and challenges than Dubai in terms of the political and economical status, lack of investments, trade and tariffs restrictions in addition to the poor of employees skills and lack of awareness toward the sustainability.

Dubai International Airport SWOT Analysis	Cairo International Airport SWOT Analysis
Strength Network of destinations Modern and well-equipped hub airport Innovative strength Reputation and brand recognition Network of international partners Strong marketplace	Strength High growth rate Barriers of market entry Existing distribution and sales networks Experienced business units
Weakness Lack of capacity during peak times	Weakness Lack of investments in research and development
Opportunities Traffic and transport from strongly emerging regions Collaboration with airlines and other partners Supply chain innovation and sustainability initiatives Direct international train connections to and from the airport International activities	Opportunities Growing economy Growing demand New acquisitions Venture capital 5. New markets 6. Global markets
Threats Competition from other airports Relatively limited economic growth Intensified security requirements European regulations Threat of terrorism	Threats Technological problems Tax changes Financial capacity Price changes Increasing rates of interest Government regulations Increase in labor costs Economy is in a Recession Increase of Operating Costs 11. Trade restrictions and tariffs 12. Political instability

Table 1: Comparison of SWOT Analysis between Dubai and Cairo International Airports

Source: The Interviews Output

6. Conclusion

The concept of Sustainable Green Airport (SGA) is becoming one of the main concern and at the top priority of most of the developed countries. It was also concluded that Cairo International Airport is on its way to be sustainable green airport comparing with Dubai. However, it faces some obstacles and difficulties, especially after the Arab Spring in terms of lack of investments, devaluation of the Egyptian currency, and the war against terrorism. It is important to note that the green industry costs too much in terms of the main infrastructure and the technology needed at Airports. The renovation of terminal 2 at Cairo International Airport is considered as a vital step towards sustainability. Consequently, Egyptian Airport authority should pay attention to personnel and equip them with the needed skills under their various employee training programmers in efficiency performance operation. It is important to focus on new facilities and investments with testing programs and simulations to reach the green concept. Measuring Operational Efficiency in Airport Elements such as Airspace and Airfield – Aircraft Support and Emergency Services - Aircraft Passenger Terminal – Terminal Landside Ground Access – Vehicles and fixed transit system is vital for the sustainable airports. Increasing the number of staff will lead to increase the performance of the operator in inspection procedures in order to minimize the congestion in airport which usually has a negative effect on average waiting time which affects automatically on the satisfaction of passenger and his comfortable which effect too on the concept of going green. The Egyptian government has a major role in order to adopt sustainable green airports by allocating find for investment and capacity expansion. The employees at the civil aviation should be well trained on the new technology of green aviation and increasing the awareness of the new trend technology in aviation around the world in order to update our system and procedures inside the Cairo international airport and to increase the rank of the top international airport.

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Environmental Impacts and Sustainability

Investigating practitioner interest in a maritime environmental causes and consequences framework

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Introduction

There are many environmental hazards, which in turn create risks for industry when assets and livelihoods are under threat; some of those hazards are natural, such as storm surges and erosion, whereas others are anthropogenic (e.g. chemical contaminants). Adverse effects from natural hazards also increase as the result of human actions, for example, the removal of vegetation from shorelines can make the effects of storm surges more severe (Elliott et al., 2016). Thus, risk assessment and risk management are becoming an integral part of business management for environmental effects (Cormier et al, 2013). Due to this increasing need, we previously introduced a conceptual environmental risk assessment and management framework to provide guidance for businesses and their stakeholders, including government, to define and tackle environmental problems and potential problems (Grant & Elliott 2016). This paper extends that work by presenting the results of an inductive, qualitative study with maritime practitioners, i.e. shippers and port operators, after soliciting their views on, and investigating their interest in, using the conceptual framework. This paper indicates the efficacy and value of the framework in order to modify it based on expert practitioner opinions and refine it for wider use in the maritime and other industrial sectors.

Literature Review

Grant and Elliott (2016) argued that generally accepted major pollution and other environmental effects from ocean and short-sea shipping include many aspects. These include carbon dioxide (CO2) and sulphur dioxide (SO2) emissions in ports and at sea, fuel consumption of non-renewable resources, contamination and pollution from ballast water, sewage and garbage discharges, space occupation that may remove or inhibit natural ecosystem development, and reduced pH levels from acidification of ocean and sea levels from CO2 and SO2 emissions (OSPAR Commission, 2009). Many of the measures that shippers and their ocean carriers are implementing to improve economic efficiency, most notably slow steaming, are assisting carbon mitigation efforts. Only a small number of UK ports actually measure and report their carbon emissions, but an analysis of emissions generated by ships calling at these ports by Gibbs et al. (2014) indicated ship emissions generated during voyages between ports are far greater than emissions generated at ports and that 70% of shipping emissions occur within 400 km of land.

Rising concentrations of CO2 in the atmosphere results in a slow acidification of the surface ocean (Elliott et al., 2016). Anthropogenic emissions of sulphur and nitrogen oxides (SOx, NOx) creates acidification and eutrophication of freshwater and estuarine ecosystems and in terms of atmospheric aerosol effects on regional and global climate, but deposition also occurs over oceans in the form of sulphuric and nitric acids. Since the late 1990s international shipping has been recognized as a significant contributor of SOx and NOx to the atmosphere on local, regional, and global scales. However, the problem is less significant in the Baltic Sea compared to the Pacific Ocean and elsewhere in Asia (Hassellöv et al., 2013). Materials placed or discharged into the environment are contamination unless they

cause a biologically harmful effect, in which case they are regarded as pollution (Gray & Elliott, 2009). Such materials can be chemical (e.g. trace metals, antifouling agents), physical (e.g. sediments, structures) or biological (e.g. microbial pathogens, invasive species). Hence, the introduction of organisms, such as those emanating from discharged ballast waters or falling from hulls and anchor chains, are both contamination and pollution if they cause risks to the environment (Elliott, 2003). After almost two decades of intensified research, regulatory and political activities have focussed on the prevention of harmful organisms and pathogen transfers around the world (Olenin et al., 2011).

Since the 1970s, the EU has developed many Directives for controlling the harmful effects of marine activities (Boyes & Elliott, 2014). These are implemented by Member States and enforced through local and national enabling legislation. For example, while a Member State has to comply with pollution control required by the EU Directives (otherwise the Member State gets reported to the European court and placed in infraction proceedings for which the Member State is liable for a fine), controlling discharges within its environment is under national legislation such as pollution control regulations which can lead to individuals and companies rather than Member States being fined. Hence it is important that businesses are aware of the legislation and are complying with it. Corporate strategic decision-making for shippers and ocean shipping lines creates further challenges when it comes to sustainability in the face of thin profit margins, rising fuel and other operating costs and global economic uncertainty. However, because of environmental controls, a sustainability risk strategy is required, particularly in the shipping industry (Kun et al., 2015). Given these constraints, a company is duty-bound to select an appropriate risk assessment and management framework or technique to incorporate sustainability into its corporate strategy. This then must include the need to assess such matters as the economic viability, technological feasibility and environmentally sustainability of that strategy. Some tools and techniques currently exist, however they are focussed on discrete situations and events or are not holistically inclusive. Many countries have adopted the DPSIR (Drivers-Pressure-State-Impact-Response) framework (Atkins et al., 2011; Patricio et al., 2016).

There were, however, some anomalies in the DPSIR approach that were rectified in a new, enhanced framework termed DAPSI(W)R(M) (pronounced dap-see-worm) problem-solving approach (Scharin et al., 2016; Elliott et al., 2017), which were adopted for the framework. The Drivers of basic societal needs (D) remain the same, however they now require Activities of society (A) that in turn generate the Pressures resulting from these activities (P). The Pressures are mechanisms that effect a State change on the natural system (S) that in turn generates Impacts on human Welfare (I(W)) that are changes affecting wealth creation and quality of life. These revised Impacts on human Welfare then require to be solved using Responses that, following terms in EU Directives, can defined as Measures (R(M)). The '10-tenets' for sustainable management (Elliott, 2013; Barnard & Elliott, 2015) determine various criteria underlying the DAPSI(W)R(M) approach and predominantly apply to society and the economy rather than the natural environment. Nine of the 10-tenets have a societal and economic basis and hence an assessment of environmental change is not restricted solely to natural environmental aspects of the Pressures (i.e. the management measures introduced in response to the State changes) but also to the human consequences (i.e. the Impacts on human Welfare). The 10-tenets relate to actions or management measures that are important for all stakeholders and are available from and carried out by the relevant stakeholders. Within the DAPSI(W)R(M) approach, State changes and Impacts on human Welfare together represent the changes to the receiving environment, direct human interaction with the environment is represented not just by Responses and Measures, but also by the Drivers as the demands on the system leading to the Activities causing the Pressures (Scharin et al., 2016).

In essence, we assess the Pressures, State changes and Impact (on human Welfare) but manage the Drivers and Activities (Elliott et al., 2017). Indeed, 'environmental management' can be regarded as a misnomer in that we are not managing the environment but rather the people and their actions. For example, we assess the change to the seabed during port dredging but we manage the dredging frequency, intensity, extent and duration. Fulfilling the 10-tenets would mean that environmental management would potentially be seen by wider society as achieving sustainability and in turn would be more likely to be accepted, encouraged and successful. The ten tenets (Barnard & Elliott, 2015) are that environmental management actions should be socially desirable/tolerable; ecologically sustainable; economically viable, technologically feasible, legally permissible, administratively achievable; politically expedient; ethically defensible; culturally inclusive, and effectively communicable. To integrate the DAPSI(W)R(M) approach and the 10-tenets criteria, the framework adopted Bow-tie risk management analysis which has been long used in industries especially those constructing and operating new plant such as power stations (Cormier et al., 2013). It is a combined concept that integrates both techniques in a common platform, considering the top-event and initiating event (i.e. the environmental problem of concern) as linked to a common event called a critical event. It links a central problem to be addressed with the causes and the consequences of that problem occurring. It then inserts prevention mechanisms between the causes and the central problem, and mitigation and/or compensation mechanisms between the central problem and the consequences. As with fault tree analysis (FTA) and event tree analysis (ETA), Bow-tie analysis uses the probability of failure of basic events as input events on the FTA site and the probability of occurrence (either failure or success) of events as input events on the ETA site for evaluating the likelihood of critical and outcome events. For quantitative Bow-tie analysis the probabilities of input events are required to be known either as precise data or defined probability density functions (PDFs) if uncertainty needs to be considered. If such quantitative information is unknown then an expert judgement approach can be taken although of course this may produce only a semi-qualitative set of outcomes.

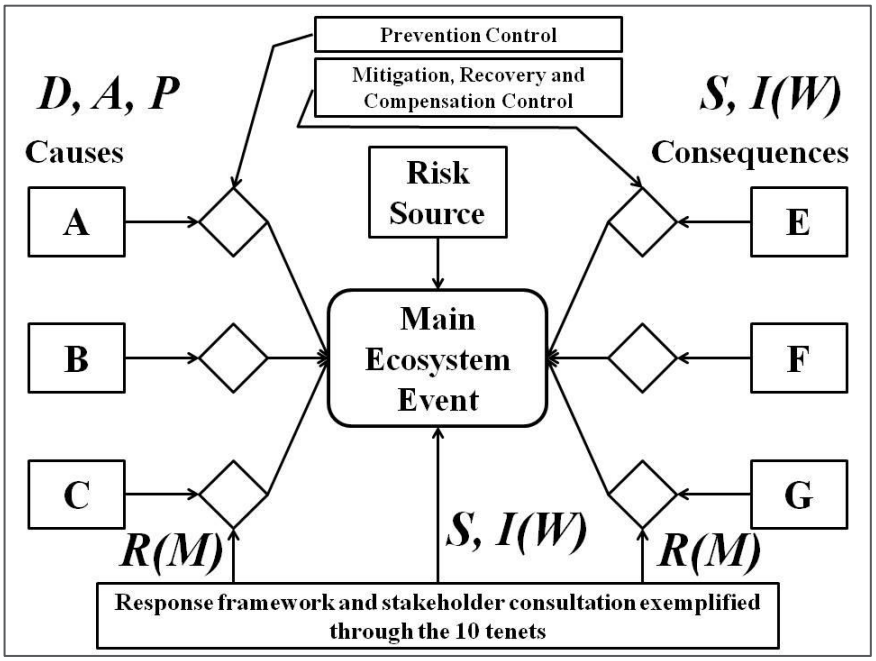


Figure 1: Proposed Framework (Adapted from Grant & Elliott, 2016)

As with any risk assessment and risk management approach, the Bow-tie analysis method is initially a qualitative model for displaying links between causes, hazards and consequences, but can be further developed with quantitative modelling. For example, Baysian Belief Network modelling based on probabilities of cause and effect has recently been linked to Bow-tie analysis (Stelzenmüller et al., 2014). By linking this method to a DAPSI(W)R(M) approach based on the ten-tenet criteria, it enables scoping, identification and analysis of causes (based on the Drivers, Activities and Pressures) leading to the main events, anticipatory prevention measures (the Responses using Measures), including those limiting the severity of the main event, consequences of the events (the State Changes and the Impacts on human Welfare), and mitigation and compensation measures (the Responses using Measures) aimed at minimising those consequences (Burdon et al., 2015). Figure 1 shows the overall framework for three potential causes of a related environmental issue (Grant & Elliott, 2016). Examples of these causes could include inter alia CO2 or SO2 emissions (A), ballast water discharges into the water while in port (B), and acidification (C). The consequences resulting from these causes could include inter alia high levels of biological pollutants in the receiving environments (water and sediment), (E), harmful air emissions around the ship (F), and an increase in human illness and disease resulting from increased emissions, discharges and acidification (G).

Research Design and Method

While this framework appears useful, the next step is to test it. This initial study reported in this paper aimed to investigate the efficacy of the framework and we used an inductive, qualitative study with maritime practitioners, i.e. shippers and port operators. Our research objective was to solicit their views on, and investigate their interest in, using the framework. This was done primarily to obtain content and face validity of the framework to conduct a further empirical study with a larger sample and using quantitative methods such as an extended survey to determine appropriate and acceptable measures for this framework and develop more generalizable findings. We used in-depth interviews which are an effective method to obtain a rich understanding of a new phenomenon such as the framework that is under-researched (Miles & Huberman, 1994). We developed questions from the literature and the framework's conceptual design for a semi-structured interview protocol. Questions revolve around (i) the type of marine risks the interviewee's company or organization considers important and how they dealing with them; (ii) the types of risk management systems and/or tools the company or organization is currently using if any; (iii) a discussion about the framework; (iv) whether the company or organization would be interested in trialling the framework); (v) some basic demographic data of the company or organization, and (vi) whether the company or organization had any other comments.

Our sampling strategy was informed by personal experience as we invited potential interviewees based on our contacts and previous experiences with them. We initially aimed to interview up to ten firms in port management shipping however meeting interviewees face-to-face proved difficult. We conducted the first interview by telephone and provided a brief description of the framework with a simple example in advance, based on the Grant and Elliott (2016) paper so the interviewee could comfortably discuss it or ask questions. We assured the interviewee that the audio recording and researcher's notes were confidential as are the interviewee's identity and firm. From responses by this interviewee and other invitees regarding their time constraints, even for a telephone interview, at their suggestion we subsequently sent the brief framework description and series of questions by e-mail to three other invitee firms who accepted. Interview transcripts were analysed using content and thematic analysis techniques to

determine similarities and differences (Miles & Huberman, 1994). However, the small number of interviews for this exploratory study does not justify the use of qualitative data analysis software (QDAS) such as NVivo (Dey, 1993). Research quality is determined in a qualitative context by trustworthiness and its four criteria (Halldórsson & Aastrup, 2003) as opposed to usual quantitative quality measures of external and internal validity, reliability and objectivity (Guba & Lincoln, 1989). The four criteria for trustworthiness are credibility (degree of match between respondents' view of reality and a researcher's representation of these views), transferability (extent to which the study is able to make general claims), dependability (concerned with the stability of data over time), and confirmability (findings represent the results of the inquiry and not the researcher's biases). Despite the small number of interviewees, responses were quite similar and thus we reached a level of consensus that gives confidence and leads us to believe our use of the trustworthiness elements and criteria has enabled collection of some of the rich data anticipated.

Findings

Table 1 provides generic information about the three respondents. For confidentially reasons we cannot name them or provide very specific demographic details.

Company	Type	Interviewees	Demographic Details
A	Shipper/ Agent	Managing Director	Multi-cargo UK shipper and shipping agent specialising in abnormal cargo solutions
B	Port Operator	Health & Safety Manager; Harbour Master; Conservancy Operations Manager	Multi-site UK port operator handling general cargo and container ships
C	Shipper	Managing Director	UK subsidiary of northern Europe shipping operator handling roll-on, roll-off (Ro-Ro) and passenger ship services

Table 1: Respondent Information

Company A

The Managing Director for Company A, a shipper and shipping agent, was interviewed in person. He identified its important marine risks as a shipping agent to be looking after a ship owner's interests regarding issues of fuel oil slops in tanks or ballast tanks, ballast water, low sulphur fuel, and garbage. As an own-shipper, the company is concerned with issues of fuel, CO2 emissions, ballast water with its own system or port-side cleaning, and spill prevention control and countermeasure (SPCC) systems for good port behaviour. Company A assesses risk as a shipping agent by checking with the ship's captain to ensure garbage removal, fuel oil slops and cleaning of ballast water and dunnage, particularly wood are completed. Every one of its ships has an electronic and manual file or log to assess and manage any risks. Company A uses ISO 9001 as a quality and risk management tool for its ships on the water, as well as for the small road haulage element of their business. Regarding the proposed framework Company A, the Managing Director first noted that a problem regarding how a business is run sustainability relates to the

penalty for not complying either with guidelines or legislation. He suggested that many companies in his sector and elsewhere are not truthfully looking to work with the environment; they are 'talking the talk but not walking the walk'. The Managing Director considers the framework is relatively valuable but should be reduced to a simple check-list to consider and deal with risk, and focus on particular and specific issues. There is also an issue of the split between ports and shipping regarding who is fully responsible for managing the environmental risks. Company A would not trial the framework given their intermediary role as agent.

Company B

Company B is a port operator and their participation in the research was conducted over e-mail. Three individuals responsible for sustainability and risk management answered the questions totally from a corporate perspective. They identified important risks relevant to their operations as buildings and infrastructure, dredging of the port area and disposal of dredged material, discharge of pollutants, proper space occupation by users in port i.e. ships, oil spillages (accidental and deliberate), handling of ballast water and aerial gases (emissions). Company B assesses these risks by environmental impact assessment and planning regulations for building infrastructure, Port Marine Safety Code (PMSC) risk assessment for Oil spills and space separation of vessels, base line protocols for dredging, environmental impact assessment for pollutant discharge from the port, and monitoring. They also liaise with local statutory bodies such as the UK environment, maritime safety, nature conservation and fisheries agencies. They have responsibilities for ballast water discharge, contingency planning, harbour authority duties and vessel traffic service (VTS) traffic management systems for managed space separation. They manage such risks by using an oil spill response plan, response equipment and drills and bunkering procedures for vessels, base line protocols, monitoring of change and risk. They interact with the Marine Management Organisation (MMO) disposal consents and consents for dredging, environmental management system and procedures for pollution, environmental impact assessment for building infrastructure, and relying on compliance with international regulations ballast water. This breadth of agencies, bodies and duties emphasises the complex nature of marine and estuarine management in a developed maritime state such as the UK (Lonsdale et al, 2015; Boyes & Elliott, 2015). The types of risk management systems and/or tools currently used by Company B include using base line protocols for dredging, the PMSC and adaption of the BOMEL plc assessment protocol using an online-based system designed for ports, ISO 14001 for environmental impact assessment, and planning application requirements. Their comments about the proposed framework were that it is too broad and does not give sufficient detail for practical implementation and as such is open to very wide interpretation. Further, they were confused about for whom it is meant to apply. The three respondents believe the 10-tenets criteria are good but that their individual assessments should be judged against each other and they need to be developed into more of a working tool. However, they believe that the framework is currently too far removed from a practical application. Thus, they believe the framework is insufficient in its current form, and needs more detail and further development for more practical use. Despite this, Company B agreed that they would trial the framework and indicated they will try and apply it on current expansion and development plans.

Company C

Company C is a shipper and the Managing Director's participation in the research was conducted over e-mail. He identified important risks as oil leakage during bunkering or due to grounding, chemical leakage from cargo units, fire on board, sewage from Ro-Ro vessels to sea, and open loop sulphur scrubber system effluent to sea. Risk assessment is done in connection with annual business planning and tools used include risk importance/likelihood where

possible preventive actions are also identified. Their environmental risk management integrates tightly with a Maritime Safety and Quality Management system. Information from near-miss and actual incidents are collected from vessels into a common incident handling system and corrective actions are done based on reports. The Managing Director considered that this kind of systematic and profound analysis would enable more efficient focusing of preventive and corrective actions and would also be good to review different stakeholder aspects related to the risks. However, he considered that it is too labour intensive at present to be implemented with short notice in practice. So, while the framework would be good to have it would need some simplifying as well as a supporting tool. Company C would not trial the framework in its present form.

Discussion and Concluding Remarks

This paper has presented preliminary findings from an in-process exploratory research study into the efficacy and value of a framework for environmental risk assessment and management (Grant & Elliott, 2016). Several important aspects were mentioned by the five individuals responding to the interview questions in three companies. The fact that all three companies recognised potential risk areas that are applicable to their respective firms suggests that the development of horrendogram-based (conceptual model) risk factors is appropriate for the maritime sector. However, all companies considered that the framework as presented is too complex or insufficiently simple for companies and other organizations to understand in order to be able to be implemented. Presenting all possible repercussions and linkages in the form of conceptual models (horrendograms) has both advantages and disadvantages. The diagrams are valuable in conveying the message that many aspects are linked, that the natural and social systems are complicated, and thus organisations require multi- and cross-disciplinary approaches and ways of thinking. While it is valuable to show the complexity and the means of linking all aspects, it is possible that organisations become overwhelmed by the complexity. Hence, they may need advice and assistance in working with and within the regulatory system and in following the plethora of marine legislation. Similarly, they may also face ‘consultation fatigue’, given the number of interactions, not have the requisite number of skills and amount of expertise, and be concerned at the financial and time costs of following complex environmental management systems. Given the complexity of the frameworks, it is suggested that as communication and analysis tools, it may be better to present and explain small elements of the framework rather than the whole system at one time à la Elliott (2014). The complexity of the horrendogram due to its large scope may not have allowed the firms to properly delineate their areas of responsibility for risk assessment and management. This in turn affected their ability to assess the framework on the totality of the three elements underlying it – the 10-tenets criteria, the DAPSI(W)R(M) problem setting approach and the Bow-tie analysis. Indeed, the question by the shipper about dividing the responsibility between ports and shippers and the port operator’s confusion about for whom the framework is meant underscores that issue. However, all companies also believed there is merit in the holistic framework, particularly the 10-tenets criteria and even though the port operator had issues with how it would work in practice. Two respondents are interested in trailing the framework to see if it can improve their risk assessment and measurement. In summary, we are encouraged by the responses from these three companies as all indicated the framework has potential and none rejected it out of hand. We appreciate that five interviews is a small sample, however this work was exploratory and a consensus achieved nonetheless. Hence, the findings give us a good platform to proceed with further framework development and testing in a bid to allow firms to substantially analyse their environmental management efforts.

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Investigating sustainable green air transport (sga) in Egypt, a swot analysis of Cairo International airport compared with Dubai international airport

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1. Introduction

Aviation is one of the world's most important contributors to the advancement of modern society. (Morten, 2015). It contributes about 2% of global greenhouse emissions and supports 8% of the world economic activity (Sarkar, 2012).It has the role of improving and enhancing the community development by providing jobs, skills and opportunities. As any other industries, aviation industry has an environmental impact which should be taken into consideration to minimize its negative impact on the environment to the minimum.

Aviation recorded high occupancy rates of 65% to 70% compared with those of road and rail transportation (Neal, 2015). Air transport entirely covers its infrastructure costs. Unlike road and rail, it is a net contributor to national treasuries4 through taxation. The world's 900 airlines have a total fleet of nearly 22,000 aircraft. They serve some 1,670 airports through a route network of several million kilometers managed by around 160 air navigation service providers. It was recorded that aviation industry supports nearly 63 million jobs all over the world and supports the global GDP by 2.7 trillion (Gill, 2016).

According to Schafer and etal. (2009), they found that air transport is faster in growth compared with the automobiles. They found that the travel growth of passengers by automobiles is expected to be more than double from 2010 to 2050. Although this increases, air transport is still the faster in growth. The concept of green air transport is closely linked to the reduction of emission level in the atmosphere. Recently, there is growing trend towards air safety and environmental health. This paper is discussing the concept of sustainable green air transport system by focusing on the recent achievements in the aviation industry regarding this concept in respect of the new innovative technologies combined with emission mitigation efforts towards sustainable growth of air transport industry. Also, this paper represents the main achievements done regarding green air transport in Dubai International Airport comparing with Cairo International Airport in order to determine the main barriers behind implementing such concept in Egypt.

2. Literature Review

2.1 Sustainable Air Transport

The Core Concept of Green Airport Green airports have become one of the top priorities in the nation, primarily due to federal, state, and local initiatives. Green airports can be defined as a holistic approach of how airports could be managed to ensure to the integrity of the Economic viability, Operational efficiency, Natural resource conversation, and Social responsibility of the airport. Bartolotti and Siniscalo (2014) mentioned the main benefits that will return on the state if we applied green airport design through the following:

Initial Cost Saving: By reducing infrastructure cost, material use, savings in construction waste disposal and savings from downsizing mechanical equipment. Reducing Operating Costs by lowering energy costs, reducing water costs and ensuring greater durability and increasing its depreciation rate. Environmental Benefits: Through decreasing the global warming impact, and minimizing local and regional water pollution.

2.2Trends of International Airport towards the sustainable green aviation industry

2.2.1Green Aviation Technology

Biofuels –the third generation biofuels are characterized as fast growing algae to provide a drop-in fuel substitute. 2. Advanced composites – The future composites will be lighter and stronger than the present composites which the airplane manufacturers are just learning to work with and use. 3.Fuel cells - Hydrogen fuel cells will eventually take over from jet turbine Auxiliary Power Units (APU) and allow electrics such as in-flight entertainment (IFE) systems, galleys etc. to run on green power. 4. Wireless cabins – The use of Wi-Fi for IFE systems will save weight by cutting wiring - leading to lighter aircraft. 5. Recycling - Initiatives are now underway to recycle up to 85% of an aircraft's components, including composites - rather than the current 60%. By 2050 this could be at 95%. 6. Geared Turbofans (GTF) - Already under testing, GTF could prove to be even more efficient than predicted, with an advanced GTF providing 20% improvement in fuel efficiency over today's engines. 7. Blended wing body aircraft - These flying wing designs would produce aircraft with increased internal volume and superb flying efficiency, with a 20-30% improvement over current aircraft. 8. Hydrogen-powered aircraft - By 2050 early versions of hydrogen powered aircraft may be in service - and if the hydrogen is produced by clean power, it could be the ultimate green fuel. 9. Advanced air navigation - Future ATC/ATM systems based on Galileo or advanced GPS, along with international co-operation on airspace, will allow more aircraft to share the same sky, reducing delays and saving fuel. 10. Quiet aircraft - Research by Cambridge University and MIT has shown that an airliner with imperceptible noise profile is possible - opening up airport development and growth. 11. Open-rotor engines - The development of the open-rotor engines could promise 30%+ breakthrough in fuel efficiency compared to current designs. By 2050, coupled with new airplane configurations, this could result in a total saving of 50%. 12. Electric-powered aircraft - such as UAVs are already in service. 13. Solar-powered aircraft - After UAV applications and the Solar Impulse round the world attempt, solar-powered aircraft could be practical for light sport, motor gliders, or day VFR aircraft. Additionally, solar panels built into the upper surfaces of a Blended-Wing Body (BWB) could provide additional power for systems (Agarwal, 2012).

2.2.2Green Infrastructure Technologies

1. Electric/hybrid ground vehicles – Use of electric, hybrid or hydrogen powered ground support vehicles at airports will result in reducing the carbon footprint and improve local air quality. 2. Multi-modal airports - Future airports will be connected with other modes of transport to connect passengers seamlessly and quickly with other destinations and encouraging them to depend less on cars. 3. Sustainable power for airports - Green airports of 2050 could draw their energy needs from wave, tidal, thermal, wind or solar power sources. 4. Greener helicopters - Research into diesel powered helicopters could reduce fuel consumption by 40%, while advances in aircrafts edges design will cut the noise. 5. The return of the airship - Taking the slow route in a solar-powered airship could be an ultra 'green' way of travel and carve out a new travel niche in 'aerial cruises', without harming the planet.”

Through these technological, operational and infrastructure innovations, the aviation industry has acted to reduce mankind's environmental footprint. With the necessary commitment and the already-existent willpower, it sets an example for other, more polluting industries (Agarwal, 2012; Aerospace International, 2009).

2.3 Challenge Facing the Sustainable Green Airports (SGA)

However the main benefits that can be gained when transferring an airport to a green airport, still there are a lot of barriers and challenges that are representing as barriers for airports in order to be green. Agarwal (2010) determined that High cost, Lack of Funding, Improving Efficiency Airport Operation, Lack of Sustainable Concept Awareness and lack of staff Experience. While Capegimini (2012) stressed on the mechanical and technical barriers in terms of Poor Management Support, Harmful Air Emissions from Aircraft Engines and the obstacles facing the innovation of designing green planes.

3. Research Method

This study can be described as basic research by investigating the sustainable air transport in Egypt by conducting a comparative study with Dubai International airport and to determine the main challenges facing Cairo Airport in terms of the sustainable air transport.

This research follows the qualitative data approach as qualitative data are characterized by their richness and value through the ability of the researcher to explore a subject or a phenomenon in as real a way as possible (Saunders etal, 2012). Bartunek and Seo (2013) and Saunders et al. (2012) characterized the qualitative research approach as the interaction between individuals to imply the social properties, rather than separate the phenomenon, from the individuals in its construction. Qualitative data was gathered depending on a set of semi-structured interviews targeting general managers and operators at Cairo International Airport as a case study to discuss the actions taken to apply green transport within the period of study.

The main aim of these set of interviews is to investigate the main caused preventing the green concept to be applied in Cairo airport and to discuss the possible solutions for these causes or problems. A comparative study is conducted between Cairo airport and Dubai airport through SWOT analysis which is an analytical tool used to identify the strengths, weaknesses, opportunities and threats facing Cairo airport and same as Dubai Airport.

Dubai International Airport has been chosen as it is the primary airport serving Dubai, United Arab Emirates and is the world's busiest airport by international passenger traffic. It is also the 3rd busiest airport in the world by passenger traffic, the 6th busiest cargo airport in world, the busiest hub for the Airbus A380, and the busiest airport in the world operating with two runways only (Sahoo, 2017). The investigation held on Dubai Airport helped in describing and explaining the main major global standards for going green followed in order to reach the sustainability of air transport. Cairo Airport has been chosen as it is the initial airport and the busiest Airport in Egypt and serves as the primary hub for Egypt Air and Egypt Air Express as well as several other airlines. It is the second busiest airport in Africa after O.R. Tambo International Airport in Johannesburg (writer, 2016).

4. Results and Findings

4.1 Dubai International Airport SWOT Analysis

According to previous survey doing by several researchers on Dubai international airport so we can mention Dubai international airport SWOT analysis as follow:

Strength:

Dubai airport have big wide international connection with a lot of countries around of the world. Also, Dubai airport designed to contain high technology and modern hubs as well as good innovation strength and up to date to all the new trends in world aviation such as aircraft or operations. Furthermore, Dubai airport has great reputation with the international airlines companies inside the country and around the world. As well as they using high technology inside and outside the facility which made it from the highest developed Airport Cities (Bitelmal, 2010).

Weakness:

In the weakness which face Dubai airport is not the increasing of capacity but to manage demand by channeling it to off peak times or to alternate sites. The rationale underlying all these approaches is that capacity and demand must somehow be brought into equilibrium in order to prevent or reduce delay (Townsend, 2015).

Opportunity:

Dubai airport have collaboration with many airlines and partners around the world to transport passengers and cargos from strongly emerging regions. Also Dubai made link between the international trains with the airport to make it easier on the passengers. Furthermore, Dubai airport continue improving supply chain innovation and sustainability in all operation and management inside the airport as well as its international activities in sustainability and green environment (Bitelmal, 2010).

Threats:

Dubai airport is considered from top rank airports in the world so the competition from other airports inside Dubai and airports around the world take place. On other hand the Threat of terrorism effect negatively on the airport's operations as well as unexpected European innovation and the intensified security requirements needed and travel procedures.

4.2 Cairo International Airport SWOT Analysis

According to the set of semi-structured interviews held with the top managers of operations of the Cairo Airport and with the airline companies located inside the airport, the following SWOT analysis could be concluded:

Strengths:

In our investigation there are some of strength points that Cairo has to going green, this point such as high growth rate in Egypt which increase demand on airports all over Egypt generally and Cairo international airport especially.

Another point of strength is that existing distribution and sales network considered as strength point because of the number of existing of suppliers and sales networks and distribution centers of Cairo international airports for customers to be satisfied and to go green.

Weakness:

According to our investigation in Cairo international airport we noticed that the weakest point that Egypt face during the application of green concept is the lack of investments in research and development that restricted from knowing the new technology and trends in global green aviation around the world.

Opportunities:

Cairo international airport have great opportunity in growing the economy as well as increase the awareness demand for sustainability of the environment by investing and building projects that funded by the government to achieve the growing of the economy. Furthermore, the globalization of the market will take into the consideration of the major opportunities for Cairo international airport in the transport of the passengers and cargo around the world. Regarding the airports expansion, Cairo airport is subjected to a comprehensive scheme of airport modernization according to international standard, in addition to contracts with private sectors are signed under a BOT concept for infrastructural development.

Threats:

There are some threats that facing the government and Cairo international airport which is the technological problems and how the employees will deal with it if they are not qualified or not training well to solve these problems. Furthermore, the economy in Egypt is in recession and this will lead to tax changes, increase in labor cost and financial capacity. Furthermore, Trade restrictions and tariffs Political instability will take into consideration.

5. Discussion

This research found that Cairo International Airport is making an environmental awareness and management efforts as an integral part of its growth strategy. Cairo Airport sets its environmental goals in compliance with local, international environmental legislation and the civil aviation guidelines to ensure the best practice of the civil aviation industry in Egypt and the environmental issues with all is different branches. In addition, Cairo Airport Company (CAC) has proved after the expansion of terminal three and the expansion held in terminal 2 that it was the best environmental and economical solution for the expansion (http://www.cairo-airport.com/environment.asp).

Another aspect that Cairo Airport is committed to be a green sustainable airport, it is now certified by ISO 9001/2008 in the quality management system in 2016. It is certified by the Swiss Company (SGS) after ensuring that the airport is performing according to the International standards (http://www.egypt-business.com/News/details/1634-Cairo-airport-is-now-certified/54592).

The renovation of terminal 2 at Cairo Airport is considered a major indicator that this airport is taking all the needed measured towards the sustainability. It adopted green building practices for modernization through implementing a sustainable airside design by maximizing savings in the use of natural and existing resources and material durability. This expansion aims at reducing the taxi distances and times in order to reduce air and water pollution from combustion process. It also aims to reduce the number of passengers' vehicles by assigning a convenient shuttle service to reduce the traffic congestion and air and water pollution. Minimizing the use of electricity is one of the major contributions of the renovation of terminal 2 by using natural light for illumination and the use of the daylight

dimming control system with high efficient energy lamp providing the electrical power consumption. This will help in reducing the CO2 emissions. The design of the new building is designed according to the international standards to ensure the reduction of noise level resulting from the operation, take-off and landing of aircrafts.

It is also operated with insulated glazing system providing thermal efficiency and prevents unnecessary heat/cool transfer. The expansion also adopts non-toxic materials in its interior materials and resources which has a positive impact on the environment and health. The renovation of terminal 2 through minimize gas emission by establishing air quality monitoring stations in order to make the airport has a minimum significant impact on the surrounding residential area.

On the other hand, there is some major problem that prevents the efficiency of terminal 2 performances and minimizes its green operation which lies in the lack of investment, lack of the green technology and lack of making new project that will facilitate the operation with the passengers at the peak time. In addition to the poor level of Service including space, time and distance, comfort and convenience, performance standards, reliability and effectiveness in addition to the delay processing, long waiting time and facility and equipment lack of performance.

On the other hand, the government and the Egyptian authority takes on their behalf the efforts and responsibility of dealing with such disasters like the natural disasters and terrorist attacks…etc. that leads in many times to very late of response due to the lack of resources, experience, good preparedness and a major cause of the deficiency in efficiency performance at Cairo international airport.

Comparing with Dubai International Airport as shown in the table below, it was found that Cairo airport is going on its way to be a sustainable green airport (SGA), however the problems mentioned above. Lack of investments, the devaluation of the Egyptian pound, the current status of the Egyptian economy in addition to the existing war in Egypt with terrorism are considered the major obstacles and barriers preventing Cairo Airport to be a sustainable green airport, at least at this specific period of the economic recession compared with Dubai Airport. It was found that Cairo and Dubai airports are somehow similar in strength points as well as opportunities but Cairo Airport is facing more difficulties and challenges than Dubai in terms of the political and economical status, lack of investments, trade and tariffs restrictions in addition to the poor of employees skills and lack of awareness toward the sustainability.

Dubai International Airport SWOT Analysis	Cairo International Airport SWOT Analysis
Strength Network of destinations Modern and well-equipped hub airport Innovative strength Reputation and brand recognition Network of international partners Strong marketplace	Strength High growth rate Barriers of market entry Existing distribution and sales networks Experienced business units
Weakness Lack of capacity during peak times	Weakness Lack of investments in research and development
Opportunities Traffic and transport from strongly emerging regions Collaboration with airlines and other partners Supply chain innovation and sustainability initiatives Direct international train connections to and from the airport International activities	Opportunities Growing economy Growing demand New acquisitions Venture capital 5. New markets 6. Global markets
Threats Competition from other airports Relatively limited economic growth Intensified security requirements European regulations Threat of terrorism	Threats Technological problems Tax changes Financial capacity Price changes Increasing rates of interest Government regulations Increase in labor costs Economy is in a Recession Increase of Operating Costs 11. Trade restrictions and tariffs 12. Political instability

Table 1: Comparison of SWOT Analysis between Dubai and Cairo International Airports

Source: The Interviews Output

6. Conclusion

The concept of Sustainable Green Airport (SGA) is becoming one of the main concern and at the top priority of most of the developed countries. It was also concluded that Cairo International Airport is on its way to be sustainable green airport comparing with Dubai. However, it faces some obstacles and difficulties, especially after the Arab Spring in terms of lack of investments, devaluation of the Egyptian currency, and the war against terrorism. It is important to note that the green industry costs too much in terms of the main infrastructure and the technology needed at Airports. The renovation of terminal 2 at Cairo International Airport is considered as a vital step towards sustainability. Consequently, Egyptian Airport authority should pay attention to personnel and equip them with the needed skills under their various employee training programmers in efficiency performance operation. It is important to focus on new facilities and investments with testing programs and simulations to reach the green concept. Measuring Operational Efficiency in Airport Elements such as Airspace and Airfield – Aircraft Support and Emergency Services - Aircraft Passenger Terminal – Terminal Landside Ground Access – Vehicles and fixed transit system is vital for the sustainable airports. Increasing the number of staff will lead to increase the performance of the operator in inspection procedures in order to minimize the congestion in airport which usually has a negative effect on average waiting time which affects automatically on the satisfaction of passenger and his comfortable which effect too on the concept of going green. The Egyptian government has a major role in order to adopt sustainable green airports by allocating find for investment and capacity expansion. The employees at the civil aviation should be well trained on the new technology of green aviation and increasing the awareness of the new trend technology in aviation around the world in order to update our system and procedures inside the Cairo international airport and to increase the rank of the top international airport.

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Food Supply Chains

Contextual Factors Affecting Food Security: A Behavioural Framework

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Introduction

Globalised distribution networks together with advances in information and communication technologies as well as transport routes and infrastructure have led to long and complex food supply chains where the physical footprint of production operations are located far from the points of consumption. This increasing complexity exacerbated by surges in global food prices due to low levels of production in grain-producing nations and the rising costs of oil, fertilizers, and transportation, is raising concerns about food security in many countries, especially those that rely on food imports to feed their population. On the other hand, several academic challenges associated with food security comprise unpacking this multi-faceted concept and finding ways to improve it.

In fact, food security is at the top of the agenda in countries with relatively low capacity to be self-sustaining in food. An example is Qatar, which consists of low, barren plains covered with sand and subject to intense heat during dry seasons. Another relevant aspect for Qatar is the annual population growth of 2.87% (WorldBank, 2017), which is above the average population growth in the Gulf Cooperation Council (GCC) countries in the region. With increasing population and food provision depending on imports that comprise more than 90% of the food consumed in Qatar, it is not a surprise that food security is a top priority. This paper is a research outcome of the SAFE-Q Project, which aims to contribute to food security efforts in Qatar with the overarching research idea of a holistic approach to food distribution, food consumption, and food waste (Figure 1).

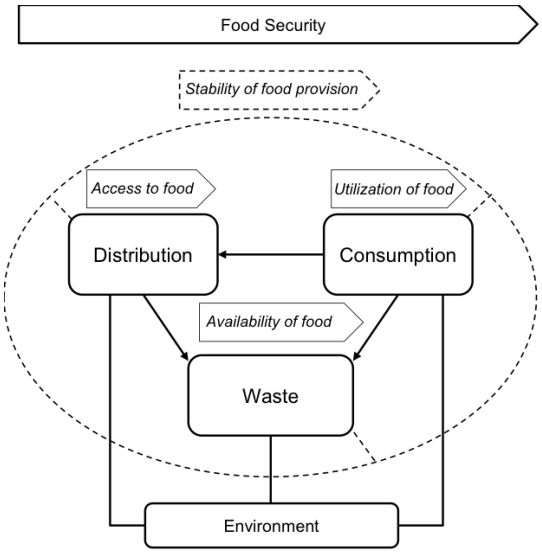


Figure 1 The overarching research idea of SAFE-Q and links to food security

We highlight the research challenges and their relation to food security and environmental sustainability of food supply chains in Figure 1. These two concepts are indeed tightly connected. Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food which meets their dietary needs and food preferences for an active and healthy life (FAO, 2003). It is comprised of food availability, food access, utilisation, and stability. Availability neither assures access, nor a healthy and nutritional diet. That is why a holistic approach to understanding the interconnectedness of the policies in this domain is required to assist decision makers during the implementation of policies to reduce waste and improve food security.

The food supply chains distribute the food demanded by the consumers; however, wastes occur both in operations and at the end of the chain, in the consumption stage. Some of this waste is unavoidable, but there are opportunities to reduce certain types of waste by improving operations and changing consumption behaviours. As part of the framework in Figure 1, this paper presents the research outcomes in relation to the utilisation of food, where we focus on food consumption and its implications for food waste. Our research question is “How can we explain the food waste behaviour?” in an effort to find ways to change it. For this purpose, first we review the literature that studied consumer attitudes toward food waste and explained food waste behaviour. We then synthesise literature findings with the SAFE-Q field work on identifying the factors affecting the food waste in Qatar bringing the contextual element into the research. We employ a questionnaire survey with consumers and present our findings using a Partial Least Squares Structural Equation Modelling (PLS-SEM) approach. Our conclusions establish the multifaceted nature of the food waste problem and the interconnectedness of the contributing factors.

Literature Review

The highest value-added is lost when food is wasted at the end of the supply chain, after consumers’ purchase. Food waste at consumer end has the greatest economic, social, and environmental implications because of its value, the opportunity cost of not feeding other people who might be living in hunger, and the loss of biodiversity. To reduce the food waste, we need to understand the factors associated with food waste behaviour.

Theory of Planned Behaviour (Ajzen, 1991) has been widely applied in various contexts to understand the consumers' behaviour and reveal the predictive power of attitudes, norms, perceived control, and intentions to explain it. Within the context of the Theory of Planned Behaviour (TPB), attitudes represent positive or negative evaluation of self-performance of a specific behaviour; subjective norms represent the perception of social pressures or relevant others' belief that one should or should not behave in a specific way; perceived behavioural control indicates the perceived ease or difficulty of behaving in a specific way; intentions represent the willingness to behave in a specific way; and finally behaviour is the observable action taken, ranging from simple strategy choices in games to actions of appreciable personal or social significance. Hence, we put forward the following hypotheses in line with the TPB:

H1: Positive personal attitudes towards food waste are associated with a higher level of intentions to reduce food waste.

H2: Subjective norms on food waste are positively associated with intentions to reduce food waste.

H3: The higher the lack of perceived behavioural control, the lower will be the intentions to reduce food waste.

H4: The higher intentions to reduce food waste will lead to lower food waste.

H5: The higher the lack of perceived behavioural control, the higher will be the food waste.

On the other hand, when it comes to food waste behaviour, previous literature suggests other explanatory factors such as financial attitudes, planning routines, social relationships, food surplus, or contextually, Ramadan. For example, financial attitudes have been found to be negatively related to food waste behaviour over planning routines (Visschers, 2016; Graham-Rowe et al., 2015, Scholderer et al., 2004). Similarly, planning is a significant part of the food-related lifestyle instrument developed and tested by Scholderer et al. (2004), where the main aim of it is to reduce the food surplus. In fact, food surplus has been identified as the main contributor to food waste (Stefan et al., 2013; Stancu et al., 2016), mainly associated with buying more than what can be consumed and buying products unintentionally. Social relationships are associated with consuming food with others such as family members and friends both at home and outside, e.g. at a restaurant (Scholderer et al., 2004). In fact, the SAFE-Q exploratory research identified serving food in abundance to show one's hospitality in Qatar (SAFE-Q, 2016). Another aspect is about changing food consumption habits across specific periods of the year. In particular, for Qatar, the Ramadan period has been identified in the SAFE-Q exploratory research when people's eating behaviour change for the duration of a month. In fact, previous work from Turkey, which is similar to Qatar in terms of observing Ramadan has reported changing consumption patterns manifested as unplanned purchases, buying special products, and increased spending amounts (Odabasi and Argan, 2009). In Figure 2 we denote the constructs of the TPB in pink and contextual factors we consider in blue.

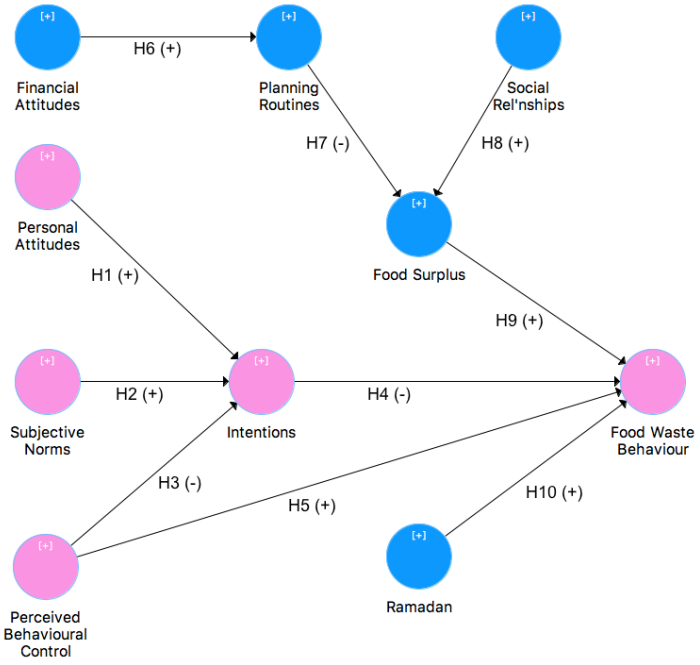


Figure 2 Conceptual Model to Explain Food Waste Behaviour

In Figure 2, financial attitudes measure the financial awareness when shopping for food products; planning routines represent how much preparation one has before they shop groceries, whether they have shopping lists or they check the food cupboard prior to a trip to the supermarket; social relationships capture the changes in food consumption when socialising with others at home and outside; food surplus indicates having more food than needed; and finally, Ramadan represent the changes around food consumption and waste during this specific period of the year. The hypotheses on the contextual factors with which we extend the theory of planned behaviour to explain the food waste are as follows:

H6: Financial attitudes are positively associated with planning.

H7: Planning is negatively associated with food surplus.

H8: Social relationships and interactions with others result in higher levels of food surplus.

H9: Higher levels of food surplus are associated with higher levels of food waste.

H10: Eating routines during Ramadan lead to higher food waste.

Methods

To explain the food waste behaviour, we drew on the literature presented above and employed an online questionnaire to collect data from consumers in Qatar. For brevity, we present a sample measurement item of each construct defined in the conceptual model in Figure 2 together with the underlying literature in Table 1. The figures given in brackets after the constructs show how many measurement items we used for that construct in the questionnaire.

Table 1 Constructs, corresponding measurement items, and the underlying literature

Construct	Measurement Item	Relevant Literature
Financial Attitudes (3)	I compare prices between food products to get the best value for money.	Scholderer et al. (2014)
Planning Routines (3)	I make a shopping list of food products I want to buy prior to my shopping trip.	Stefan et al. (2013), Scholderer et al. (2004)
Social Relationships (2)	It is my culture to serve a lot of food to show my hospitality.	Scholderer et al. (2004), SAFE-Q (2016)
Food Surplus (3)	I tend to buy a few more food products than I need at the supermarket.	Stefan et al. (2013), Stancu et al. (2016)
Ramadan (4)	I feel that I throw away food more than usual during Ramadan.	Pirani & Arafat (2015), Odabasi & Argan (2009), SAFE-Q (2016)
Personal Attitudes (4)	I feel bad when uneaten food is thrown away.	Ajzen (1991), Visschers et al. (2016), Stefan et al. (2013)
Subjective Norms (4)	My friends think my efforts to reduce food waste are necessary.	Ajzen (1991), Visschers et al. (2016)
Perceived Behavioural Control (3)	I find it difficult to prepare food from left overs.	Ajzen (1991), Visschers et al. (2016)
Intentions (4)	I intend to generate as little food waste as possible.	Ajzen (1991), Stefan et al. (2013), Stancu et al. (2016)
Food Waste Behaviour (4)	I waste food whenever I go out with friends/family.	Ajzen (1991), Scholderer et al. (2004), Stancu et al. (2016)

The respondents stated their agreement with the measurement items on a 7-point Likert scale (strongly disagree, disagree, somewhat disagree, neither disagree nor agree, somewhat agree, agree, and strongly agree). The survey was distributed through the SAFE-Q research team's networks, Qatar Ministry of Development Planning and Statistics, and universities located in the Education City. The survey was piloted in Dec 2016 and the primary data was collected Jan-Apr 2017.

We test the conceptual model presented in Figure 2 with the non-parametric PLS-SEM method, which does not necessitate the data to meet certain distributional assumptions. PLS-SEM is widely applied due to its broad scope and flexibility in terms of theory and practice. It makes it easy and swift to introduce a new latent variable, an indicator, and an inner model relation, or exclude an element to test for predictive relevance. In terms of the measurement of latent constructs, we treat all constructs except food surplus as reflective. The reason for considering the food surplus construct as formative is the fact that the measurement items under this construct come together to form the concept of food surplus; rather than being reflected by it. Hence, contrary to the rest of the measurement items, the correlation among them is low. The non-parametric nature of PLS-SEM mean that parametric significance tests such as those in regression analysis cannot be used to test the significance of outer weights, outer loadings, and path coefficients. We therefore employ a non-parametric bootstrap procedure to test the significance of path coefficients (Hair et al., 2017). Bootstrapping method comprises subsamples of randomly drawn observations from the original data, which are then used to estimate the PLS path model. We set the process to repeat until 1,000 subsamples are drawn and subsequent PLS models are fit. We assess the model fit using the Standardized Root Mean Square Residual (SRMR), which is an absolute measure fit representing the standardised difference between the observed and the predicted correlation. For SRMR, a value less than 0.08 is considered a good fit (Hu & Bentler, 1999).

Findings

From the survey tool, we had 363 responses recorded. However, we had to exclude responses where there were many unanswered questions (we did not force response any of the questions). After excluding observations where more than 15% of the questions were not answered, we had 235 usable responses. We then filtered the respondents who were based in Qatar and the final set of observations that we analysed comprised 213 responses. The reason for having responses outside Qatar is that we announced the link to the survey on the SAFE-Q project blog, which is open to public (https://blogs.commons.georgetown.edu/safeq/). The demographics of the survey are as follows: Fifty-one different nationalities are represented in the responses demonstrating the multicultural and international nature of Qatar. All participants work and live in Qatar where 16% of the participants are originally from the UK, 11% are from Qatar, and 9% are from the USA. 70% of the participants were female and 26% of them were male; 4% did not state their gender. 67% of the participants were married and 27% were single; 6% did not state their marital status. A balanced age distribution is observed as shown in

Table 2. In terms of annual income, 70% of the participants had an income between QAR 10,000 to QAR 70,000.

Table 2 Age and Education Distribution of the Sample

Age band	Percentage		Education	Percentage
18-24	14		Secondary Education	5

25-34	35		A Levels	4
35-44	27		University Undergraduate	30
45-54	14		Masters	38
55-64	7		PhD	9
65-74	1		Diploma	12
Not stated	2		Not stated	3

We analysed the questionnaire data using SmartPLS 3 (Ringle et al., 2014). All constructs except food surplus are measured reflectively as we explain in the literature section. In the case of reflectively measured constructs, all measurement items had a loading greater than 0.70 (Sarstedt et al., 2014), suggesting indicator reliability is achieved. Composite reliability (Jöreskog, 1971) values above 0.70 are considered 'satisfactory to good' (Hair Jr et al., 2013). The model's composite reliability values were 0.821 and above for all reflective constructs, satisfying internal consistency reliability. Average Variance Extracted (AVE) measuring the convergent validity should be 0.50 and above. The AVE values of all constructs were greater than 0.605, suggesting convergent validity is achieved.

Once the measurement model satisfies the reliability and convergent validity of constructs, it is subjected to the discriminant validity test, which determines the extent to which a construct is empirically distinct from other constructs. The most conservative criterion that evaluates discriminant validity, the Fornell and Larcker (1981) criterion compares the square root of the AVE of each construct with the inter-construct correlation of that construct with all other constructs. The model satisfies the discriminant validity with no inter-construct correlations higher than the square root of the AVE. Measurement model results are presented in Table 3.

Table 3 Measurement Model Results

	Cronbach's Alpha	Composite Reliability	AVE

Financial Attitudes	0.807	0.886	0.721
Food Waste Behaviour	0.781	0.859	0.606
Intentions	0.811	0.876	0.640
Perce. Beh. Control	0.694	0.830	0.620
Personal Attitudes	0.800	0.870	0.626
Planning Routines	0.721	0.840	0.637
Ramadan	0.938	0.956	0.844
Social Rel'nships	0.652	0.852	0.742
Subjective Norms	0.842	0.892	0.674

As the measurement model is satisfactory, we fit the PLS-SEM model to explain the food waste behaviour with the nine hypotheses proposed in the literature section. According to the PLS-SEM results, all hypothesis except H2 are supported. As explained in the Methods section, the significance of path coefficients can be determined by bootstrapping, which we performed next. We present the estimations from the bootstrap samples along with the p-values in Table 4. The original sample explains 47.8% of the variation in food waste behaviour, and the bootstrap confidence interval for the Squared Root Mean Residual is [0.043, 0.055], lower than the suggested threshold of 0.08 (Henseler et al., 2014). When we try to explain the food waste behaviour only with the TPB constructs, we can explain 38.6% of the food waste behaviour and the contextual factors that we incorporate provide approximately 10% additional percentage points.

Table 4 Structural Model Results

Hypotheses	Path Coefficient	p-value	Conclusion
H1: Attitudes > Intentions (+)	0.497	<0.001	Supported
H2: Subjective norms > Intentions (+)	0.051	0.433	Not supported
H3: Perceived Beh. Control > Intentions (-)	-0.190	0.002	Supported
H4: Intentions > Food Waste Behaviour (-)	-0.212	<0.001	Supported
H5: Perce. Beh. Control > Food Waste Beh. (-)	0.346	<0.001	Supported
H6: Financial Attitudes > Planning Routines (+)	0.235	<0.001	Supported
H7: Planning Routines > Food Surplus (-)	-0.152	0.019	Supported
H8: Social Relationships > Food Surplus (+)	0.391	<0.001	Supported
H9: Food Surplus > Food Waste Behaviour (+)	0.240	<0.001	Supported
H10: Ramadan > Food Waste Behaviour (+)	0.193	0.01	Supported

Discussion and Conclusion

We investigated the consumers' food waste behaviour by extending the theory of planned behaviour using the extant literature and the exploratory results of the SAFE-Q project. We identified financial attitudes, planning routines, social relationships, food surplus, and Ramadan as contextual factors which help explain the food waste behaviour and the results supported our initial hypotheses. It was not possible to establish a significant relationship between social norms and intentions, which may be explained by the status of food waste awareness in Qatar. The questions in social norms focus on what participant's family and friends think about food waste. It could be the case that the food waste is not at the forefront and a pressure to reduce it is not yet evident across the board; hence the norms have not started to affect intentions to reduce food waste yet. Outcomes of this research has potential to impact policy through informing the policies on managing food waste and regulating food markets whilst enabling a food-secure environment for the citizens.

Future research could focus on measurement of food waste rather than using a self-reported scale as we did in this work. We limited our sample to people who are currently based in Qatar to explain the food waste behaviour in Qatar with the factors affecting it. Future work can focus on other countries in the region which have similar conditions in terms of climate, food dependence, and socio-cultural aspects. We incorporated Ramadan as a socio-cultural element changing food consumption behaviour in Qatar; a follow-on analysis could focus on other significant times of the year such as Christmas, Easter, or other periods with increased level of celebrations. In our work, we could not focus on weddings or other celebrations where increased amount of food waste is observed. Future research can investigate how people's behaviour changes at such events compared to their day-to-day practices.

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Exploration of innovations in online grocery logistics practice: the case of Ocado

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Introduction

The online grocery sector has become a notable, newsworthy element of business in recent weeks. Following Amazon's announcement, in June 2017, of its acquisition of Whole Foods for $13.7 billion (Rigby, 2017) other developments in the sector, just from the UK, have included, Marks and Spencer and Ocado exploring a potential tie up (Jolly, 2017), Ocado reaching an agreement with a European Retailer to use its Smart Platform (Ocado*, 2017) and Tesco launching Tesco Now, a one hour delivery service within London, with no minimum order spend (Tesco, 2017). In many ways, it is not surprising that online grocery provision is attracting this level of attention. With the modern pace of life and the timesaving possibilities online grocery shopping can provide the market potential is all too evident. Technology developments, including faster broadband speeds and expansion into mobile devices, as well as the maturation of a generation that has grown up with the internet and is fully web-savvy are progressively broadening the customer base interested in online grocery options. As a result, this escalator effect on demand means that it is viewed as a channel where growth will naturally be achieved (Melis, 2016). Therefore, online groceries represents a highly attractive market to move into with large volumes, regular shopping patterns and market growth acting as the lure.

However, while the demand for online grocery provision is clear it remains one of the toughest types of online retail businesses to master, especially from a supply chain and logistics perspective. One by one, notably in the early days of the e-Business boom just after the turn of the century, many of the 'pure-play', online grocery logistics start-ups, such as Webvan, Peapod and Home Grocer, disappeared after going bankrupt (Delaney-Klinger et al, 2003). Established grocery retailers too have struggled ever since to adapt. Their online grocery logistics supply models have been characterised for the most part as being quite short-term, relatively in-efficient options aimed at fulfilling a growing, but low volume initial need. As a result, their logistics solutions, based around in-storepicking including so-called dark stores, have been seen as largely a defensive move. They have been labelled as strategies aimed at not being out of step with competitors and fulfilling a customer need, but, as the online business cannibalises the traditional store business and is questionable in terms of its operating profitability, a channel not to overly push. Indeed, over two years to 2016 most of the UK multiples have overseen small declines in their online grocery sales (IGD, 2016).

The core question posed initially at the time of those early bankruptcies, and still very pertinent today is, given all the operational and logistics challenges inherent in online groceries provision, is it possible to set up and operate a successful, profitable, online grocery business? This paper focuses on examining this. After a structured review of the principal challenges, it uses a case study methodology to look in depth at how a leading online grocery leader in the UK, Ocado, has sought to conquer the operational and logistics challenges that are typically found in the online grocery business. It is proposed that Ocado can act as an exemplar in that it provides a practical illustration of how

innovative answers to the key operational and logistical challenges faced in each phase of online grocery retailing (ordering, fulfilment and delivery) are being addressed with viable solutions.

Market Overview

The two world markets leading the way in the online grocery sector, where online grocery is strongest in terms of the proportion of grocery shopping bought online, are South Korea and the UK. However, the two markets are quite different in character. In South Korea, the world's largest online groceries market, (19.7% of FMCG sales in 2016 were through e-Commerce (McKevitt, 2017)), online groceries is growing quickly. In the first three months of 2017, fresh produce sales through online shopping grew by 35.6% compared to 2016, driven by an aggressive expansion of fresh foods and intense competition leading to shorter delivery times (Retail Asia, 2017). Leading companies such as Hello Nature, Baemin Fresh and additional e-Commerce sites expanding into online groceries from other areas, such as Ticket Monster and WeMakePrice, are ensuring the pace of innovation is driving the market forward in the country. Notably many are targeting smaller households with ultra-fresh ingredients, often made in the morning to be delivered later the same day.

In the UK, the online grocery market can be characterised quite differently. For instance, the average spend per shop is higher at $83.40, the largest in the world, four times more than the average offline spend (in South Korea it is only twice as high) (McKevitt, 2017). The growth level is steadier too. In market share terms, online grocery spending has been gradually rising though reaching 7.3% in 2016, doubling the percentage share attained in 2010. This measured growth is having a compound effect. From 2017 to 2022, the UK online grocery market is expected to grow by 54 percent in the UK to £16 billion compared to an overall market forecast growth rate of 15.4% for the same period (IGD, 2017). This growth is being driven partly by the increasing frequency of online shops: in 2016 on average UK grocery shoppers used online 15.4 times a year compared to 14.1 in 2015 (McKevitt, 2017).

Other notable online grocery markets are France, Taiwan and China where the share of the total grocery markets all exceeded 4.0% by 2016. There is a different picture in other developed countries, with Spain, the Netherlands and the USA all having an e-Commerce share of the total grocery market of below 1.7% in 2016 (McKevitt, 2017) (The Amazon/Whole Foods deal may well re-catalyze interest in grocery channel shift in the US). Therefore, the UK market provides a leading example to investigate how the supply challenges in online groceries, which have been identified in the academic literature and practice and are seemingly stifling market growth in many countries, can be overcome.

Literature Review

Grocery retailing is unlike many other forms of retailing due to one notable factor: customers invariably purchase by the basket, not in single items. Therefore, grocery retailers have justified their worth in the chain of supply as a viable intermediary as they act, through their supermarket concept, to improve the efficiency of the exchange process, providing time, place and possession utilities (Alderson, 1954). Rather than customers having to move from one purveyor to another for the assortment of goods they seek, a more convenient solution is provided with all the grocery goods the customer requires supplied in one place. As a result, despite the theatre of selling, grocery retailers are fundamentally logistics companies at heart, whose role is to assemble an authoritative range of choice from a myriad of suppliers for the convenience of the customer.

In most world markets, grocery retailing is seen as being a very competitive aspect of business to operate within, so is characterised by a high degree of innovation and change. Today's landscape is no exception to this rule with modern grocery retail logistics continuing to go through a period of profound transition. One feature of this has been the emergence this century of the online grocery retailer, who is able to supply, through a new channel direct to the customer, providing the customer with potentially enhanced value compared to the conventional supply route through stores.

What do Customers value?

Customers perceive value through many means. Value metrics they deploy include money, time, convenience and so on. Shopping online has the potential to offer improved value across many of these dimensions. Online shopping means it is easier to compare prices, so the focus on price is an ever-present, it can save the time and perhaps fuel the customer would have spent travelling to and from the supermarket and can offer more convenience in terms of searching, payment and the delivery operations the customer has traditionally undertaken themselves. So with customers looking for an enhanced experience in completing what for many is a routine undertaking, in shopping for groceries, online grocery provision is potentially an attractive option to consider and try out.

However, while the initial allure to try online grocery shopping is evident, customer expectations for this potential value enhancement to be realised are high and their loyalty fickle. If the customer feels their expectations are not being fulfilled they will invariably switch to another supplier of online groceries or back to the conventional route of shopping at the store itself. This high expectation is not is not just in the ordering and delivery experience. Meyer and Schwager (2007) assert that the customer demands a consistently high experience across all touch points – if a grocery retailer cannot provide these, they will move elsewhere. The holistic experience of low price, easy searching, ordering, delivering and returning all need to be simple and convenient to complete time after time, as grocery shopping is a frequently repeated activity. In addition, the story of customer value in this sector does not end there. This is an era of profound change and customers' perceptions of value are continuing to evolve. Quicker, sooner, faster and freer is the mantra and supply innovations that enhance the holistic value offering can become order-winning criteria relatively quickly.

Why the Online Groceries Supply Challenge is Immense?

Grocery retailing in general is characterised by hyper-competition which leads to very tight operating margins of 1-2 per cent being the norm in most markets (Boyer et al., 2003). Operating parameters are challenging. Retailers must logistically manage wide catalogues, highly perishable products, with low value to sales ratio, differing temperature regimes (chilled, frozen and ambient), widely varying customer tastes, a customer fixation on price and a need to minimise food waste.

Online grocery needs to successfully manage all these operating parameters and deal with the requirement of multiple item order fulfilment. In most e-Commerce retail markets, such as in clothing or small packaged goods, like books or household durables, orders are placed in singles or at most what can be described as small orders. In groceries, the number of items ordered at any one time is, on average, significantly higher. In addition, as we noted above, online grocery ordering invariably inflates the order size compared to in-store ordering. The online grocery retailer must be able to cope with accurately picking, assembling and delivering multiple item orders with excellent

availability levels and first-class product quality rates on a frequent basis. There are also substantial costs associated with extending the supply chain to the customer's home or chosen place of delivery. A paradox is evident here. The extra costs involved do not seem to fit with the objective of providing competitive pricing in a really price sensitive industry. Another challenge of online groceries is delivering the order on time. Moreover, the speed of delivery requirement appears to becoming a more significant factor.

In summary, online groceries, despite being an attractive market to serve, is an immensely challenging market to supply effectively and profitably. Vanelslander, et al. (2013) summarise this: "Although e-commerce has been growing rapidly as a sales channel for the past decade, reaching and maintaining profitability has sometimes proven difficult. This is especially true for the segment of the sales of online grocery items". As a result, it is not surprising that many early pure-players went out of business and others are losing money and not incentivising it (despite often claiming to be making a profit). The properties of grocery products mean that online selling is extremely complicated (Kornum and Bjerre, 2005). Collective wisdom did seem to suggest that it was not possible to make it work. However, one pure-play online grocer from the UK, Ocado, stands-out as overcoming these obstacles and is building a profitable business. What strategies have they adopted to make the online grocery business work for them? Others hoping to develop viable businesses in the markets they serve around the world can learn from their experience.

Method

This paper focuses in on the supply chain logistics challenges of the online grocery channel using a case study methodology. Taking the UK leading pure-play, online grocery leader, Ocado, as an exemplar it examines how innovative viable solutions to the key logistical challenges faced in each phase of online grocery retailing, ordering, fulfilment and delivery, are being developed.

A semi-ethnographic research methodology has been adopted. As a foundation, many secondary data sources have been accessed including the Ocado website, the company financial reports and associated press statements made by the company. In addition to becoming familiar with existing secondary data sources in the online grocery sector, primary field-based research has been undertaken with Ocado over a period of two years. This has involved site visits, invited business presentations, interviews and discussions and co-sponsored research projects. Underpinning this series of activities, a research relationship has been built up between the researcher's institution and key players and senior managers at Ocado. In addition, the research has been supported by first hand sampling of ordering and receiving of deliveries over a four-year period.

This has meant a degree of emersion in the area of research being achieved. The research has been undertaken with the organisation over an extended period, which has provided unrivalled access into how the organisation functions and operates and this has helped to unlock new insight. Tracking the logistical flow of the supply chain from customer order, through picking to distribution and delivery and the practices that are carried out by those who are managing and operating the processes has meant that a robust understanding of the logistics system has been developed. Three core areas of activity, the ordering, picking and delivery processes, have been used to focus the research.

Findings

Online grocery retailers have adopted various logistics models to serve their customers. Vanelslander, et al. (2013) identified three:

pure-play van delivery: a central fulfilment centre is used to pick customer orders where direct deliveries are made to customers – the model adopted by Ocado;

pure-player – parcel delivery: a parcel carrier is used to undertake the delivery to customers;

click and mortar solution: usually established conventional retailers combine their store and online service models picking online orders at store locations or nearby special dark stores and then offering click and collect services as well as dedicated home deliveries. This is a topical area of recent research focus that has addressed the challenges retailers are encountering moving from Multi-channel to Omni-channel operations for instance. (e.g. Kozlenkova et al, 2015).

To this list, other models can be added such as the crowd sharing facilitator model offered by Instacart in the US. Here, inventory lists are streamed from local stores via an app and online made orders via the app are picked and delivered by shoppers, who have time on their hands and are keen to make a little extra money (Instacart.com, 2017).

Vanelslander, et al. (2013) conclude that the 'pure-play van delivery' model, used by Ocado, has very high initial investment costs (Tanskanen et al., 2002) and challenges around delivery as the customers are located a long way away from the central distribution centre, but has the advantage of a high service level and low risk of stock-outs. Certainly, building an infrastructure to start proved to be the downfall for others, but Ocado have seemingly conquered this challenge now and have developed, as we will discuss, an ingenious delivery model to overcome the higher delivery costs associated with this model.

The Ocado model essentially results in the disintermediation of a number of the conventional stages of the supply chain. Traditionally, manufacturers would supply grocery products to retailers who, through their distribution centre networks, would move goods onto their stores for selling. Customers would travel to stores to select and pay for their goods and transport them back to their homes. In the Ocado model, a more direct operation is used. Manufacturers supply a fulfilment centre where customer orders are received and picked, and the customer's basket of goods are transferred direct to the customer. Thus, the conventional distribution centre and store legs in the supply chain are removed and the need for the customer to travel back and forth to the store is made redundant along with their efforts that had previously been required to undertake to select, pick and pay for their goods. In their place an online ordering facility backed up by a fulfilment centre with a direct delivery operation are added to the chain of supply.

The model, in effect, provides a transfer of responsibility from the customer to the provider of certain supply chain activities giving valuable 'D' time for Ocado to work with. The 'D' time is the delivery lead-time: what the customer or market requires for delivery (how long is tolerated between dispatching an order and receiving the product/service ordered). The 'D' time represents one half of what is known as the P:D ratio, developed by Shingo (1980) as a fundamental way of determining where the location of the decoupling point (the key stock holding point) in a supply

chain can be. The 'P' is a measure of the production lead-time: how long it takes from the customer sending the order to the customer receiving the finished product or service ordered, which is under the control of production/logistics provider – in this case Ocado. By working out the ratio between two independent variables, P and D, supplying organisations can assess where their decoupling point should be: if P is greater than D then the decoupling point needs to be moved nearer to the customer; if D is greater than P then the decoupling point can be moved away from the customer. For Ocado the customer gives time for the order to be picked and delivered: this may be a few hours for a delivery location close to the fulfilment centre or the next day when the distance is greater. This 'D' time is a crucial opening window of time giving room for the Ocado model to operate within. What is critical is that Ocado has the operational and logistics capability to ensure the 'P' element works effectively every single time: i.e. the customer order is fulfilled and delivered on time and in full every time it is called upon.

Ocado's online grocery operations and logistics model can be broken down into three processes: - Ordering - the provision of grocery catalogue which customers can order from;

Basket Picking – the selection and amalgamation of ordered lines, and organisation for shipment to customers;

Delivery – the transportation of the ordered and picked basket of products to the customers' homes or chosen pick up points.

To make online grocery logistics work all three processes need to be well-controlled for the whole logistics system to be effectively provided. Ocado's solutions for each will be appraised briefly below:

Order Placement

The process of making catalogues available for ordering is a key activity in online grocery logistics. Behind this, the process for making lines available for picking (forecasting, supplier ordering, stocking, maintaining shelves etc.) are all vital support activities. The actual process of customer ordering needs to be easy and convenient. For customers there is invariably a combination of planned and impulse purchases and many online retailers are developing and trialling innovations in this area, such as using QR codes in brochures, Amazon's 'Dash' buttons, or fridge cameras.

Ocado have worked hard to ensure their ordering process is simple, easy, fast and convenient to use. Ordering online, even on a mobile device, with confidence generates loyalty and the benefits then multiply as customers familiarise themselves with the ordering systems. Ordering with minimum clicks and simple timesaving devices such as Ocado's repeat ordering options, predictive shops and the checkout walk make the ordering more convenient and easier to navigate.

A key differentiating point is the size of catalogue Ocado can afford to offer its customers. With essentially only two stocking points at its the mature fulfilment centres at Hatfield in North London and Dordon, near Birmingham, it is feasible to run an extensive range of around 47,000 lines to satisfy niche areas of potential demand. These include world food ranges associated with 17 different countries as well as ranges to suit certain dietary requirements. At a time when the leading UK supermarkets (20-30,000 lines typically) are rationalising their ranges in response to the discounters' ultra-tailored catalogues of approximately 1,500 lines this differentiator is becoming an even more significant component of Ocado's competitive advantage strategy as time moves on.

Finally, the means of payment needs to be clear, safe and efficient. Two models prevail, both used by Ocado – a subscription model (Smart Pass) and pay per-order model where the customer pays for each delivery. A subscription incentivises smaller and more frequent online orders, which has the benefit for customers in lowering grocery costs, if well used, and for retailers encouraging repeat ordering and loyalty. The greater the customer density, lowering extra costs associated with more frequent deliveries, is an important factor in making it worthwhile for the supplying retailer to provide subscriptions (Belavina, et al., 2016).

Picking Process

As discussed above what really differentiates the Ocado model compared to its competitors in the UK is the way orders are picked. While many of the others are multi-channel players, operating a store base as well as an online channel, and have thus chosen to do trolley picks in stores, and more lately as volumes have increased using what are called dark stores, Ocado, as a pure-play online provider, uses purpose built fulfilment centres for its order picking supported by its own in-house technology experts. Here the pick rates are immensely more efficient and effective than the alternative operations used by most of its competitors. With groceries shopping characterised by multiple item basket ordering this is an enormous advantage for Ocado. It also means smaller inventory holding costs and spin off implications such as lower food waste levels, as inventory is held in fewer locations. The central fulfilment centre model is still very unusual though due to the primary drawback of the considerable up-front investment costs involved. However, over time this erodes. Therefore, although store based picking can work, and it may have represented a good way to enter the market, it is not sustainable way to compete in terms of efficiency and effectiveness.

Ocado have been helped by two significant horizontal collaborations, which have helped it generate scale. The first was with Waitrose, where Ocado initially were the sole provider of their online offer. Although this agreement has expired and Waitrose now provide their own online channel, the Waitrose catalogue is still available through the Ocado online channel, which has been helpful in attracting a more affluent customer base who are more likely to place larger orders and appreciate the timesaving. The second tie-up was with Morrison's who were late to move to provide an online offer and hence saw a partnership with Ocado as a quick means for their ambition to catch up with their competitors in the online market place. The mooted deal with Marks and Spencer could provide even more size economies. As online volume grows, more fulfilment centres in the UK are planned (Erith, London is due to open in 2018) and Ocado are experimenting with a smaller scale option, which involves less up-front investment costs, at Andover in the South of England currently.

Delivery Operations

Arguably, delivery is the most challenging aspect of the direct model. There is what has been called the last mile problem, but there is also the miles before this too. JIT and J4U delivery is not cheap. The larger the fulfilment centre is the more extended the delivery area is too. In addition, the demand pattern for groceries is not even, skewed to Friday and Saturday with seasonal peaks and troughs too. With deliveries required at a precise time and van fill rates crucial to ensure efficiencies the delivery aspect of the model is a challenge to plan and execute efficiently yet effectively day in day out to make the Ocado online model work.

The core of the solution that Ocado have developed is the hub and spoke delivery model. Deliveries local to the main fulfilment centres can be delivered direct, but for customers further away delivery is first made to a hub point, which are each optimally located around the UK. For a delivery to an address in Cardiff, the order, which is picked in Dordon (Birmingham), is shipped first to the Bristol hub before completing its journey to the customer's assigned delivery point by the delivery van.

Routing software with built in knowledge of time/distance and up to date traffic information is combined with experiential knowledge of the typical time it takes to deliver to on route customers so that Ocado are able to hit the promised one-hour delivery window with 95% accuracy. Goods are delivered in carrier bags packed in totes, which work as a circular economy of packaging: the totes are returned and even the carrier bags from the previous shop are taken back to reduce the net carrier bag charge cost, with used bags being melted down to make new ones. Customer density matters and in this respect Ocado has been helped significantly by the demographics of the UK. Like South Korea, the UK is a fairly urbanised population today with a high concentration of its populace living in the south of the country, close to main transport arteries such as the motorway network.

Creating a Market and Operations orientation

What has won out for Ocado is a business model built around fulfilment centres but based on process optimisation. Ocado has shown that if you get the customer experience right this leads to success. On the marketing side Ocado have a clear customer proposition. Prices match Tesco.com, they provide a date-life guarantee, and promise a 1-hour delivery window with 95% on time delivery, full temperature integrity for temperature controlled products and an extensive range to choose from. On the operations side Ocado have worked hard to create an 'Operations Excellence' culture with quality, cost, delivery, employee safety and morale as key focusses of attention. "Failures associated with mis-match between marketing and operations strategies" (Boyer et al, 2003) are avoided. What Ocado demonstrates is how a market orientation and a logistics process orientation can be successfully fused together to produce a winning business recipe. Added to this are key differentiators such as the extensive range, and freshness of the delivered product (fish caught in the North Sea can be with the customer within 30 hours). Therefore, Ocado underline the idea that poor process management is no longer acceptable if you wish to compete successfully, and getting the logistics right is a crucial ingredient in establishing a reputation for reliability. Quality logistics is consistently achieving the perfect order, fulfilled on time in full, every time with continual gains in efficiencies. To achieve this operational excellence must match the marketing promise. Ocado are showing the way on this and illustrate that the fundamental of effective competition is to get the market orientation and operational/logistics orientation completely aligned. This model is summarised in Figure 1 and underpins the Ocado approach.

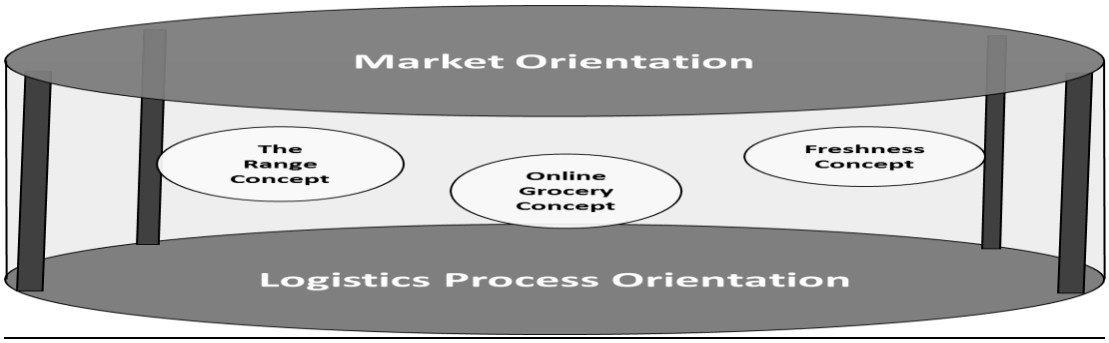


Figure 1: A Framework showing how Ocado's Business Model has differentiating concepts supported by the foundation of well-developed Market and Logistics Process Orientations

Conclusion

There has been scepticism whether the pure-play online grocery system can be made to work: "the biggest challenge remains resolving the tension between what connected consumers want and how retailers can deliver this profitably" (McKevitt, 2017). This paper has been concerned with how a leading company focused on online grocery logistics is attempting to understand and optimise performance within the channel. Ocado has proved, with sales of over £1.2 billion and a small operating profit of 14.5 million in 2016, that this model can be cracked and a strong business can be created. Operating methods involved in ordering, picking and delivery have been further designed and refined and are considerably different from the early days, with Ocado hitting impressive key measure operating targets regularly. Its two mature fulfilment centres are now between them handling over 350,000 orders a week and generating alone close to 10% of revenue to profit and Ocado in their retail business continue to grow strongly ahead of the online market (Ocado**, 2017).

Online grocery shopping is in its early days and it will be a hotly contested area. Amazon's arrival will be a wake-up call for all. Future questions include, can Ocado's first mover advantage be copied, what operating model will new entrants adopt, how will the traditional retailers respond, how will the offering landscapes found in other countries impact on the way online groceries evolves, will Ocado be able to sell their and scale up their operation in the UK and can the Ocado solution be offered as a viable business in other locations? One change is beginning to occur. Faster deliveries, even down to an hour from order placement, are beginning to emerge in large urban areas. So, will the online grocery market fragment into small quick orders and larger bulk shopping orders? Will Ocado's model be able to cope with this? The conclusion form this research is that Ocado will be a tough act to dislodge in the UK online grocery market place and that many lessons can be learnt from how Ocado has developed.

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Shared Logistics Models in Urban Distribution of Food Products

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Abstract Purpose:

Due to increased urbanisation, more people live in cities. For example, around 80% of the population is estimated to live in urban areas in Europe by 2020 (EEA, 2010). Therefore, there is an increased demand for items in urban areas and above all, more food products need to be transported to and distributed within cities. Consumers' needs are not the same and a differentiation is required among the provided services; such as a wide variety of products with different quality and prices and alternative options for the last mile delivery: Home Delivery or Click & Collect services. The new services are challenging the traditional methods of distribution and lead to an unsustainable business model in terms of increased operational costs, carbon emissions, traffic, and noise. The aim of this work is to identify situations in which different parties of the market (i.e. farmers, producers, thirdparty logistics providers, haulage companies, and retailers) could collaborate in the distribution of food in urban areas achieving a sustainable logistics model. Firstly, we investigate the current market structure and analyse the operations focusing on food distribution in urban areas and how retailers are fulfilling orders. Then, we propose new process models for food distribution in which our main objective is to optimize economic, environmental, social costs whilst maintaining service levels. One way of achieving this is using shared logistics models and shared facilities which involve collaboration only in the logistics activities by pooling demand of multiple firms. Under this approach, we can achieve a reduction of the volatility of demand, minimise the empty runs and improve fleet utilisation.

Research Approach:

We evaluate our proposed shared logistics models via simulation and by solving different variations of the vehicle routing problem for the operations of daily supply to warehouses aiming to satisfy customers' demand using: i) primary data from a major UK online retailer, ii) secondary data published by online retailers, and iii) data from a survey about customers' preferences for groceries purchased online.

Findings and Originality:

We develop the following three collaborative models for the grocery market: i) shared vehicles for the last mile, ii) shared vehicles for the stem mile, iii) and shared collection points. For these models, there are specific constraints and realistic assumptions that retailers face every day. We focus on including appropriate incentives for these supply chain members aiming to move from independent logistics models to collaborative models. We show that the reduction in the total travelled distance for the case of shared collection points is on average 8% when two retailers with comparable market shares collaborate. The benefits are more significant for the case of the last mile, but the results for the first model are currently under development. Our results are based on real market data.

Research Impact:

Through our comparative analysis between the existing situation and the proposed collaborative one, it is possible to quantify the collaboration benefits not only in terms of economic aspects, but for environmental, and social aspects, too. A limitation of our work is that we use the existing network of distribution centres without proposing any structural changes at tactical level, but only at operational level. Future research could define the ideal locations for shared facilities either distribution centres or collection points, and could to examine the impact of the application of a Collaborative Planning, Forecasting and Replenishment system in these operations.

Practical Impact:

Retailers can use our proposed collaborative models to reduce their operational and environmental costs whilst maintaining service levels.

Keywords:

Online food retail, Shared logistics, Collaboration, Sustainability

Introduction

In supply chains the distribution capability has an important role because it determines how effectively the whole chain is designed; especially, in the grocery supply chains where the retailers work in an uncertain environment and must cope with fast changing market demands. The retailers have to ensure that the right products are in the right place at the right time to meet the final demand (Eng, 2016). Moreover, retailers should be flexible to follow the customers' trends and preferences, while improving the services that they provide to their customers; an important factor if they want to keep and raise their market share. Nowadays, the distribution capability is more crucial than ever, as there is a trend of urbanisation and more items must be transported to and distributed within urban areas, making the problem of finding the optimal routing more complex. The complexity raises both the economic and the environmental cost because it is almost impossible to determine the optimal solution in a very short period of time as the retailers have to act immediately and satisfy their demand. Sometimes the time framework of retailers' reaction is less than one day. Therefore, many academics and practitioners try to optimize the distribution systems proposing more sustainable solutions that raise the efficiency of these systems.

In this work, we focus on the grocery retail sector in the UK and especially in the online groceries. The grocery retail sector in the UK is very competitive, as six major retailers (Tesco, Sainsbury's, Asda, Waitrose, Ocado, and Morrison's) possess around 80% of the whole market. According to the IGD (2017) the total grocery sales in the UK in 2016 are worth £179.1 billion and are corresponding to the 50.2% of the total retail sales. During the last years, there is a growth in the grocery market, making this industry of groceries the biggest sector in the retail market (IGD, 2015). In the retail market, there are many predictions that highlight the online services and that the online markets would dominate the retail sector in the next few years, while the online shops would harm the traditional retailer shops (Doherty and Ellis-Chadwick, 2010). The latter is the major reason that we focus and examine the online market in the UK grocery sector. The sales in the online UK grocery market accounted more than £9.9 billion in 2016 (Mintel, 2017) and it is estimated to reach £17 billion by 2021 and to be around 10% of the whole grocery market (Figure 1). The reason for selecting the online UK grocery market is that this market is the second biggest online market in the world (in terms of size) after the Chinese online grocery market (IGD, 2016).

The grocery retailers under their attempt to raise their customer base and their market share, they offer online services and enter to the new online market. Of course, the retailers' objective remains to develop efficient business models to raise their market share without compromising their profitability (Murfitt, 2014). On the other side, consumers always ask for more and better services. Especially, in the case of the time pressured consumers, it is important to be able to buy groceries online and seek services to receive the groceries at their homes or at locations that are more convenient than visiting a traditional grocery shop. Therefore, the online consumer would like to use the retailers' web platforms to order their groceries and nowadays it is a common way of buying groceries. This means that the online retailers have to provide non-core services of distribution and logistics, which raise their cost. The existing situation in the UK is the following: the online retailers provide home delivery and click & collect services as possible ways to deliver the groceries' orders of their customers. These new services; i.e. home delivery and click & collect present major logistics challenges to the online retailers in the grocery market including economic and environmental conundrums.

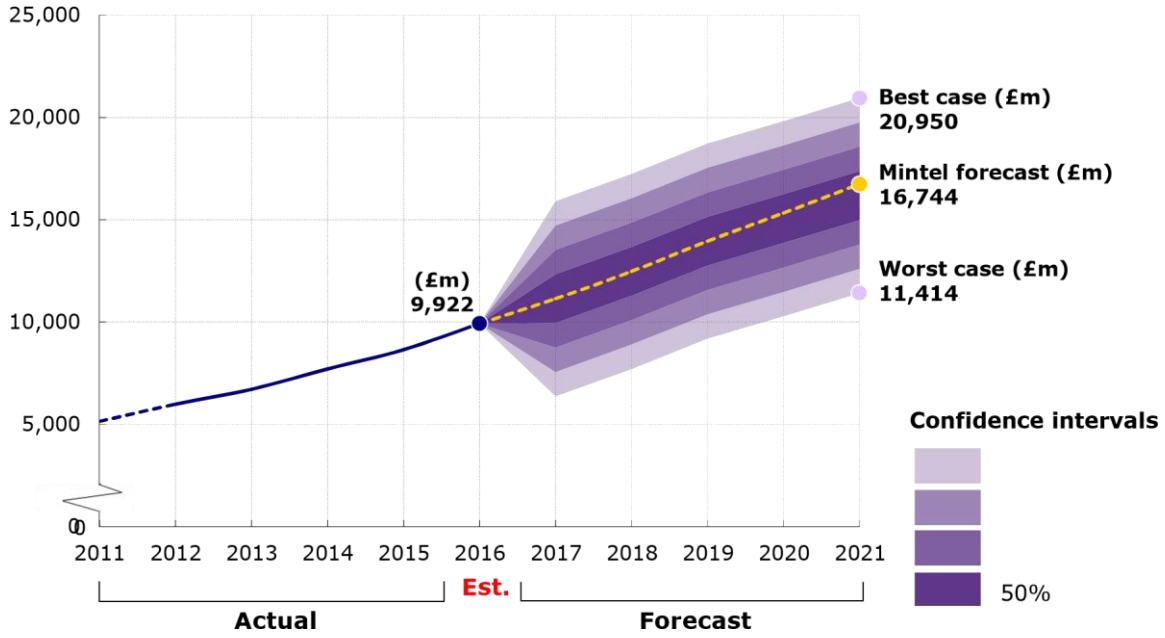


Figure 1 The past and the future of the sales in the online UK grocery market

The distribution model which is used in the online UK grocery market is totally competitive, without any kind of collaboration in distribution among the retailers. Customers are free to decide from which online retailer will buy their groceries. So, on some days some retailers have to serve (i.e. to visit) customers who live at nearby neighbourhoods at the same time. From a holistic perspective, this means that there are overlapping areas during the daily routing of the retailers' vehicles to meet the online demand. These overlapping routings increase the total transportation cost, decreasing the capacity utilization of vehicles while negatively affecting both the society (through traffic congestion, accident fatalities, noise pollution, etc.) and the environment (through carbon and NOx

emissions). The ideal scenario would be to propose and use a model that eliminates these overlapping routings, increasing the vehicle utilisation whilst adhering to customer service levels.

Proposed Model

A way to eliminate overlapping routings is the retailers to participate in a joint model where all of them will work as a team and all the decisions about the food distribution will be made by the team. Therefore, in this section, we develop and propose a shared logistics model that includes both economic and environmental incentives for the online retailers to collaborate with their competitors in the food distribution. Collaboration of retailers in logistics activities does not mean that competition is over as it continues in other aspects of the business.

It is important the retailers participate voluntarily and share their information with the rest because it is in their self-interest. The grocery retail sector is a free market, so any proposed model that constrains the retailers' freedom is not a realistic one and could never be applied. Thus, our proposed idea is to reach a more efficient solution for all the participants (this means a better solution in global terms). The next step in our approach is to apportion the additional benefits to the retailers in a way that all of them will receive a better pay-off compared to the existing model. This could be possible under the improvement in the global level (first step).

In the U-TURN project (http://www.u-turn-project.eu/), we propose the idea that the retailers satisfy their online grocery delivery demand via micro hubs and we develop three different business models, two for home deliveries and one for click & collect services (U-TURN, 2017). The proposed business models are:

Shared micro hubs with focus on shared last mile delivery from these micro hubs to the consumers' houses (home deliveries services).

Shared trucks and routings from retailer picking locations to shared micro hubs (home deliveries services).

Shared micro hubs with focus on space for consumers to collect their online orders (click & collect services).

We simplify the online grocery market in the UK to the following three elements (Figure 2): a) picking locations of retailers; these could be stores, dark stores, hubs and dedicated online fulfilment centres), b) micro hubs located near consumers; these facilities can be used by two or more retailers, and c) consumers' locations; i.e. specific addresses with a UK post code as the destination.



Figure 2 Online grocery flows

The main responsibilities of a micro hub will be: i) to organise the schedule and to meet the consumers' demand; i.e. when (time preference) and how (home delivery or click &collect services) the consumers will collect their orders,

and ii) to keep the orders under the required conditions, i.e. temperature restrictions for chilled and frozen products until the consumer collects his or her order.

In this work, we focus and present only the third model that is related with the click & collect services. In this case, the micro hub is a 'click & collect' point. All the online retailers transport their orders to the common micro hub by a shared fleet which collect the orders from the retailers' picking locations. Then, the consumer collects his orders from the shared micro hub in a predefined time window. The collaboration focuses both on the common fleet and on the space shared by retailers while their customers use the micro hub as a click & collect point.

In our proposed model, we assume that there are four time intervals for the customers to choose when they decide to use click & collect services. The customers have to select among the following time windows: A) 8:00-11:59, B) 12:00-15:59, C) 16:00-19:59 and D) 20:00-23:59 to collect their orders. The service fee depends on the preferable time window and of course the demand among them is not the same. Based on the primary data set and a survey which ran for the U-TURN project, we conclude to generate the demand for the click & collect model using the following ratios: 19.7% for the time window A, 20.6% for the time window B, 36.8% for the time window C and 22.8% for the last time window D. The results are reported based on the above four choices and we make observations among the different demand rates.

In our proposed model, we calculate the 12 key performance indicators (KPIs), first under the case that the online retailers work independently (the As-Is situation) and then when they collaborate under the proposed shared logistics model and finally compare the KPIs. Through the comparison between the As-Is and the To-Be situation, we evaluate the performance of our model and measure the economic and the environmental impact. The 12 KPIs in the U-TURN project are the following:

The total distance that must be covered (optimisation objective),

The average distance per route,

The average distance per order,

The maximum number of routes required to satisfy the demand,

The average number of served hubs per route,

The total driving time for the whole fleet,

The average driving time per route,

The total drop-off time for the whole fleet,

The average drop-off time per route,

The total time (i.e. driving time plus the drop-off time) for the whole fleet,

The average time per route,

The utilization of fleet at the starting point (i.e. at the picking location).

Analysis

We have exclusive data from a major retailer who offers online grocery services in the UK. The data includes: the total number of deliveries, the indexed numbers by postcode, the postcode of the fulfilment location which served the specific order (i.e. postcode), the percentage of orders delivered by hour by day, the percentage of orders checked out by hour by day, the average number of deliveries for postcode, the average order weight for postcode, and the average order volume for postcode. Due to reasons of confidentiality, the data was aggregated over a year and anonymised. The data set concerning 346,745 online orders on a specific area of the northwest London from 1st June 2014 to 31st May 2015. From the analysis of the data, we present the distribution of aggregate consumer demand over time in Figure 3 (U-TURN, 2017).

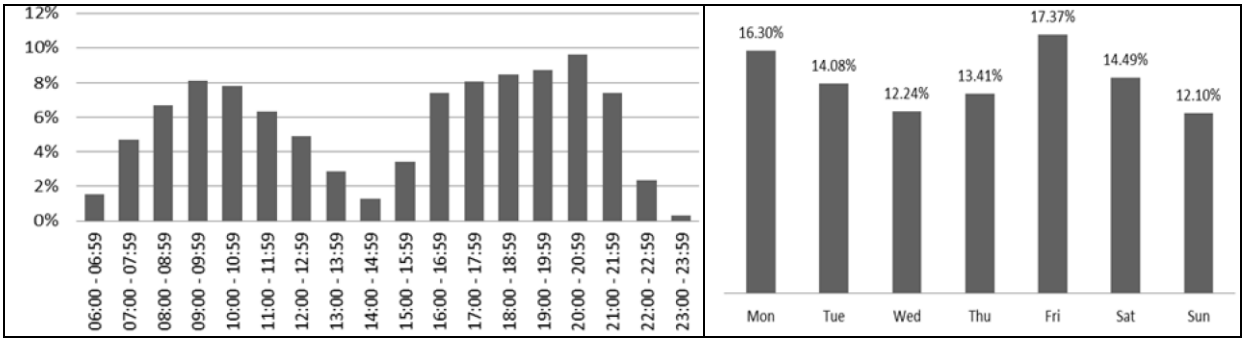


Figure 3 Demand distribution of groceries purchased online, Source: U-TURN, 2017

As a remedy to the lack of another set of primary data from a different retailer, we develop a methodology to generate secondary data for online grocery demand for the six major UK retailers (Tesco, Sainsbury's, Asda, Waitrose, Ocado, and Morrison's). To measure the benefits from collaboration in the online grocery market which arise via our proposed model, we intend to use the generated demand and all the calculations will be on the generated demand. We evaluate the accuracy of our approach (i.e. generation of annual demand for home deliveries) based on the available primary data set which obtain (for more details, U-TURN, 2017). We summarize the main steps of data generation methodology for the online grocery market as follows:

Establish the overall UK online grocery market size.

Define the individual market shares of the six major UK retailers.

Adjust the online grocery sales based on the areas served by each retailer and the UK population data.

Calculate the average online orders per capita by postcode sector for each retailer.

Adjust the demand by postcode sector by retailer using the retailer's store footprint.

Calculate the total number of online grocery orders.

Apply a seasonality profile to total online demand per year to derive daily orders (Figure 3).

Estimate the demand for six major retailers.

Based on the primary data set, we restrict our attention only to the postcode sectors where the demand is high (at least 30 postcodes served within the sector) to fit a theoretical probability distribution. It is assumed that each postcode sector is a drop zone served by a single micro hub. In the UK, there are 12,381 postcode sectors where a postcode sector is 18.78 square kilometres and had 6,979 residents on average in 2011 (ONS, 2011). In our primary data set, there are 266 postcode sectors out of 533 with at least 30 observations for which the aggregated number of orders are reported. Then, we test the following seven theoretical probability distributions: Cauchy, Exponential, Gamma, Logistic, Lognormal, Normal, and Weibull, assess the goodness of fit, choose the distribution and finally estimate the parameters with the minimum Akaike Information Criterion for each postcode sector. The analysis has been done in R. The distribution of the online demand is Lognormal in 256 (out of 266; i.e. 96%) of all postcode sectors, while the demand in the remaining sectors follows the Exponential distribution.

To calculate the 12 KPIs, we use the following five model parameters:

The average speed to be 20km/h.

The average time to drop per location to be 20 minutes.

The average time per order to be 2 minutes.

The shift length per route to be 480 minutes.

The average loading time per route at picking location to be 30 minutes.

Results

We assume an example of only two retailers with comparable market shares to Morrison's and Ocado will decide to collaborate via our proposed model (To-Be situation) to evaluate our approach. The estimation of the number of annual online orders for these two retailers based on our generated demand is around 13.3M, possessing 16% of the total online market. Based on the primary set, we assume that both retailers operate two picking locations with different capacities to serve the consumers who live in London. We assume that every postcode sector is served by a single picking location and under this assumption, the first picking location serves 199 sectors and the remaining sectors are served by the second picking location. So, a rough estimation about the capacity of the two picking locations is that the first one is three times bigger compared to the second one. In this work, we do not propose any modifications to retailers' network, since it is too costly for retailers to change their existing distribution network (Cachon, 2014). Therefore, we assume that the picking locations are fixed.

First, we examine the existing situation and estimate the KPIs for the case that both retailers work in on individual basis. Then, we estimate the same 12 KPIs under the proposed shared model in our scenario where the two retailers work as a single team and make the comparisons. The benefits of the collaboration will be quantified based on all the proposed KPIs. All the calculations have been done under the assumption of the specific values of the five model parameters, as we describe in the previous section.

We examine two vehicle capacities of 15 and 20 orders for two picking locations with different capacities. The available time windows are: A) 8:00-11:59, B) 12:00-15:59, C) 16:00-19:59 and D) 20:00-23:59 when the consumer could collect their groceries from the shared click & collect point. The vehicle capacity is the maximum numbers of orders that can be delivered per vehicle per route. Table 1 and Table 2 present the summary of benefits that arise from the collaboration on the first and the second picking location, respectively.

Table 1: Benefits when two retailers collaborate via the first picking location

Capacity	C15				C20				Mean
Time window	A	B	C	D	A	B	C	D	
Distance (↓)	6.6%	7.3%	8.6%	6.6%	9.0%	9.1%	10.5%	9.1%	8.3%
Distance/route (↓)	11.8%	11.2%	9.2%	11.6%	12.2%	13.2%	12.2%	12.6%	11.7%
Distance/order (↓)	6.6%	7.3%	8.6%	6.6%	9.0%	9.1%	10.5%	9.1%	8.3%
Routes (max) (↓)	4.9%	2.4%	-1.3%	2.1%	-3.5%	0.0%	1.7%	2.8%	1.1%
Stops/route (↓)	26.1%	25.7%	31.8%	28.0%	24.5%	25.9%	32.6%	26.8%	27.7%
Driving Time (↓)	6.6%	7.3%	8.6%	6.6%	9.0%	9.1%	10.5%	9.1%	8.3%
Driving Time/route (↓)	11.8%	11.2%	9.2%	11.6%	12.2%	13.2%	12.2%	12.6%	11.7%
Drop-off Time (↓)	16.1%	16.6%	21.1%	17.4%	16.1%	16.6%	21.1%	17.4%	17.8%
Drop-off Time/route (↓)	20.8%	20.1%	21.6%	21.9%	19.1%	20.3%	22.5%	20.6%	20.9%
Total Time (↓)	10.9%	11.4%	13.8%	11.3%	12.5%	12.7%	15.4%	13.1%	12.6%
Total Time/route (↓)	14.7%	14.0%	13.9%	15.2%	14.4%	15.1%	16.4%	15.0%	14.8%
Vehicle Capacity Utilization (↑)	-5.1%	-4.0%	-0.8%	-5.6%	-2.9%	-3.9%	-2.2%	-3.4%	-3.5%

When two retailers operate in the same area under the proposed shared scheme, it is possible to achieve a reduction in the total travelled distance which is the optimisation objective in our proposed model around 10% (8.3% on average for the first picking location and 13.8% on average for the second picking location), achieving important benefits in terms of the time reduction. Moreover, we observe that the collaborative benefits are greater when the capacity of trucks is 20 orders. This is not surprising; however, we can note that a 33% increase in the number of orders that can be fit in a van results in approximate 27% reduction in the number of micro-hubs to be visited per

route. This is a preferable result, since the vehicle is expected to maximise the time spent on deliveries rather than the time spent in transit. A comparison between the results will indicate the differences among different capacities at the picking locations. Therefore, we observe that there is a more intensive need for collaboration among the retailers when the capacity at the picking location is lower (Table 2). In fact, our literature review and interviews with stakeholders also suggest this conclusion; collaboration makes sense for postcode sectors where the drop density is low.

Table 2 Benefits when two retailers collaborate via the second picking location

Capacity	C15				C20				Mean
Time window	A	B	C	D	A	B	C	D	
Distance (↓)	13.1%	13.5%	11.5%	12.2%	15.8%	15.5%	13.8%	15.2%	13.8%
Distance/route (↓)	8.7%	8.8%	9.1%	8.6%	10.2%	9.9%	10.5%	9.0%	9.3%
Distance/order (↓)	13.1%	13.5%	11.5%	12.2%	15.8%	15.5%	13.8%	15.2%	13.8%
Routes (max) (↓)	7.7%	20.0%	4.8%	7.1%	0.0%	18.2%	6.3%	9.1%	9.1%
Stops/route (↓)	15.8%	16.7%	27.8%	18.5%	14.6%	15.7%	27.1%	15.9%	19.0%
Driving Time (↓)	13.1%	13.5%	11.5%	12.2%	15.8%	15.5%	13.8%	15.2%	13.8%
Driving Time/route (↓)	8.7%	8.8%	9.1%	8.6%	10.2%	9.9%	10.5%	9.0%	9.3%
Drop-off Time (↓)	15.0%	15.7%	20.4%	16.0%	15.0%	15.7%	20.4%	16.0%	16.8%
Drop-off Time/route (↓)	10.6%	11.1%	18.2%	12.5%	9.3%	10.1%	17.4%	9.8%	12.4%
Total Time (↓)	14.0%	14.6%	15.5%	14.0%	15.4%	15.6%	17.1%	15.6%	15.2%
Total Time/route (↓)	8.7%	8.9%	12.5%	9.7%	9.0%	9.1%	13.2%	8.6%	10.0%
Vehicle Capacity Utilization (↑)	4.9%	5.4%	2.6%	4.0%	5.5%	5.6%	3.5%	6.6%	4.8%

Conclusions

In this work, we examined the UK online grocery market and we proposed shared models to the retailers, focusing on click & collect services. Under the shared models the online retailers could improve their operational efficiency in logistics, reducing the total transport distance which is required to satisfy their demand. The direct consequences are to reduce the operational costs and obtain a more sustainable supply chain, with less traffic congestion in the urban areas and a significant reduction in the carbon emissions making the cities friendlier to live.

The evaluation of our proposed model is based on specific sustainable KPIs and our results based on these economic and environmental KPIs suggest that it is theoretically possible for the online retailers to work in a collaborative way with their competitors in the logistics activities and improve not only their profitability but to protect the environment, as well. Of course, implementation of a

shared logistic model poses many challenges due to the totally competitive structure of the retail market.

Potential extensions of our work are firstly, to define what are the ideal locations for the shared facilities and then to examine scenarios in which more than two online retailers work collaboratively to satisfy the consumers' demand for online orders.

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Global Challenges for supply chains

Investigation of the supply chain impacts and opportunities for the UK of Brexit

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Abstract:

The supply chain, trade and economic impacts of Brexit are the subject of widespread public and political debate. An analysis of the academic literature provides conflicting theories and points of view on the likely effects; it is a complex system with multiple decision pathways. The result of a trade shock on tariff and nontariff costs will likely induce changes with a hysteresis effect, the final new state being quite different from the old. Possible supply chain re-organisations arising from changes in UK trade arising from the so-called 'Rotterdam effect' may also have an economic impact which will vary by industrial segment. There is no definitive published data on the specific industry impacts. This paper reports on an attempt to correct that by creating a generic analytic of trade flows and WTO tariff structures applied to the food and automotive sectors. The modelling of the trade dynamics is based on relative tariff and non-tariff charges. The findings and limitations are developed into a proposed method by which companies can understand the impacts on their specific supply chains.

Introduction

The withdrawal of United Kingdom from European Union is expected to be a major politico-economic event with an uncertain outcome. Former Prime Minister, David Cameron warned that Brexit would be "a leap in the dark"(Cameron, David, Oral Statement to Parliament, 22nd February 2016) whereas prominent UK businessmen argued that outside EU, businesses "will be free to grow faster and expand into new markets".(http://www.telegraph.co.uk/news/2016/05/15/eu-referendum-more-than-300-business-leaders-back-abrexit/ accessed 20/05). Opinions are split on whether Brexit is going to revitalise or adversely affect the British economy in the long term but, in view of such a disruptive event, UK businesses should hedge against potential risks during and shortly after the withdrawal process to ensure their prosperity.

International trade has been connected with the nation's economic welfare (Smith, 1776) and the UK, historically being a trading nation, owes its economic success to it. Currently trade, accounts for the largest part of the British economy at 60% of GDP. EU-UK transactions are almost half of total trade with the value of imports measuring approximately GBP 291 billion and GBP 222 billion worth of exports. Although, researchers report that UK's trade volume with EU increased 172% after the creation of the European Single Market, the current trade deficit supports the argument that developed EU countries are likely to be mature economies for the UK with little growth potential (Burrage, 2014). There is a point of view that the apparent deficit is magnified by the design of large corporations' EU supply chains in what is called the 'Rotterdam effect'. This is when goods of non-EU origin enter the EU via the Netherlands at Rotterdam (or Belgium via Antwerp) and are then moved to the UK as goods in intra EU 'free circulation'. (House of Lords, 2016)

Upon leaving, the UK trade will come under WTO rules as defined in principle by two multilateral agreements, the General Agreement on Tariffs and Trade (GATT) and the General Agreement on Trade in Services (GATS). The current EU tariff schedule will be superseded by the individual schedule which the UK will be free to negotiate with WTO. GATT is a comprehensive framework concerning the trade of goods and includes detailed tariff schedules that the WTO members will impose on each specific category of product when imported from foreign counties. Non-tariff barriers are also included and cover a wide array of elements, from technical specifications and certifications to sanitary and trade-related measures. A prominent example is the Rules of Origin Agreement which basically prevents imports from third countries with a lower external tariff entering a partner country with higher tariff schedule. RoO view a product as a set of components which may be imported from and processed in different countries, thus setting the tariff of imported goods by mix of impact that each country had on the final product (WTO, https://www.wto.org/english/tratop_e/roi_e/roi_e.htm). Trade in services are covered through GATS which does not include any specific tariffs but sets out general obligations that each member has to follow when treating foreign services suppliers and market access limitations unless a bilateral agreement has taken place. Both agreement are constructed on the principle of "the Most Favoured Nation" (MFN), a practice meaning that a WTO member must treat all other members equally and restricts the ability to apply different trade barriers on each occasion. Therefore, if a country decides to lift certain limitations posed by standard WTO rules as part of a bilateral agreement between nations, it's compulsory to apply this change to every other member.

The impact of tariff and non-tariff barriers on the supply chains of specific business sectors is not yet clear and is complex to predict. Outcomes will be strongly connected with the set of new policies covering a long list of elements that forged the Brexit debate, such as trade & manufacturing, immigration, financial services, foreign investment and the internal UK market. (Woodford, 2016)

This paper reports on a research project to close that gap in understanding of the impacts and to test the potential to use trade and tariff data to provide guidance on how supply chains will need to realign. It is an attempt to provide the specific insights that have been mostly missing from published reports as well as a method for the future. The investigation has been focused into the effect on the food and automotive sectors of newly imposed regulations and tariffs according to WTO rules.

The literature on the economic theory and impact assessments

The economic literature is remarkably rich, advancing many theories and evidence on trade and economic development. A full review is available from Kotios (Kotios, 2017) and this summary highlights some of the key thinking from both economic theory and recent Brexit related publications. Papers look at both macro and micro economic factors and cover tariffs, exchange rates and structures.

Traditional theory views international trade as a mere transaction of goods, services and capital across borders. However, as the world has become increasingly connected, a more comprehensive definition is needed to cover the arising synergies. Caschilli et.al. (2015) present a framework of interdependent economic networks that characterise trade flows, such as global supply chains, international trade agreements, transnational credit and foreign direct investments including factors that facilitate trade (e.g. infrastructure) and various trade barriers.

The famous Heckshe-Ohlin model applies the classical theory of comparative advantage (Ricardo, 1817) to international trading patterns, stating that a country tends to export their abundant and cheap factors and import products that require factors that are domestically scarce. The deriving theorem essentially concludes that exports from capital-abundant countries are based on capital-intensive industries which poorer countries cannot sustain and thus led them to import such goods. In return, these countries export labour-intensive goods that mature economies consider profligate to produce locally.

A more modern approach from Krugman (1996c) considers “trade might reflect an overlay of increasingreturns specialisation on comparative advantage” which can develop irrespective of factor endowments. This novel idea set the basis of the New Trade Theory (NTT) and developed further to factoring network-wide effects arising from complexity and sectoral interdependencies (Economides, 1989). The most recent studies shift their focus from sectors to firm-level to accommodate the structural changes that globalisation brought upon trade patterns like the growing trend of intermediate goods, often referred as “New” NTT (Melitz, 2000, 2003; Antras, 2003).

The majority of empirical research addresses the profound trade liberalisation that occurred during the last decades, observing the implications of this movement using econometric models and qualitative analysis. Trade is linked to economic growth with earlier studies (Rivera-Batiz and Romer, 1991a; Grossman and Helpman, 1991; Segerstrom et al., 1990; Krugman, 1988) providing contradictory views on its relationship with trade liberalisation. However, these studies elaborate on extreme policy reforms assuming an outright shift from autarky to free-trade, a change which is not feasible in real world terms since liberalisations are performed in incremental steps. Helpman and Krugman (1989) support the view that the effect of incremental changes is case specific and can be pro or anti-growth. In particular the outcome relies on the type of barrier, the kind of liberalisation, countries involved and the market competition of the industry in question. Thus, trade policy changes are neither universally negative nor positive since the impact on each business sector can be entirely different.

Disentangling the network effects of trade and economic growth, there is evidence that the level of trade openness and policies promoting financial and political cohesion may have an indirect effect on incoming capital flows like FDIs (de Mello, 1999; Alfaro et.al., 2010). Studies like Balasubramanyam et al., (1996) demonstrate that an FDI can positively affect economic growth only under liberalised trading environments that are able to facilitate spillover effects (de Mello, 1997).

The relationship of international trade outcomes with exchange rate volatility has been a prominent subject in the literature. Leading economic theorists often use real exchange rates and national income to model trade flows (Baldwin & Lyons, 1991). Such studies define rates as the value of one currency relative to the other. Arize, Osang and Slottje (2000) proved a causal relationship between volatility and changes in outcome, suggesting that exchange rate volatility has a short-term negative effect on exports due to risk-aversion with further empirical studies like those of Chowdhury (1993) and Arize (1995) supporting this argument. On the other hand, Asseery & Peel (1991), Holly (1995) and Bredin et.al. (2003) report a positive relationship claiming that firms may try to reap the opportunity value arising from volatility at times and thus the exports tend to increase. A contradictory view is provided by Baccheta & Wincoop (2000), who argue that there is no relationship between the two (Baccheta & Wincoop, 2000) and that exchange rate volatility is has no statistically significant effect on the volume of trade (Secru & Uppal, 2000). They both conclude that monetary policies on fixed exchange rates cannot improve the trade outcome. These

ambiguous results lead to the conclusion that the relationship is not straight forward and subject to different data sets, namely time period, countries and the currency characteristics.

Relating to the research question, small scale exchange rate variations in these models cannot sufficiently factor the magnitude of the recent GBP depreciation after the Brexit vote and are hence not particularly useful. Looking at large scale exchange rate shocks, Baldwin & Krugman (1989) pointed out that large scale shocks can have persistent effects that possibly change the market structure itself and as a result alter the parameters of estimated trade equations of these models, violating their main assumptions.

Hysteresis is a situation "where one-time disturbances permanently alter the path of the economy" (Romer, 2001, pp. 471) and refers to the remnant memory of the disturbance in the economy, after the shock has passed. Baldwin (1990) studied large scale exchange rate shocks as the 1980s dollar cycle was unfolding and was the first to introduce the idea of hysteresis in trade. The argument was built on the concept that a foreign firm incurs sunk entrance costs to establish its presence in a domestic market and periodical maintenance costs in order to sustain it. A substantial temporary rise in the exchange rate will favour the entrance of foreign firms because of the aggregated value for its offerings in the foreign currency. These new entrants will not unilaterally abandon this market, even if the exchange rate returns to previous levels because the entry costs are sunk. As a result, it is suggested that the relationship between exchange rates and imports is reversed under the new market structure which remains persistent after the change and therefore the previously estimated equation no longer applies. The deriving Beachhead Model (Baldwin, 1988) is based on the assertion that real exchange rate shocks can change the domestic market structure and this structure affects import prices and volumes.

In summary there is theoretical ambiguity regarding policy change and the overall effect on trade. The outcome cannot be directly inferred based on conventional notions that consider a shift as either bad or good. The literature implies a trend that the study approaches shifted from a sole macroeconomic point of view, aligning with the New Keynesian school of thought, trying to find micro-economic foundations to explain trade dynamics. Hence, an in-depth systematic analysis on each sector and the sector-specific determinants is more likely to identify the real impact in view of a wider environment change. The results could possibly provide a potential overall outcome, although is important to illustrate that totally accurate results would still be difficult to achieve, because of the complexity and the interdependencies with other macro-economic factors.

Tariffs are an instrument of fiscal policy in the form of taxation on imports and exports of products and is traced back to the Bronze Age, closely following the transition from local to intra-regional exchange of commodities. Ancient Greeks were levying duties for goods entering and exiting Athens to "maximise the benefits of social life for its citizens". The actual word has Arabic origins and translates as "notification" and derives from a Spanish coastal town, Tarifa, which was the first port in history that charged traders for the usage of docks. (http://self.gutenberg.org/articles/eng/Tarifa).

Historically associated with protectionism, these duties were imposed to secure the local production industry against foreign competition by making the transaction more expensive while also introducing a new source of funding for public policy (Cato Institute, 1998). The Great Depression had a lasting effect in changing the approach of nations regarding global trade. The U.S. took a leading role in the liberalisation of trade, pushing for a multilateral agreement between its trading partners and shortly after World War II, the General Agreement on Tariffs and Trade (1947) was

signed by 23 counties. GATT was drafted to reduce tariffs and other trade barriers substantially as well as eliminate preferences on a reciprocal and mutually advantageous basis, introducing 45000 tariff concessions of an approximate value of USD 10 billion when brought into effect. Nowadays, international trade is governed by the WTO framework and tariff schedules are regulated by GATT. The growing trend of globalisation "redefined the relation between production and territoriality, nation-states, economic institutions and social structures" (Robinson & Harris, 2000) and thus changed the direction of capitalism from a nation-state phase to global accumulation of capital. Concurrently, GATT went through 8 revisions to adapt in the new environment with the most current ratified by 123 countries in 1986. Nowadays, international trade is regulated by the World Trade Organisation, established in 1995 as a successor of GATT and tariff schedules are still derived in compliance with the same rules. Under this framework, there are three types of tariffs:

Most Favoured Nation Tariffs: The highest level of tariff level currently in effect that a country can impose to other WTO members unless the trading parties enter into preferential trade agreement to reduce the reciprocal tariff imposition or abolish it completely. This agreement may concern a customs union or a free trade area and must cover a substantial part of the total trade.

Bound Tariffs: The tariff schedule for each commodity line that a country submits when it joins WTO. This is the absolute maximum MFN tariff level that a country can impose, rarely applied in practice since negotiations between WTO partners lead to reductions that have to be applied unilaterally under the MFN rule. However, a large difference between the Bound and MFN tariff makes a country unpredictable for disruptive changes in trade policy.

Effectively Applied Tariffs: A concept that is directly linked to WTO Rules of Origin and the mix of impact that each trading has on the final product. If the majority of impact originates from a country engaged in a free trade agreement with the importing nation, then a preferential tariff applies, while an MFN tariff is imposed in any other case.

Regardless of type, a tariff is most commonly calculated as a percentage of the imported product value (ad valorem) but a tariff schedule may also use different factors to determine the custom duty. These tariffs are called non ad valorem and are considered to be less transparent with higher distorting effects.

Neoclassical economic theories view tariffs as a harmful interference to the free market which distorts the economic equilibrium. There is a constant effort for reductions and admittedly rates are much lower than at the beginning of the 20th century. However, the practice of tariff imposition still remains persistent for political economy reasons (Baldwin, 1985) and their impact cannot be disregarded since they still bear a substantial cost. Literature provides an abundance of examples for specific product categories subjected to high rates and identifies industrial sectors that are still experiencing intense distortive effects. The effects can vary from compressed margins, to reduced trade volumes and diversion effects in export patterns (Haveman & Thursby, 2000).

Tariff barriers' effect on the food and confectionary industry trade volume has been studied extensively with the literature citing the sector as particularly vulnerable. An immediately apparent challenge is that contrary to other industrial manufactured goods, foods products are difficult to categorize and find appropriately even matches in order to make direct comparisons between countries. Researchers have to rely on the exact product description,

often compelled to travel to different countries to find appropriate matches or even forced to make assumptions on "equivalent in use" basis (Bradford, 2001).

Haveman & Thursby (2000) used U.S. trade data to develop a regression model that estimates the elasticity of demand and tariff rate for agricultural commodities in an aggregation level of 3-digit SIT codes. In their study, we find that a 1% tariff increment in Fruit and nuts category (SITC 017) is able to decrease the trade volume between 4.6% and 12.84% in addition to any compressing or diverting effects. Dairy products (SITC 202) trade pattern can be diverted to different exporters, anywhere from 0.39% to 25.11% of the total volume. On average, a percentage change in tariff rate, incurs a 14.6% negative distortion of demand over 72 agricultural product categories.

International trade transactions are subject to additional forms of controlling measures beyond custom duties, known as Non-Tariff Measures (NTMs). NTMs are comprised of multilateral agreements, such as the Technical Barriers to Trade (TBT), Sanitary and Phytosanitary Measures (SPS), Import Licensing Procedures, Customs Valuation and Rules of Origin (Gurler, 2002). TBT is aiming to secure the compliance for technical regulations, international standards and ensure that the conformity assessment procedures are performed with minimum impact to trade and on a non-discriminatory basis. The SPS measures we introduced to protect humans, animals and plants from diseases, pests and contaminants. The Rules of Origin, is essentially a NTM, even though their impact of final tariff determination is direct. The deriving barriers can take various forms like quotas, anti-dumping duties, subsides, technical/safety regulations and, unlike tariffs, they can vary across countries and sectors (WTO, 2012).

WTO reports that the contribution of NTMs to overall trade restrictiveness is significant and in some cases far more intensive than actual tariffs. More specifically, their relative contribution to the overall level of domestic protection has a positive correlation with level of GDP per capita. For direct comparison, the impact of NTMs is depicted as an "ad valorem tariff equilavent" (AVE), specifically the level of ad valorem tariff that would have the same restricting effects. Kee et.al (2009) estimated that NTMs have a 12% AVE on average using a sample of 91 countries.

Academia presents TBT as the most important trade barrier (Baldwin, 2000; Chen & Novy, 2009) along with transportation costs. A finding that is expected since compliance and certification is expensive and only the most productive firms can withstand these high fixed costs to sustain their exporting activities, a fact that is supported by recent trade literature on heterogeneous firms (Melitz, 2003; Melitz & Ottaviano, 2008). Arguably, such studies present only one aspect of NTMs effects. In reality these measures have both negative and positive impacts on the economy. In some cases, these measures may also have a positive effect on the traded volume and the consumers. Standards and technical regulations may raise producer costs but can reduce customer costs because product quality information is more readily available. Trade increases if the positive effect on demand is greater than the negative effect on supply (WTO, 2012). An argument which is not touched in the identified trade literature is the widely recognised fact that standardisation decreases the overall production and supply chain costs.

Overall, WTO finds that TBT/SPS measures have positive effects on technologically advanced sectors like manufacturing, where customer information costs are more important than the regulatory adaption costs. On the other side TBT/SPS impact the trade of food & agricultural sector negatively, especially in developing country exports. Finally, it is apparent that the export market diversification is reduced because smaller firms cannot withstand the market entry costs associated with these measures. Greater trade integration and mutual recognition of standards is viewed as a way to mitigate the negative effects of NTMs.

The effects of Brexit are therefore not predictable based on economic theory, but it appears they will be sector and context specific and may be quite dramatic in their impact when the combination of exchange rates, tariffs and non-tariff barriers are factored in for a specific firm. A study in 2011 based on high level sectoral analysis suggested impacts would be in the range from 0% to just short of 10% based on Most Favoured Nation tariffs. (Ottaviano et al, 2011). However the studies cited above suggest some segments will experience a greater impact.

The complex nature of international supply chains is recognised in official documents through the repeated mention of the 'Rotterdam Effect'. Because of supply chain structures that move goods through single European ports and re-export to the UK, it is clear that the UK trade with the EU is overstated in terms of ultimate origin. (House of Commons, 2016). Specifically, the report says

The EU, taken as a whole, is the UK's major trading partner, accounting for 44% of exports and 53% of imports of goods and services in 2015. …. Some argue that the share of UK trade accounted for by the EU is exaggerated by the "Rotterdam effect" whereby trade recorded as being with the Netherlands is actually with non-EU countries. While this effect cannot be quantified, it does not alter the fact that the EU is the UK's main trading partner.

The CBI report on The Future of Trade of the UK prepared by Clifford Chance and published in February 2017 noted of the Rotterdam Effect, as a footnote, that an ONS article estimated that 50% of all goods exports (value for imports not available) to the Netherlands was re-exported to non EU Countries. (CBI, 2017) It also estimated that the Rotterdam Effect would account for 4% of the UK's exports of goods. (ONS, UK Perspective, Trade with the EU and Beyond). The House of Lords European Union Committee published a report in March 2017 under the title 'Brexit – Trade in Goods'. This analysis also points to the Rotterdam Effect. Both the CBI and the House of Lords reports identify the food and automotive sectors as being vulnerable to WTO tariffs but offer no definitive guidance on the scale of the issue. It is that gap that this work has tried to fill.

Study Methodology

The study's analytical methodology was designed to quantify the specifics of the impact of both ad valorum and non-ad valorum tariffs on the two sectors that were identified as being at risk: food and beverage and automotive. The analysis was based on securing a comprehensive database of trade statistics compiled by MDS Transmodal in its Box Trade Intelligence business. MDST has been compiling trends in global trade in support of its work for more than 20 years and its database is unique in the completeness of its scope and trend capability.

The dataset that was made available covered every incoming and outgoing flow between the UK and its global partners for 2015 and 2016, grouping the data onto its corresponding Standard Industrial Trade Classification (SITC) with the accompanying mass (in tonnes) and value (in USD) working at the complete level of detail.

The Standard Industrial Trade Classification traces its origins to a report, "Minimum List of Commodities for International Trade Statistics" published by the League of Nations in 1938 as the result of a greater need for comparability of international trade merchandise statistics (UN, 2016). The SITC was formally established in 1950 by the United Nations as a statistical classification entering international trade, intended to facilitate comparability and provide commodity aggregates appropriate for the purposes of economic analysis (OECD, 2001). The SITC nomenclature is made up of 9 Sections (0-8) corresponding to the first digit of each code, with each Section breaking down to a total of 89 Divisions (2-digit code). Onwards, the Divisions are broken down to different level of

aggregation with 3-digit Groups and 4-digit Subgroups, culminating in Items of each Subgroup (5-digit). Although the system continues to be maintained by the UN, currently on 4th Revision (2006), its primary usage is limited to analytical purposes because the adopted standard for trade statistics internationally shifted to the Harmonized Commodity Description and Coding System (HS). The commodity descriptions of SITC Rev.4 corresponds directly to those of the HS (HMRS, 2016), providing compatibility.

The HS was developed by the World Customs Organization (WCO) in 1988 to encompass similar purposes and is ratified by more than 200 countries, corresponding to the 98% of all merchandise goods traded internationally. Beyond trade statistics, the HS serves as the basis on which custom tariffs are determined as well as internal taxes, rules of origin, trade policies, freight tariffs, transport statistics etc. The system is much more detailed and complex compared to SITC, with 5000 commodity groups on a disaggregation level of 6 digits, arranged in a legal and logical structure to achieve uniform classification (WCO, 2017).

SITC trade data are published whereas similar HS statistics appear to be less easy to compile and were not available to this research. It should be noted that there is an industry that supports trade classification on the HS system and the process of tariff management with the aim of optimising tariffs for goods owners and shippers.

The analytical work organised the very large data set, profiled the relevant trade sectors for both import and export flows and then merged the SITC data with the WTO tariffs (ad valorum and non-ad valorum) based on the HS tariff tables. This data was then inspected to pinpoint the tariff effects and the results of the analysis discussed for their implications based on the insights from the literature.

Analysis Results

The data for SITC headline codes 0 and 1 have been used here to illustrate the analysis approach. Table 1 shows the SITC code breakdown for these categories. The product SITC divisions in question are presented with their comparable HS equivalence in Table 2. During the research, it was recognised that even with the highest level of SITC disaggregation (5-digit), one code usually corresponded to multiple HS tariff lines. Also, the EU is heavily protecting its food & beverages sector, imposing a mixture of Ad Valorem (AV) and Non-Ad Valorem (NAV) tariffs. This is illustrated in Table 3; note that the imposition of Non-Ad Valorum tariffs was absent from the work of Ottaviano et al. (2011). This implies that this research will have under-estimated the impact of WTO trading conditions.

SITC Section 0 – Food and live animals		
SITC Division (2-digit)	HS equivalent	Description
00	Section I – 01	Live animals other than animals of division 03

01	Section I – 02 Section IV – 16	Meat and meat preparations
02	Section I – 04	Dairy products and birds' eggs
03	Section I – 03 Section IV – 16	Fish (not marine mammals), crustaceans, molluscs and aquatic invertebrates, and preparations thereof
04	Section II – 10, 11 Section IV – 19	Cereals and cereal preparations
05	Section II – 07, 08, 11, 12 Section IV – 19, 20	Vegetables and fruit
06	Section I – 04 Section IV – 17	Sugars, sugar preparations and honey
07	Section II – 09 Section IV – 18, 21	Coffee, tea, cocoa, spices, and manufactures thereof
08	Section II – 12 Section IV – 18, 23	Feeding stuff for animals (not including unmilled cereals)
09	Section I – 04 Section II – 07 Section III – 15 Section IV – 19, 20, 21	Miscellaneous edible products and preparations
SITC Section 1 - Beverages and tobacco		
11	Section IV – 22	Beverages
12	Section IV – 24	Tobacco and tobacco manufactures

Table 1 – the SITC breakdown for Food and Drink

Tariffs Measure	HS Tariff Lines (%)	SITC subheading coverage

SITC Section 0 – Food and live animals		
Ad Valorem	1379 (56.6%)	43%
Non-Ad Valorem	929 (38.2%)	44.8%
Duty Free 100%	127 (5.2%)	12.2%
SITC Section 1 - Beverages and tobacco		
Ad Valorem	101 (37.3%)	27.6%
Non-Ad Valorem	131 (48.3%)	44.8%
Duty Free 100%	39 (14.4%)	27.6%

Table 2 – the coverage of HS to SITC showing more HS than SITC

NAV Measure	Description
EUR/kg	Fixed price charge per 100kg or 1000kg
EUR/kg net eda	Fixed price charge per kg of drained net weight
EUR/kg net sacchar.	Fixed price charge per kg of saccharoids net weight content
EUR/kg lactic matter	Fixed price charge per kg of lactic matter content
EUR/kg tot alc	Fixed price charge per kg of total alcohol content
EUR/pst	Fixed price charge per 100 or 1000 items
EUR/hl	Fixed price charge per hectolitre
EUR/%vol hl	Fixed price charge per alcohol percentage volume
MIN	Minimum applicable tariff as % of value or EUR/kg if the primary charging method calculates a lower amount

MAX	Threshold tariff as % of value or/and EUR/kg if the primary charging method calculates a higher amount
EA	Agricultural component – Additional tax that estimates the content of certain agricultural goods present in the product using Milk fat, Milk proteins, Glucose/Starch and Sucrose/Invert sugar as indicators and charges their correspondent NAV
EP	Entry price - Tariff is calculated using the value of the product and increases as the import price drops
ADSZ	Additional duty on sugar content
ADFM	Additional duty on flour content

Table 3 – the available Non-Ad Valorum Tariffs

The trade database was used to interrogate the trade flows for the selected categories of food, beverage and automotive sub sections. The scale of this data makes it difficult to manage and present the salient features for illustration. Analysis was completed for both tonnes and value on both a global basis and with the EU27. Figure 1 shows the trade picture both in and out of the UK by value in Euros for the code under inspection. The red line is inbound trade to the UK and it is immediately obvious that the UK maintains a deficit in all but oil and fish.

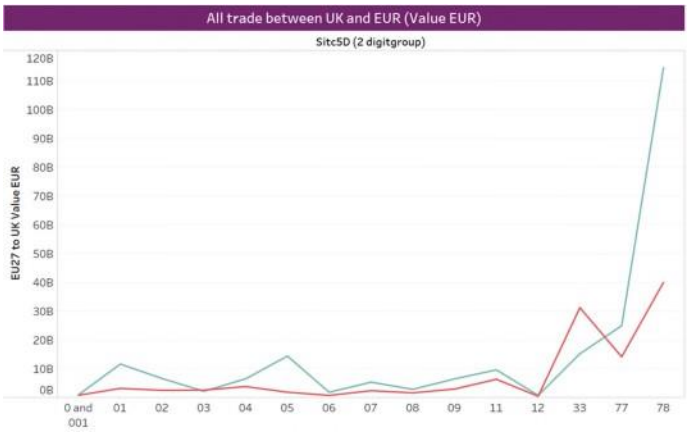


Figure 1 – Trade statistics by SITC – UK <> EU 27 (33: petroleum products and excluded from the commentary)

The main assumption is that a post-Brexit UK would have to submit a WTO tariff schedule similar to that of the EU in order to avoid appeals and lengthy negotiations with all WTO member states. Based on the literature, the most likely scenario is that the UK would support “at risk” industries by different policy means during any restructuring phase and until FTAs with major trading partners have been set up. Only then would the UK would have the ability and the negotiating power to enter into time consuming negotiations with the WTO. It is therefore on the basis of WTO MFN

rates that the impact of both Ad Valorum and Non-Ad Valorum tariffs have been modelled to establish the likely effects.

WTO tariffs and non-ad valorem trade measures as % of value		
Sitc5D (2 digitgroup)	WTO Tariff % of value EUR	NAV KG % total cost
0 and 001	3.2%	26.1%
01	41.4%	88.0%
02	50.8%	85.7%
03	13.7%	
04	27.7%	78.7%
05	12.7%	15.7%
06	42.3%	89.8%
07	13.0%	49.3%
08	20.5%	96.0%
09	11.7%	15.4%
11	4.0%	75.9%
12	35.7%	3.0%
33	1.3%	
77	2.0%	
78	9.1%	

The summary of this calculation is provided in Table 4. It shows the aggregated average AV percentages and NAV figures of the applicable HS tariff lines at the two digit level, based on calculations for each 5-digit SITC.

Petroleum (SITC 33) has a lowest tariff of 1.3% with Electrical machinery & parts (SITC 77) following with 2%. Road vehicles (SITC 78) face 9.1% in duties, confirming the consensus in the literature that car tariffs would range around 10%. However, this figure should be regarded as an estimate due to our aggregated trade flows.

The majority of the Food, Beverage & Tobacco sector would be subject to much greater tariffs reaching up to 50.8% for Diary products & birds eggs (SITC 02), followed by Sugars etc (SITC 06) at 42.3 % and Meat products (SITC 01) with a 41.4% added commission. Some sub-segments within these two digit codes will incur yet higher rates.

Table 4 – the modelled output of post Brexit tariffs.

Live animals (SITC 00) and Beverages (SITC 11) would face the lowest costs in the sector with 3.2% and 4% respectively. Beverages could be an area of interest for the UK which runs on a surplus globally but with a deficit from the EU side. With this lower tariff, UK beverage industry could have potential gains if it could reverse the current balance.

The reason why the Food, Beverage & Tobacco sector ends up with such high duties is due to the NAV tariff measures of the EU which charge by some form of quantity regardless of actual value. The variety of NAV types encountered were presented in Table 3, but the prevailing measure in terms of frequency was EUR/kg (NAV KG). Table 4 shows the impact of NAV tariffs expressed against the value of the trade and it is clear that many trading categories could experience overall tariffs of more than 100%. Indeed, NAV per KG alone is responsible for more than 80% of the cost, stretching up to 96% for Animal food (SITC 08). It is clear that the EU is severely guarding the whole sector, effectively restricting foreign inputs of lower value in order to protect internal production. Interestingly, Fish (SITC 03) which was shown to be a net trade contributor for the UK, is not protected by restrictive NAVs, just some relatively high AV duties. Beyond the NAV per KG measures, all other measures are less frequent and applied case by case; however, they could be severe when applied.

The trade statistics by EU country have been analysed to ascertain the profile by SITC and country as well as in aggregate. The importance of the Netherlands as a trading partner exceeds its ability to either consume or manufacture and this confirms the Rotterdam effect. What is not clear is the extent to which the goods recorded originate or are destined for outside the EU as opposed to the billing and handling arrangements for the EU having been centralised in the Netherlands.

The relative value : volume relationships of aggregate trade by country shows conclusively that each economy has specialised based on its factors in an EU where goods are in free circulation. The detail of UK trade to each country also points to the billing arrangements for statistical recording being quite different from the origin to destination flows. Figure 2 below shows the automotive sector with Ireland as the greatest in tonnes from the UK and number 3 by value compared to Germany being number 2 by tonnes but number one in value by a factor of 2. This can only imply that these supply chains are being operated for organisational and process convenience, but at a level of detail that is not exposed.

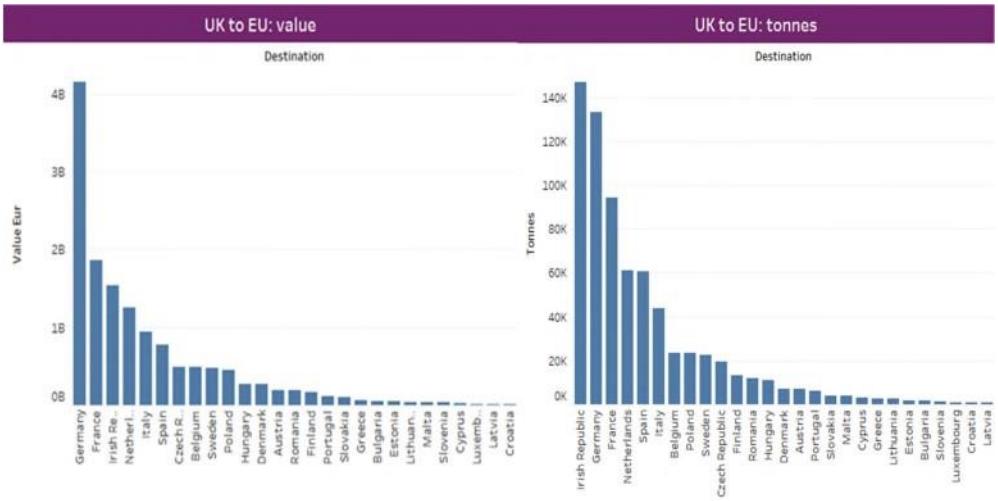


Figure 2 – SITC 78 Trade from the UK to EU27 ranked by country – EUR and Tonnes

Supply chain implications

The implications for the two sectors, food and automotive, are quite different.

For food it is likely that there is not much intermediate processing but the data shows a disproportionate impact for Belgium and Netherlands. This implies the presence of the so-called Rotterdam effect and as a result tariffs may have already been levied when the goods arrive in the UK. Re-export duty relief schemes or re-aligning the flows to UK ports will mitigate the impact on consumers However for local EU production, the impact of AV and NAV tariffs will be potentially serious and unsustainable. Companies in the food sector should be tracing origins, applying the duty measures and considering new sources or realigning flows. This may well be a boost for the UK food industry, as cost of tariffs outweigh any production cost differences with low cost Eastern EU producers.

For automotive goods and the components the picture is yet more complex. The UK automotive industry produces an annual turnover of GBP 71.6 billion and ranks first in exports worth GBP 34.3 billion which are estimated to have added approximately GBP 18.9 billion of real value to the British economy in 2015 (SMMT, 2016). The European Union absorbs more than 35% of these UK exports and reciprocally export goods with a value of more than GBP 13.5 billion to the UK (OpenEurope, 2015). Various reports flagged the automotive industry as one of the most critical sectors following Brexit (KPMG, 2014; OpenEurope, 2015; CBI, 2016; KPMG, 2017).

The major concern is not limited to individual tariffs cost but with imposed NTMs under WTO trade rules, especially RoO. The UK content is estimated to be less than 40% of the product value with 20-50% depending on the case, sourced from the EU (KPMG, 2014). In the same report, industry professionals from automotive companies trading within the UK like Ford and Nissan state that their pan-European operations are built for the Single Market. And that's because the EU market provides the opportunities for economies of scale, especially for niche products for emerging markets.

Practically, the automotive sector is built around intense supply chain operations which transport generic parts and WIP in and out of the UK in different forms, linking different large and specialised production units until the final product is assembled. An illustration of a driveline supply chain by GKN in Figure 3 provides a representative example of automotive supply chain operations. Some parts of the constructing blocks were UK made and exported to an EU destination for production and would be subjected to EU tariffs. EU-produced WIP blocks will be subjected to tariffs as they enter the UK for further processing. The driveline will be produced in the UK to be used in domestic production or exported to EU and re-imported to the UK as part of a vehicle.

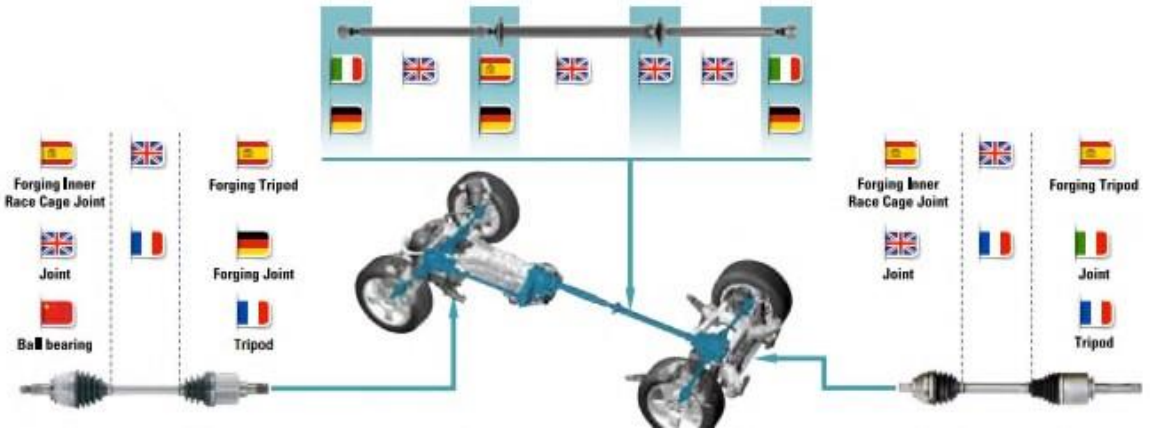


Figure 2 – Sourcing and assembly of EU Automotive Drive Trains (Source GKN)

Assemblers will be able to for component duty relief on export so, the ultimate question concerns mostly the finished consumer product, which is most important in value-creation and market price. RoO and final UK & EU content in case of a WTO trading environment will be critical as content limits will be imposed. The disaggregated analysis into 5-digit SITC could give an insight of the costs and emerging risks. However, a completely accurate analysis is possible only by considering each production and supply chain setting separately. The required supply chain adjustments can be determined by tracing current component flows and final country composition. The expectation is that UK assemblers will drive for increased local content to hedge the risks; this is a trend already reported by some industry insiders.

The implications for supply chains based on these short insights is that they will respond to costs and risk by re-configuration. This is an opportunity as well as a threat and the impact will be firm specific. It appears boards in the two sectors analysed should be undertaking detailed supply chain mapping and risk mitigation – sooner rather than later. Application and limitations

The analysis in this paper shows that the use of trade data and WTO tariffs can provide detailed insights into the scale of trading and supply chain risks post-Brexit based on WTO rules. As such, the method is proven and can contribute to companies' and government planning. Companies should be using the approach alongside detailed mapping to determine where to 'straighten out' their chains based on detailed mapping and analysis.

It is clearly not a complete or perfect methodology since the actual experience of individual businesses based on their particular supply chains and classifications will vary – hence the need for detailed mapping and scenario testing. It also appears unsafe to generalise because data is distorted by corporations' fiscal architectures and physical shipping patterns. The conclusions of the method may also be limited by the trade data used; the obligation to report precisely for trade is less hard than for duties and the intra EU trade has no trading duties at present. Post Brexit there will be an increasing need for duty classification services and complex duty relief schemes – all of which exist today, but are not applied by many companies.

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Green Logistics and CSR

A predictive model for corporate social responsibility compliance in global supply chains

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Abstract

Purpose: Our ultimate goal is to develop a tool that can be used by firms to detect supplier deviance behaviour and act upon it so as to contain its impact and possible disruptions that can shake the whole supply chain.

Research Approach: Motivated by the advances in big data, we present a predictive analytics model for detecting possible supplier deviations before they become a corporate liability. The model is built based on publicly available data such as news and online content. We apply text mining and machine learning tools to design a social ethics ”warning system” on the downstream side of the supply chain.

Findings and Originality: We present an innovative application of data mining to corporate social responsibility on global supply chains.

Research Impact: In our literature review we found that there is a lack of studies that focus on the social aspect of sustainability. Our research will help fill in this gap by providing performance measures and case studies to test our model.

Practical Impact: There have been several infamous incidences where world-renowned corporations have been caught by surprise when a low-tier downstream supplier has been publicly found to be non- compliant with basic corporate social responsibilities codes. In such instances the company reputation, and consequently financial health, suffer greatly.

Keywords: Big data analytics, predictive analytics, sustainability, supplier relationship management, supply chain.

Introduction

While the economic and environmental aspects of the sustainability triple bottom line have been generally well covered by academics and practitioners, the social aspect has received much less attention (Tajbakhsh and Hassini, 2015). To address this deficiency, corporate social responsibility (CSR) has evolved from a restricted application of social responsibility to a globally institutionalized function that is integrated with strategic management and corporate governance (Carroll, 2008). Taking CSR to a supply chain level has its challenges given the intricacies in measuring sustainability through a supply chain (Hassini et al., 2012). The complexities multiply when we consider a global supply chain where products and services may be outsourced from a multi-tiered supply network that extends through different countries. In such complex supply chains it becomes difficult for a firm to have complete visibility of its suppliers and it turn monitor their CSR activities. For example, a company like Boeing makes its 787 plane at over 5000 factories around the world. When its dreamliner had a burning battery problem, the company engineers blamed their suppliers "saying that poor quality components are coming from subcontractors that have operated largely out of Boeing's view" (Gates, 2013). If Boeing engineers have found it difficult to trace and evaluate the quality of a battery supplier, we can only imagine how difficult it will be to evaluate social sustainability practices at such a supplier's premises. It is thus our goal in this paper to develop a methodology to aid companies in detecting supplier deviance behaviour early so as to act upon it and contain its impact and possible disruptions that can shake the whole supply chain.

Motivated by the advances in big data, we propose a predictive analytics model for detecting possible supplier deviations before they become a corporate liability. In our paper we use publicly available data such as news and online content. However, a firm can add its own proprietary data such as inspections and factory visit reports. We apply text mining and machine learning tools to design a supplier social ethics "warning system."

The remainder of this work is structured as follows. In Section 2 and 3 we provide a background discussion on the social aspects of sustainability as well as big data and predictive modelling. In Section 3 we review the literature on corporate social responsibility and predictive modelling. Section 4 discusses a model and its application on the Rana Plaza case study in Bangladesh. Finally, Section 5 presents a discussion and conclusions.

Corporate Social Responsibility

Nowadays, firms are experiencing significant pressures to deal with social and environmental issues of their supply chains (Vachon and Klassen, 2006); (Yakovleva et al., 2012). These pressures come from diverse stakeholder groups who want firms to not only focus on quality and delivery, but go beyond and work on labor standards, health and safety, environmental sustainability, non-financial accounting and reporting, procurement, supplier relations, product lifecycles and environmental practices (Waddock and Bodwell, 2004); Teuscher et al. (2006). There have been instances when suppliers of multi-national companies like Nike, Disney, Benetton and Adidas, have harmed the environment (Preuss, 2001) or even violated labor laws (Graafland, 2002). Thus, it is the responsi- bility of companies to maintain a balance between economic, environmental and social goals, while making purchasing and sourcing decisions (Vachon and Klassen, 2008; Pagell and Wu, 2009).

Sustainability has been defined in the literature in a variety of ways. This disparity leads to some uncertainty and confusion. For instance, consider the following definitions from journal articles. Elkington (1998) viewed

sustainability as a triple bottom line (TBL) that combines environmental, social, and economic performance. In this context, Kleindorfer et al. (2005) considered social sustainability as a component of TBL that tackles human and societal capital issues (Sarkis et al., 2010). Further, Anisul Huq et al. (2014) adopted a holistic concept to define social sustainability. The authors emphasized that social sustainability should not be considered separately but must be integrated with economic and environmental performance, identify stakeholders within and beyond the supply chain and ensure long-term benefit for society.

Moreover, for implementing social sustainability, various tools are available in the literature that range from a firms own socially responsible practices or code of conduct, to third-party standards and supplier development programmes (Anisul Huq et al., 2014).

CSR has been at the forefront of interest for both academics and practitioners. Parast and Adams (2012) noted that more than ninety percent of Fortune 500 companies are engaged in CSR initiatives. These companies have realized that making profits for the shareholders alone is not enough and that they must fulfil their responsibilities towards society. In other words, CSR stresses that firms not only have economic and legal obligations but also have social responsibilities that go beyond these obligations (Schwartz and Carroll, 2008). This reflects that firms should take actions that create positive benefits for society, and also take measures to avoid harmful consequences of their operations (Miska et al., 2013). More specifically, when firms oblige to society, their success may ensue, as recognized by (Lichtenstein et al., 2004).

CSR is an elusive concept, as Carroll (1999) noted that ”the term is a brilliant one, it means something, but not always the same thing, to everybody”. As a result, it has been defined in a number of ways. However, the underlying concept that organizations should be committed to meet the ethical, social and environmental responsibilities, remains the same (Castka and Balzarova, 2008). This may include issues like human rights, workplace and employment issues, unfair business practices, organizational governance, environmental aspects, marketplace and consumer issues, community involvement, and social development (Leonard and McAdam, 2003). As the Commission of the European Communities (2001) noted, CSR involves the voluntary integration, by companies, of social and environmental concerns in their commercial operations and in their relationships with interested parties. Further, the concept of CSR is much more than the ability to manage stake- holders (Waddock and Bodwell, 2004), or as Aguinis (2011) asserts, it involves context-specific organizational actions and policies that take into account stakeholders expectations and the triple bottom line of economic, social, and environmental performance.

Each year, socially responsible firms donate millions of dollars to address social or health issues with precision and competence. For instance, Avons initiative to create awareness about breast cancer has raised around 200 million, Patagonia safeguards its interest to protect and restore the environment by donating 1% of its share to such organizations, and Calphalon sponsored Share Our Strengths Taste of the Nation events raised millions of dollars to feed hungry people. These examples illustrate that firms are investing in CSR initiatives in order to attain performance excellence (Foote et al., 2010). However, there are conflicting views on the effect of CSR on firm performance based on empirical results (Orlitzky et al., 2003). For example, there are studies which established a positive relation with performance (Fombrun and Shanley, 1990) while others reported a negative relationship (McGuire et al., 1988). This variation in results may be due to the fact that some studies related CSR to backward-looking measures of profitability while others referred to the role of contingency variables in building the relationship between CSR and firm performance (Luo and Bhattacharya, 2006).

Scholars have also paid attention to the theoretical perspectives on CSR. This is evident from the special issues that have appeared in prestigious academic journals like Journal of Management Studies (McWilliams et al., 2006), Academy of Management Review (Bies et al., 2007), and Socio- Economic Review (Brammer et al., 2012). These studies have explained CSR by utilizing theories ranging from stakeholder theory and institutional theory to the resource-based view and transaction cost economics.

Text Mining and Predictive Modelling

With advancements in storage capabilities, enormous data collections, and ease in accessing data of interest, people nowadays are immersed in a data pool, and one of the best ways to deal with this problem is data mining. It is a process of extracting knowledge from a database. Nevertheless, 85-90% of the total data available in the world is stored in an unstructured form (McKnight, 2005). To this end, it is not appropriate to use data mining algorithms, and instead, text mining plays an important role in such situations. Text mining, also known as intelligent text analysis, text data mining or knowledge-discovery in text, has received increasing attention as an important subfield of data mining. Through this technique, structured data can be explored and important information can be extracted from unstructured data. Tan et al. (1999) described text mining as "the process of extracting interesting and non-trivial patterns or knowledge from unstructured text documents". In this sense, it can be viewed as a method that extracts meaningful information from various written resources that is not yet written down and nobody knows about it. Applications of text mining can be seen in different areas such as business documents, customer reviews, web pages and e-mails.

Although text mining is considered as an extension of data mining, their meanings differ on various grounds. The basic difference between these two mining techniques is that text mining deals with text data that is unstructured and fuzzy while data mining involves extraction of data from structured databases (Yang and Lee, 2005). In fact, the process of text mining is quite similar to data mining but it can handle unstructured as well as semi-structured data which is not possible for data mining tools. That is why, text mining provides better solutions for companies as it helps them in extracting interesting and relevant information and knowledge from the unstructured data.

. Further, databases can be easily accessed via programs, but there are no such programs to read and understand the written text. In fact, Hearst (2003) asserts that these programs can be written only if we have full simulation of how the brain works. As more than 80% of the data is in text format, it is a general belief that text mining offers greater economic benefits than data mining. Tan et al. (1999) visualized text mining as a combination of two stages. The first stage that transforms free-form text documents into a chosen intermediate form is termed as "text refining." The second stage that infers patterns or knowledge from the intermediate form is referred to as "knowledge distillation". Intermediate forms can be categorized as either structured (e.g. relational databases) or semi-structured (e.g. conceptual graphs), and document-based or concept-based. In document-based intermediate forms, each item is regarded as a document, whereas in concept-based intermediate forms, each item is considered as an object or a concept in a particular domain of interest. Patterns and relationships across documents, such as, document clustering/visualization and categorization, can be obtained by mining document-based intermediate forms. In the latter case, patterns and relationships across objects or concepts, can be deduced in the data mining process, like predictive modeling and associative discovery.

Predictive modeling is one of the most important and popular tools of text mining. The major goal of a predictive analytical model is to transform data into knowledge, and the results obtained from these models may give useful information that may assist in decision making (Miner et al., 2012). Moreover, through predictive modeling, one can understand to which class a set of data belongs to. For example, using predictive modeling, a firm can understand their target customers and accordingly develop a new model so that they can get accurate results and maintain their customer confidence (Yucel, 2011).

Case Study

To illustrate our methodology we use the example of the fire in the Bangladesh factory that occurred on April 24th, 2013 in Rana Plaza–an eight-storey complex of clothing factories, near Dhaka, Bangladesh. This was the deadliest in the clothing industry– killing more than 1,110 people and injuring thousands more White (2017). The building was originally a five storey building meant for only office space and shopping malls, but the owners violated safety rules and added additional floors to run garment factories. The owners further showed negligence by ignoring the cracks that appeared in the walls a day before, and compelled the workers to return back to work. The following morning, vibrations from the large power generators on the compound's upper floors triggered the collapse of the Rana Plaza building that housed five garment factories and produced clothes for western retailers like Benetton, Loblaw's and Primark (Anisul Huq et al., 2014). This disaster focused the worldwide attention and criticism on unsafe conditions in the garment industry in Bangladesh, and reflected on the social aspects of sustainability including human rights, health and safety.

Model

In this section we discuss our early warning system for supplier deviance. The model is illustrated in Figure 1. Below we describe each step of the model in more details.

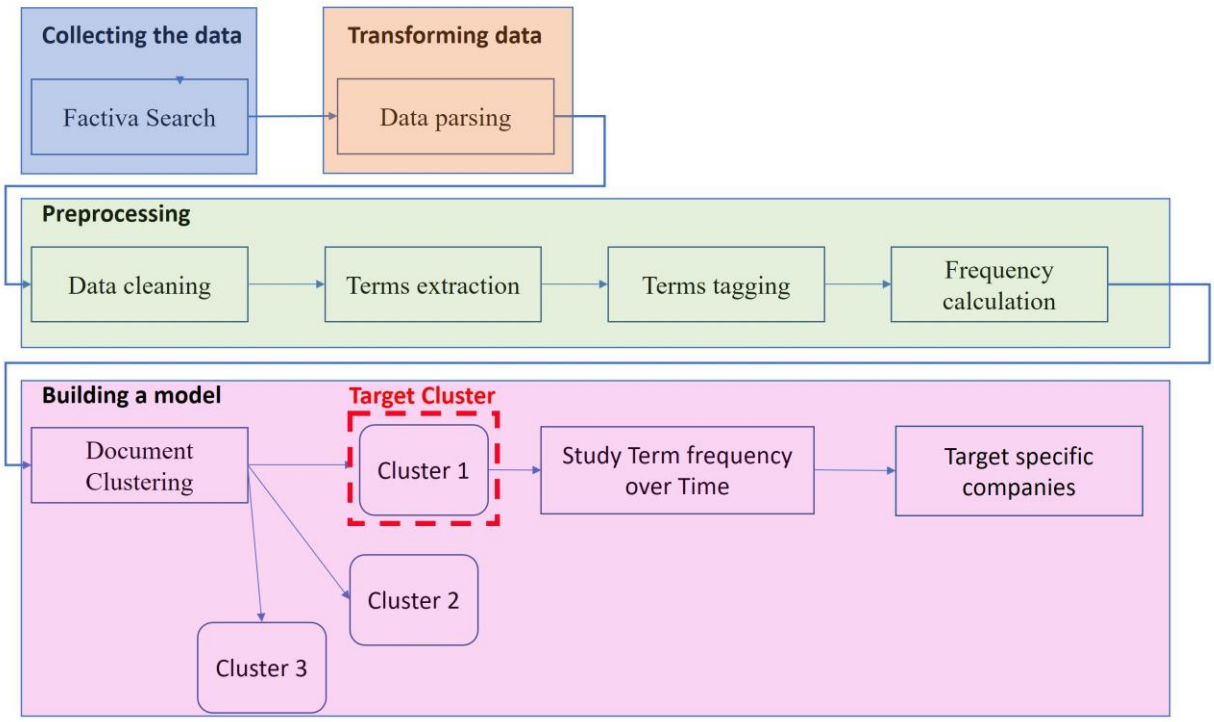


Figure 1: Text mining model.

Collecting the data

Our data was collected from Factiva, a database of newspaper articles from around the world. First, we entered specific keywords to choose the adequate news documents for text mining. Using Factiva's search tool, the following keywords were used: factory, work place safety, working condi- tions, safety, inspection, Rana Plaza, Bangladesh, building certificate, building code. In addition, we have restricted the region of news to Asia, as most firms have their factories in that region. After the search is complete, we download the documents in their raw format.

Data Transformation

To build analytical models and extract consistent knowledge, the data needs to have a specific format other than raw text. The transformation step allows as to convert the raw data into a form that is more amenable to text mining algorithms. To do so, we have developed a script that parses the plain text and transforms it into a structured data. The final file will be a document matrix, where each row is a document and its properties, such as author, source and date, are the columns.

Preprocessing

Text analysis is performed on terms that construct the documents, therefore, the text needs to be cleaned to have the adequate terms at the end. For this reason, we perform the following steps: remove numbers, erase punctuation, convert all text to lower case, remove stop words: 'at', 'the', 'a', 'in', as they do not provide any significant information, and stemming, which involves converting each word to its base word.

The resulting terms are extracted and text analysis will use their frequency matrix as well as their part of speech tagging (POS).

Building a model

Our model will group documents by their topic based on their most frequent terms. To do so, a clustering technique is applied. We used the K-means algorithm based on the documents terms' frequency matrix. This gave us an insight into the most frequent terms for each cluster. Moreover, the dimensionality of our search space to build our model is reduced. For instance, after running the K-means algorithm using 5 clusters, we obtain the top words per each cluster as shown in Table 1.

Cluster Keywordsknow, clip, video, think, iraq, u.s

garment, bangladesh, plaza, safety, clothing, garment

interfax, russian, russia, moscow, ukrainian, ukraine

commission, labour, human, human, thailand, law

ukraine, russia, rubles, kyiv

Table 1: Text mining clustering results.

Documents are now labelled with their cluster tag. Figure 2 shows document clusters. Each dot is a document and each colour represents a cluster.

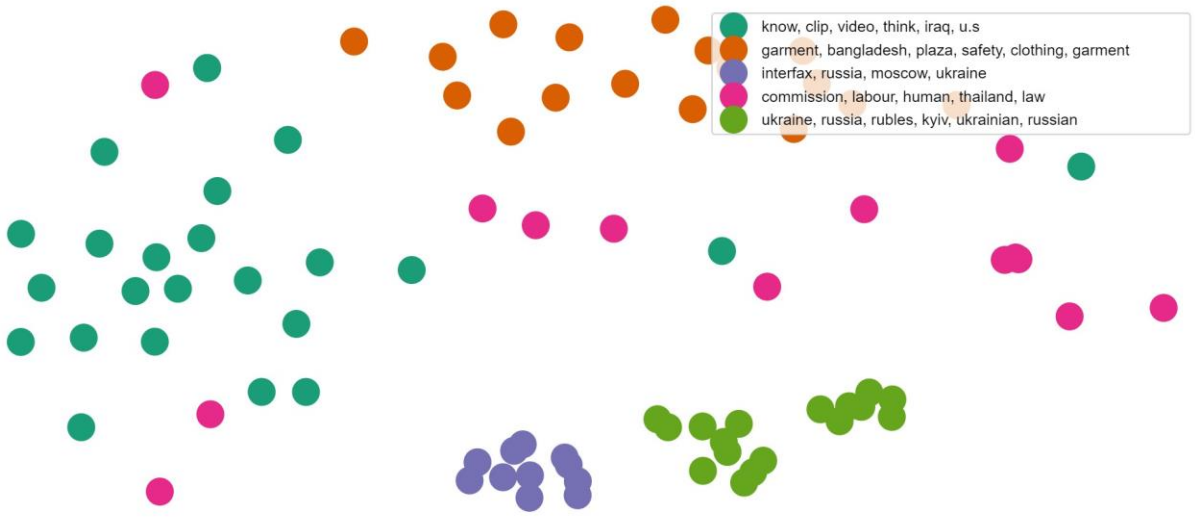


Figure 2: Mined news clusters

We can now study a specific cluster in depth to possibly find signals that would set red flags for certain suppliers. Thus warranting further investigation and inspection of the supplier facilities. For instance, Cluster 1 and Cluster 3 are good examples for further study. Using the text mining output we can then study the frequency of signals as well as potential company names (using POS tag: NNP) to call for further investigations.

Conclusion

Monitoring CSR in a global supply chain is challenging. In this paper we presented a practical model for predicting supplier deviance behaviour. We text mine data for news sources to look for signals of abnormal supplier activities. We provide a case study example using the news data related to infamous and unfortunate accident in the Rana Plaza in Bangladesh.

Our work can be extended in several ways. First, more robust algorithms should be developed for detecting signals of supplier deviance. Second, in the case of big data sets there is a need for more efficient clustering algorithms. Finally, more investigation is needed in how such models can be implemented in practice without negatively impacting the supplier trust in the business relationship.

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Finnish retailer implementation of corporate social responsibility in a challenging fashion and consumer sector

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Introduction

The fashion industry has faced significant changes in its operations since the start of the fast fashion industry in 1990, entailing outsourcing to low-labour-cost countries, shorter product lifecycles, and higher volatility of demand within a complex global context, resulting in extended, complex and inflexible supply chains (Barnes & Lea-Greenwood, 2006; Turker & Altuntas, 2014; Fernie & Grant, 2015). Overseas sourcing has increased competitiveness within the sector, further increasing pressure on suppliers to lower production costs while increasing production speed – a risky proposition. The fashion industry has thus been a part of negative social impacts such as hazardous working environments, poorly constructed factories and lack of fire exits, violations of workers' rights and unfair remuneration for the garment producing countries (Taplin, 2014). As a result, the implementation of corporate social responsibility (CSR) into business practices is important in complex and global fashion supply chains, particularly for retailers (Perry & Towers, 2013). However, fashion consumers also have a social responsibility regarding the sources of their purchases as knowledge about CSR issues occurring in the fashion industry and their beliefs in ethical fashion shapes their purchase behaviour. Through such behaviour, i.e. purchasing or not, consumers can express their concerns on CSR issues through their choice and support of retailers who manufacture under ethical conditions and enhance working environments for garment producers (Chan & Wong, 2012; Shen et al., 2012. While previous studies have investigated CSR implementation and socially responsible purchasing practices in fashion supply chains, little research has been conducted on CSR implementation by Finnish fashion retailers. Thus, this paper discusses an exploratory study on that topic that also includes a Finnish consumer perspective to gain a deeper understanding of both retailer and consumer responsibilities. We developed four research questions for the study:

RQ1: How are Finnish fashion retailers implementing CSR into their purchasing practices?

RQ2: How are Finnish fashion retailers ensuring decent working conditions (human rights, safety and a living wage) at garment producing plants?

RQ3: What is Finnish consumer awareness of social issues in the fast fashion industry?

RQ4: How has this awareness (or lack of it) affected Finnish consumer behaviour?

Literature Review

Increasing risks and disasters in fashion supply chains

During this decade several fatal man-made disasters have occurred at supplier plants for large western fashion retailers and the business model of the fashion industry has been blamed for causing these man-made disasters. There were eight disasters with deadly outcomes occurring primarily in Asia (Cambodia, Bangladesh, Pakistan) from September 2012 to May 2013. The worst occurred in early 2013 when an eight-story textile factory called Rana Plaza

in Dhaka, Bangladesh collapsed killing 1,129 and injuring 2,500 factory workers. The prevailing substandard working conditions and the risks connected to them at the Rana Plaza factory received worldwide media coverage bringing the problems of the fashion supply chains to a greater audience (Taplin, 2014). Besides poorly constructed factory buildings there are fire-related safety issues (Belal & Owen, 2005) and irresponsible business practices against worker's rights, such as insufficient wages, forced labour and indecent working hours are social issues occurring in the fashion industry (Klassen & Vereecke, 2012). Fashion business strategy raises many supply chain management challenges such as short lead-times, cost pressure, low predictability and high volatility which further increase the probability of risk and disasters in fashion supply chains (Turker & Altuntas, 2014; Fernie & Grant, 2015). Moreover, the fashion industry is a highly competitive market containing few but large retailers, and which has resulted in a business strategy of offshore manufacturing in low-labour cost countries to further reduce production costs, increase margins and gain competitive advantage in the market (Barnes & Lea-Greenwood, 2006; Perry & Towers, 2013; Fernie & Grant, 2015). Such a strategy however increases the length and complexity of fashion supply chains and awareness and concerns over CSR issues in this industry have increased among various stakeholders including customers, the media and non-governmental organisations (NGOs). This has in turn further increased pressure on companies to take responsibility of business actions and risks across their entire supply chain (Seuring et al., 2008; Caniato et al. 2012). Thus, managing CSR issues in fashion supply chains is an increasing management challenge due to several barriers such as high price pressure on suppliers, high labour intensity at supplier factories and supply chain complexity (Perry & Towers, 2013).

Implementation of CSR in purchasing practices

Scholars and purchasing managers have identified a need to include CSR in a firm's purchasing and supply management, especially for companies practicing global sourcing. Purchasing managers possess an important role in including social responsibility activities into a firm's performance as they frequently interact with suppliers and other stakeholders such as buyers, internal employees, and the community (Carter & Jennings, 2004). The power of large retailers has increased due to global sourcing, giving them more control and power over the entire fashion network (Fernie & Grant, 2015), which was valued at US$3 trillion in 2016 (FashionUnited, 2016). Decisions made by purchasing managers thus not only influence a company's reputation but could have beneficial consequences on the people and community involved, such as garment producers and the community they live in (McClelland, 2017). Three retail-buying practices impair the working conditions for the garment producers at the supplier plants: more time pressure, more flexibility to meet consumer demand, and a constant search for the cheapest manufacturer that results in short-term buyer-supplier relationships (Perry & Towers, 2013). It is suggested retailers alter their purchasing practices to include reasonable lead-times and avoid last-minute changes to further mitigate the risks for violation of working conditions at garment factories (Overeem & Theuws, 2013; Perry & Towers, 2013), as well as build long-term buyer-supplier relationships to improve the quality of work for factory workers (Fernie & Grant, 2015). Moreover, retailers and purchasing managers should conduct quality assessments such as human rights risk assessment and factory safety & risk assessments before selecting suppliers to ensure that suppliers are fulfilling the company's social standards. The quality assessment method is a proactive way of reducing or mitigating risks from happening at the supplier level. Retailers should also ensure that suppliers provide, support and develop safe working environments for their workers and respect international human rights to further avoid forced labour, inhumane working conditions and child labour (Overeem & Theuws, 2013; Begum & Solaiman, 2016). Previous studies have shown that audits, codes of conduct and quality assessments fail to ensure good CSR results as the

buyer-supplier relationships are still unequal where buyers (fashion retailers) still possesses the greatest power (Perry & Towers, 2013).

Fashion consumer awareness and consumer behaviour

Consumers should also take into account sustainability in their consumer behaviour as they have a high impact on the fast fashion industry as they are the one putting high demands on fashion retailers, which further complicates the structure of the fast fashion supply chains (Barnes & Lea-Greenwood, 2006). Fashion retailers are under constant pressure to offer the newest clothes at affordable prices and in many varieties within this high demand driven industry which further increases pressure from retailers on the suppliers violating the working conditions at the garment producing plants (Perry & Towers, 2013). However, an increase in consumer awareness and concern about social consequences of the fashion industry has pushed the fashion industry (retailers, manufacturers, and suppliers) to become more transparent and ethical (Shen et al., 2012). This has further led to the rise of ethical fashion which is also referred to as "fashion with a conscious" (Shen et al., 2012:235) or as 'slow fashion (Fernie & Grant, 2015). However, barriers such as "lack of awareness, negative perception, distrust, high prices, and low availability" (Joy et al., 2012: 289) have been identified as factors impeding the entry of slow fashion into the fashion market. Furthermore, although consumers state that social and environmental aspects are of importance in their purchasing decisions the price, availability and style of the products are still the key qualities for consumers while purchasing (Chan & Wong, 2012; Shen et al. 2012). The more information and knowledge consumers have about the fashion industry's negative impact on the society, the more likely they are to choose sustainable or ethical products, increasing the demand on ethical fashion as "every buying decision a consumer makes is a vote indicating support or lack of support for how companies conduct business" (Shen et al., 2012: 237).

Methodology

This study was exploratory to increase understanding of the phenomenon under consideration and carried out in spring 2017 (Robson, 1993). We selected three Finnish fashion retailers for interview as shown in Table 1 who each sell women's, men's and children's clothes and represent Finnish fashion companies of different company sizes, different types of companies, and with different sourcing countries.

Company (Abbreviation)	Interviewee Title	Main Sourcing Countries	Number of Employees & Stores
Company A (CoA)	CSR Manager	Bangladesh, China	≈ 8,000 & 6
Company B (CoB)	Sustainability Manager	Baltic countries, China, Portugal	≈441 & 63
Company C (CoC)	Sustainability Manager	China, India, Turkey	≈38,000 & 142 (including food stores)

Table 1: Overview of the one-to-one interviews with Finnish fashion retailers

We also selected two non-government organisations (NGOs) to interview and provide an objective view of the researched phenomenon. NGO1 (campaign coordinator) works closely with issues related to improving the fashion

sector as well as increasing awareness of social issues occurring in it while NGO2 promotes decent working and labour standards as well as the reduction of poverty and inequality in developing countries. Data were collected by semi-structured interviews with the Finnish fashion retailers and NGOs to address RQ1 & RQ2. Interviews lasted between 45-55 minutes and were recorded, transcribed and verified by the respondents to ensure credibility of the study. Additionally, three focus groups were conducted with Finnish fashion consumers between the ages of 20-30 years, both female and male, to gain in-depth knowledge about their awareness of social issues in the fashion sector as well as their resultant consumer behaviour to address RQ3 & RQ4. Each focus group lasted between 40-50 minutes and was recorded. In the results and analysis section of the study quotations from both the semi-structured interviews and the focus group interviews are presented to increase confirmability of the study. Secondary data was collected from the participating fashion retailers CSR and sustainability reports and thus data triangulation was used in this study to enhance the quality and trustworthiness of the study using four criteria of credibility, transferability, dependability and confirmability for qualitative research (Halldórsson & Aastrup, 2003). Data were analysed using a qualitative thematic analysis approach, where themes were coded to support the analysis of the data. Three themes emerged to answer RQ1 & RQ2: challenges in the fashion industry, implementation of CSR, and fashion retailers purchasing practices while three themes also emerged to answer RQ3 & RQ4: consumer awareness, barriers to ethical fashion, and changes in consumer behaviour.

Results and Analysis

RQ1 & RQ2

Challenges in the fashion industry

The fashion industry is one of the most complex and globally scattered industries, which has resulted in a lack of transparency (Perry & Towers, 2013; Barnes & Lea-Greenwood, 2006). Evidence from the interviews supports this view as supply chain transparency and traceability were seen as major challenges for retailers. CoB noted improved transparency is a challenging long-term process and they are aiming to improve it by closely working together with their suppliers. CoC have included supply chain transparency requirements into their purchase contracts. According to both NGOs a way of increasing and improving transparency and traceability would be to disclose supplier lists. Furthermore, audit reports should be published to ensure that conducted audits are legit and trustworthy (NGO1). All interviewed respondents have disclosed all or the most significant suppliers on their web pages to do so, which is an improved step towards transparency in the Finnish fashion industry. In the supplier lists the name of the supplier, factory name and address and country are provided however it is not possible to trace the origin of a certain garment from the supplier lists. Another challenge identified by both CoA and CoC is to ensure safe and ethical working conditions for workers at the supplier level, which could further be linked to issues of transparency. CoA pointed out that working towards improved working conditions is a clear priority for them and they have implemented their own codes of conduct and have been a member of the Business Social Compliance Initiative (BSCI) since 2005 to further improve working conditions in their supply chain.

CSR implementation in the Finnish fashion industry

The fashion market is a highly competitive market where corporations try to squeeze the prices as low as possible to increase margins and gain a competitive advantage on the market (Barnes & Lea-Greenwood, 2006; Fernie & Grant,

2015; Perry & Towers, 2013). However, this cannot be done at the expense of proper working conditions and human rights for garment workers and thus social criteria should be of importance while choosing suppliers. Evidence from the interviews also supported this view. Supplier qualities such as price, lead times, quality, production, and capacity were of importance for the retailers while choosing suppliers. However, sustainability criteria, such as environmental aspects and working conditions were also seen as important aspects for the respondents while choosing the supplier. All respondents pointed out the importance of supplier codes of conduct, or as CoA referred to it as the 'backbone' of their buying practices, as factories are not owned by the retailers. CoA disclosed in their 2016 CSR report that suppliers are scored with a 'supplier scorecard' on how they perform in accordance with the codes of conduct and those with the best scores receive the most orders, hence motivating suppliers to perform according to the codes. Furthermore, all respondents are members of BSCI, which commits suppliers to follow BSCI codes of conduct including fair remuneration, occupational health and safety, and ethical business behaviour. CoB pointed out that it was especially important for the non-EU suppliers to be covered by BSCI, or other audit systems as the risks for social issues occurring are bigger in countries outside EU. CoB has 99% of their non-EU products covered by an audit system and CoC audits 97% of products sourced from risk countries. CoA conducted 123 BSCI audits in factories located in risk countries as well as 92 of its own audits. However, according to NGO1, the BSCI audits do not go far enough as "Too much relies on auditing…it has been shown that many factories cheat and that it's easy to cheat… I once visited a seminar where they showed a website on how to pass BSCI audits [laughing] so I think that companies can't entirely outsource all their responsibility to BSCI". NGO2 argued it is easy for audited factories to advise workers in advance on how to behave and what to answer during audits and considered it would more effective if factory workers were interviewed outside factories during audits as it would make them feel more comfortable and possible issues at factories could be detected. Sub-contracting has been identified as a barrier to implementing CSR into companies purchasing practices as codes of conduct are solely covering the first-tier suppliers and excluding other suppliers. CoA noted that they have a section in their buyer-supplier contract forbidding suppliers to sub-contract without informing them as control and visibility over supply chains deteriorate when sub-contractors are used. Violation of human rights, safety issues, and unfair remunerations are topics constantly covered by the media and NGOs (Klassen & Vereecke, 2012; Perry & Towers, 2013; Turker & Altuntas, 2014) thus requiring focal companies to include these social issues into their corporate performance. All these aspects are included in the Finnish fashion retailers' supplier codes of conduct. All of respondents pointed out that any violation of human rights is considered a serious issue as CoB responded noted: "We have zero-tolerance for human rights violation in our supply chain. If we find out that there have been such violations in our supply chain we address these with our suppliers. Our primary measure to address these issues is not to terminate the relationship but to help the supplier improve their operations. But if the supplier fails to act in a manner consistent with the principles of our sustainability principles we are forced to terminate the cooperation." As the right to fair remuneration is a common problem in poorer sourcing countries respondents mentioned it is included in their supplier codes of conduct. "The remuneration for a regular workweek should be sufficient to provide the workers with a decent living and meet the workers and their family's basic needs. However, it needs to be addressed that reasonable working hours and living wage continues to be major challenges for the industry. We collaborate with manufacturers and joint industry initiatives to promote solving theses issues." (CoB)

Purchasing practices for improved CSR implementation

According to Perry & Towers (2013), three purchasing practices prevent the implementation of CSR in fashion supply chains: last minute changes of order, short-termed buyer-supplier relationships, and unreasonable lead-times. However, evidence from this study showed that long-term, buyer-supplier relationships are important for Finnish fashion retailers: "We prefer long-term relationships with our suppliers and we have been working with some of our suppliers for decades. Longer relationships offer greater opportunities to continuous improvement and development work in terms of e.g. quality and sustainability issues." (CoB) On the other hand, CoC mentioned that long-term relationships were not established with all of their suppliers due to reasons such as poor quality or delivery issues. Finnish fashion retailers are aware of last minute change issues and pointed out the importance of continuous and active dialogue with suppliers to avoid last minute changes. "It is something that we are very aware of at head office and especially in our local production office. It is not allowed to make changes later than a certain date and you cannot make any change you want either. Our production office is seeing to this. If we anyway decide to make a late change and the supplier agrees to it, we have to take a new later delivery date and maybe an upcharge on the price as well." (CoA) Lastly, CoA and CoC both responded they are ensuring reasonable lead-times by having a close dialogue with the suppliers and agreeing on reasonable delivery times. CoA also conducts factory visits to ensure that production is going according to plans and under ethical and sustainable working conditions. CoB noted that they are aiming to follow their internal master processes and schedules to avoid last minute changes and push lead-times that are too short.

RQ3 & RQ4

Consumer awareness

Consumer awareness and increased concerns about sustainability issues in the fashion industry has been identified in the literature (Seuring et al., 2008; Caniato et al., 2012; Shen et al., 2012). Furthermore, sustainability in the fashion industry is a relevant topic in Finland and has been covered in the Finnish media several times during spring 2017 (e.g. Palttala, 2017; Räty, 2017). During the focus group interviews, it was clear respondents were aware of the social issues and disasters occurring in the fashion industry, such as poor wages, long working hours, child labour and the Rana Plaza factory collapse. However, some respondents commented that these issues were not covered enough in the media, especially in Finland. Increased knowledge about ethical issues in the sector increases the likelihood that consumers choose ethical clothes (Shen et al., 2012). Many respondents considered they were aware of the issues and concerned about them but as one respondent (focus group 1, male, 29 years) commented "Yes, I'm aware of the working conditions in South East Asia and when I see that clothes are produced in Bangladesh I think about it but this thought lasts about 5 minutes and then it's gone and I buy it." Another respondent (focus group 1, female, 26 years) also commented that "…it's not something we are exposed to in our daily life and that's why I think we forget it so easy". Furthermore, NGO2 believes consumers do not want to think about bad and sad things and therefore continue supporting the fashion industry despite being aware of these issues. NGO1 agrees consumers are aware of what is happening in sourcing countries but price is still the most important factor for consumers and that consumers are not ready to change their behaviour.

Barriers to ethical fashion

Lack of awareness, negative perceptions, distrust, high prices, and low availability has been identified as barriers for ethical fashion (Joy et al. 2012). All these were raised by respondents as obstacles for consuming ethical clothes.

Price was by far the most relevant factor affecting young consumers as prices of ethical clothes are perceived as expensive, especially for those who are students. One respondent (focus group 2, female, 24 years) commented she is really interested in fashion and is drawn to shops like ZARA offers clothes copied from the catwalk but at a much cheaper price, which is exactly what the fast fashion sectors aims to do (Fernie & Grant, 2015). However, respondents pointed out that much depends on the type of the garment as "…it all depends on what you are buying, if I'm buying socks it doesn't matter where I buy it and for what price, but if I buy a jacket I choose a more expensive, higher quality that I know will last for many years". (focus group 1, male, 29 years) NGO2 identified consumption behaviour as a reason for major challenges in the fashion industry and therefore consumers should be more thoughtful what they purchase. The lack of transparency about the clothes was also something that the respondents experienced as challenging. "Although the price to a certain extent reveals under what kind of conditions the clothes have been made but I know that there are clothes that are really expensive but are made under exactly the same poor conditions that the cheaper clothes are made and I think it's frustrating." (focus group 3, female, 25) Several respondents commented they would like more information about what they buy and that they would be willing to pay more for the clothes they buy if they would be certain that the clothes are sustainably produced and labour conditions would be ethical. Beyond barriers identified by Joy et al. (2012), respondents noted lack of power as another obstacle for ethical fashion; they believe that as individuals they cannot change the system and affect big players such as H&M with their consumer behaviour. However, NGO1 pointed out the importance for consumers to be active citizens, which means putting pressure on retailers and governments and letting them know that consumers are concerned about these issues.

Changes in consumer behaviour

One respondent mentioned she had boycotted H&M and ZARA for one month after watching a documentary on the working conditions in Bangladesh. Both NGOs commented that boycotting should not be used without informing the retailers about it. "If you boycott a company tell them that and don't just be a silent boycotter. Let your voice be heard through many channels, to decisions makers, companies to your friend and colleagues and on social media. Raise your voice and put pressure." (NGO1) Respondents also suggested that as consumers they should demand more from retailers, such as asking the shop staff about the origin of the clothes and demanding more visibility about the origin on the product or on the websites. This was also supported by the NGOs as they pointed out the importance of asking retailers to ensure more transparency. These consumer behaviours can influence fashion retailers, which in the long run can have positive impacts on the working environment for the garment producers (Joy et al., 2012). Respondents also identified social media and word-of-mouth as efficient ways to increase awareness and knowledge about these issues. "There are many of my friends that are against fashion retailers such as H&M and of course it affects me as well. Discussions with my friends have opened my eyes to these problems and I don't want to support it when my friends are not doing it." (focus group 2, female, 21 years). Many female respondents noted they are recycling their old clothes, either giving them away to charity or then selling them to someone else instead of throwing them away. Furthermore, the usage of flea markets and websites where clothes are sold within a specific area of Helsinki is a new way for consumers to sell and buy used clothes. The majority of the respondents believe they have changed their consumer behaviour during the last few years, buying quality instead of quantity and making more thoughtful purchasing decisions and less spontaneous one. However, many respondents believe a change towards ethical and sustainable fashion is happening slowly and they are still heavily influenced by the society. The Finnish fashion retailers confirmed increased consumer awareness about sustainability

with CoB commenting “Consumers are increasingly aware of the impacts of their consumption and they are more and are interested in knowing where, how and by whom their products have been made” [but] “…they are not yet willing to pay a premium price for more sustainable products.”

Conclusions, Limitations and Future Research

This exploratory study contributes by extending existing theory on CSR implementation in retailer purchasing within a Finnish context as well as insights into Finnish fashion consumer behaviour. The lack of transparency along supply chains is the biggest challenge for Finnish fashion retailers however they have taken steps toward improving by publishing supplier lists to increase traceability for stakeholders. These retailers are implementing CSR into their supply chains through carefully selecting suppliers and taking sustainability criteria into account including audit systems such as BSCI. Respondents emphasised supplier codes of conduct as a cornerstone for maintaining social responsibility along the supply chain. The most distinctive finding was that long-term buyer-supplier relationships were established between Finnish buyers and their suppliers to reduce purchasing barriers such as last minute changes and lead-time pressure. Finnish fashion retailers consider safety and human rights are important aspects in their supply chain and corrective actions plans and close collaboration with suppliers were identified as important tools. Finnish fashion retailers are also working towards providing the garment workers with fair remuneration through collaboration with unions and other sector companies to encourage governments to increase minimum wages. Finnish consumers are aware of social issues occurring in the fashion sector and the negative impacts their consumption behaviour entails. However, price and availability were identified as main factors affecting purchase decisions. An increased interest in supporting ethical fashion was identified but there is a lack of ethical and sustainable clothes in the Finnish market, especially clothes considered appealing to younger consumers. Hence, there is a need for more ethical fashion brands to enter the Finnish market. Finally, Finnish fashion consumers pointed out a lack of media attention for these issues in the media, increased media coverage would increase knowledge among consumers. This study was limited in focus in the Finnish market and further research should be conducted across other countries.

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Greening: the machinery for supply chain competitiveness and sustainability performance

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Abstract

Purpose: Green supply chain management (GSCM) implementation has become the new machinery for enterprises seeking to become more sustainable. The purpose of this study is to review the literature on the relationship between green supply chain management (GSCM) practices, competitive advantage and sustainability performance simultaneously.

Research Approach: A conceptual model is expounded showing the relationship between (GSCM) practices, sustainability performance and competitive advantage.

Findings: Based on literature review, GSCM practices are looked at from different perspective. There is no unity with respect to conceptualisation of GSCM practices and organisational performance. Again the literature review also showed that there is mixed reaction and inconclusive findings with respect to the impact of GSCM practices on firm performance. Other researchers argue that there is no impact of GSCM practices on firm performance especially economic, while other researchers agree that adoption of GSCM practices by manufacturing firms leads to improved economic and environmental performance.

Originality/Value: This research presents as one of the first studies to comprehensively develop GSCM practices, competitive advantage and sustainability performance model simultaneously. The model also shows critical enablers that influence adoption and implementation of GSCM practices.

Implication: The findings will provide managers of manufacturing firms in UK more confidence and hope to implement green supply chain management (GSCM) practices to gain competitive advantage and sustainability performance.

Research Implication: This research helps to extend the debate on green supply chain management (GSCM) particularly the relationship between green initiatives, competitive advantage and sustainability performance.

Keywords: Supply Chain Management, Green Supply Chain Management (GSCM), Competitive Advantage, Sustainability Performance, Manufacturing

Introduction

As the world population continues to grow and preference for high quality of life increases, the difficulty facing manufacturing firms is how to satisfy these teeming demands using limited resources while generating less pollution and waste (Hami et al 2015). Manufacturing firms are therefore not immune from contributing to these environmental devastations. It is evident based on empirical and anecdotal studies that raw materials acquisition, manufacturing, logistics and marketing activities of these manufacturing firms impact negatively on the environment (Eltayeb et al, 2011). Greening the supply chain management is regarded as innovative machinery that can restore sustainability to the environment. But for the concept of green supply chain management (GSCM) to achieve its purpose, managers of manufacturing firms need to integrate environmental consciousness into every level of the supply chain such as product design, sourcing for materials, manufacturing, storing, distribution and end of life management (Rao and Holt, 2005). The rational of GSCM is to reduce and eliminate waste and reduce the use of material in production process thereby promoting efficiency and synergy among the supply chain partners to ensure competitive advantage and sustainability performance (Thoo et al, 2015). The lack of consensus on conceptual framework variables relating to green supply chain management and sustainability performance has emerged as the reason for lack of knowledge convergence, mixed reactions and inconclusive results (Thoo et al, 2015).This paper therefore presents a literature review of the relationship between green supply chain management practices, competitiveness of the firm and sustainability performance. Again this study develops a model to expound the linkages between selected green supply chain management practices, competitive advantage and sustainability performance.

2.0 Green Supply Chain Management

Green supply chain management has been defined differently and various literature on this topic has been reviewed many times (Sarkis et al 2011). One thing that comes out in all these definitions is the integration of environmental consciousness into the traditional supply chain with the aim to improve the environmental performance of the partners in the supply chain whilst harnessing the potential to improve their social and economic performances (Rao and Holt, 2005; Zhu & Sarkis 2004, Govinda et al., 2014). Other researchers also attempted to define GSCM using only one practice such as green purchasing (Green et al., 1996), green logistics (Murphy and Poist, 2003).However over the years in recognising the significant of GSCM some researchers have taken the conceptual level to a higher stage (Guang et al., 2012).

For Zhu and Sarkis (2004), GSCM consists of internal environmental management, external GSCM, investment recovery and eco design. Similarly, (Zhu & Sarkis 2007) recognise GSCM as consisting of internal environmental management, green purchasing, customer cooperation, and investment recovery and eco design. Rao and Holt (2005) defined GSCM to consist of inbound logistics, production or the internal supply chain, outbound logistics and in some cases reverse logistics which included material suppliers, vendors distributors and end users. For (Kushwaha et al., 2016) GSCM composes of green marketing, green production, green advertisement, eco labels and reverse logistics. Scur and Barbosa (2017 conceptualised GSCM practices as internal environmental management, reverse logistics, green purchasing, eco design, life cycle assessment, waste management and green manufacturing.. The difference in definitions and practices of GSCM shows lack of consensus amongst the researchers because GSCM is a phenomenon that lies between corporate environmental management and supply chain management both which are relatively new area of study and practice (Zhu and Sarkis, 2004).

Research framework

Fig. 1 presented in this study shows that GSCM practices impact on sustainability performance and competitive advantage. After literature review GSCM practices in this study are conceptualised as eight green initiatives. The eight constructs are; green purchasing, eco design, customer cooperation green production, investment recovery, green distribution, green marketing and reverse logistics. All these dimensions were extracted from extant literature (e.g. Rao and Holt, 2005; Li et al., 2006; Zhu and Sarkis, 2004; 2006; Govindan et al., 2014; Rahman et al., 2014; Hami et al., 2015; Kushwaha et al., 2016). Sustainability Performance items were developed from literature review (e.g. Zhu and Sarkis, 2004; Li et al., 2006; Govindan et al., 2014; Kushwaha et al., 2016). The competitive advantage variables were developed from literatures (e.g. Li et al 2006; Govindan et al., 2014; Porter and Van der Linde, 1995). The enablers were developed from literatures (e.g. Rahman et al., 2014; Zailani et al., 2016)

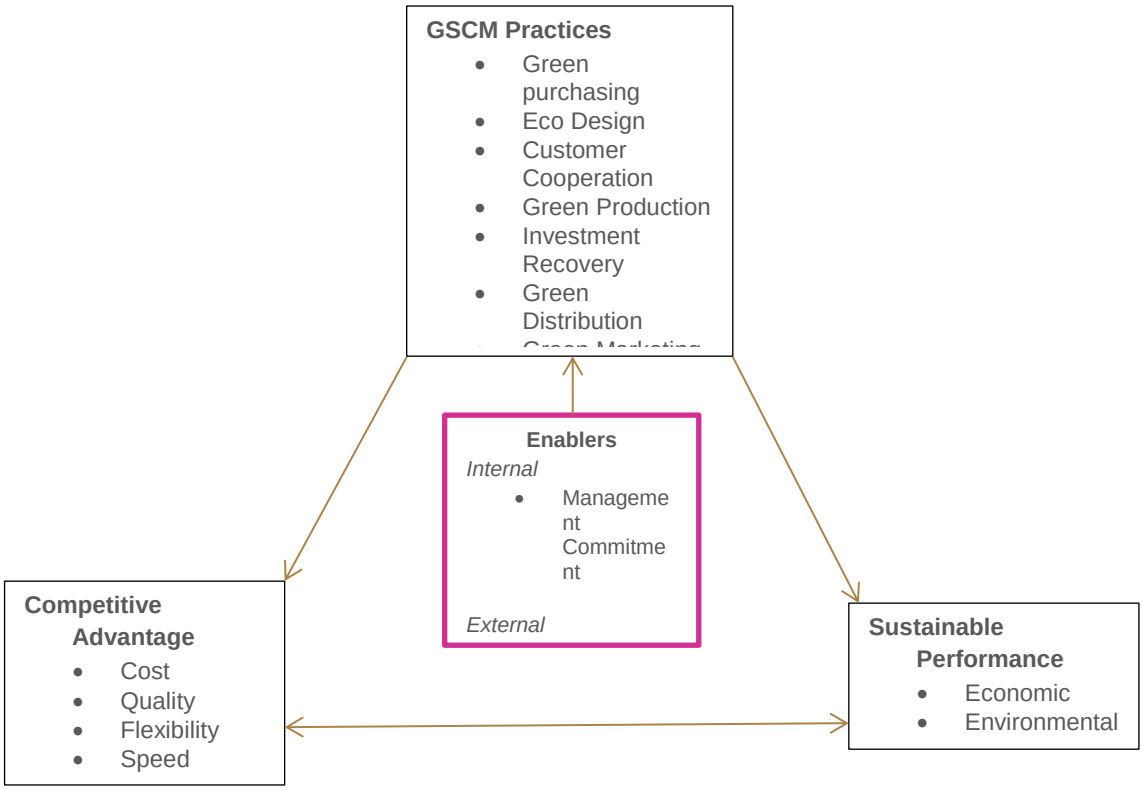


Fig. 1 Conceptual framework

Sustainability Performance

With the rising environmental awareness among stakeholders of business organisations, the concept of sustainability has become very significant to manufacturing firms. Sustainability has been described severally and (Kushuwaha et al., 2016) state that, sustainability is aggregation of activities that can be described as responsibility for the world in which we live. Zailani et al (2016) categorised sustainability into three components; economic, social and

environmental. The Brundtland report defined sustainability as development that meets the needs of present without compromising the ability of future generation to meet their own needs (GRI, 2013)The increasing environmental awareness by stakeholders is exerting pressure on organisations to be more accountable for their actions and manufacturing firms are over the years adopting more proactive environmental strategies in their supply chain management (SCM) to help achieve sustainability performance (Zhu and Sarkis, 2004).

Zailani et al (2016) further argue that firms that adopt environmental management practices not only enjoy improved corporate image but also avoid the hassle of paying expensive penalties for environmental related incidence. This study examines how green supply chain management (GSCM) practices implementation impact on each of these sustainability principles in the next chapters.

5.1 GSCM practices and Environmental Performance

Environmental performance is very important to manufacturing firms due to reasons such as competitive advantage, regulatory compliance and public perception (Zhu and Sarkis, 2004). Green et al (2012), posit that GSCM has become a strategic imperative because customers are demanding for product that are more sustainable and which their design and process of manufacturing do not impact negatively on the environment. Environmental performance has therefore become a great concern to manufacturers because of consequences such as penalties, fines, negative public perceptions (Zhu and Sarkis, 2004). This scenario has called for a total evaluation of the life cycle analysis of products using environmental sustainability performance Metrix that assesses the impact of green supply chain management (GSCM) practices on the environment (Zhu and Sarkis, 2004). Although some previous studies have not been able to establish any positive linkage between GSCM practices and environmental performance (Hart and Ahuja, 1996; King and Lenox, 2002), others have made strong case in favour of the impact. This suggests that there is mixed reaction and lack of knowledge convergence with respect to this relationship (Zhu & Sarkis, 2004)

Prior research looking at the impact of GSCM on environment has made positive strong argument with respect to the relationship between GSCM and environmental performance (Rahman et al., 2014). Zhu and Sarkis (2004) state that GSCM practices tend to have a win-win relationship in terms of environmental performance. Zhu and Sarkis (2004) conclude that proactive environmental management practices perform better and therefore impact on the environment positively. GEMI (2001) posits that customers are holding companies liable and responsible for the environmental liabilities of their suppliers because customers are unable to dichotomize the role of suppliers and the role of the manufacturer. And therefore considering the high cost of compliance many manufacturing firms find value in proactively addressing regulations.

GSCM practices within the organisation such as eco design, green purchasing, reverse logistics, green production, impact positively on the environment by helping to minimise usage of hazardous materials, reducing energy usage, reducing waste generation and reducing pollution (Govindan et al., 2014; Rahman et al., : Geng et al., 2017). For example Proctor and Gamble adds supplier experts to its planning teams to implement Design for environment (DFE) to minimize the total costs and impact of a product through its life cycle (GEMI, 2001).

5.2 GSCM Practices and Economic Performance

Economic performance of organisations represents the direct impacts of the firm's green practices on the core outcome measurement such as the market and financial outcomes in addition to customer satisfaction (Rahman et

al., 2017). However many studies have found that firms that comply with GSCM practices bear additional cost thereby hurting the profitability of the firm and therefore support the idea of trade-offs between environmental performance and economic performance (Rao and Holt, 2005). Hart & Ahuja (1996) argue that economic performance is not clearly being achieved in the short term. This scenario has created impression within the ranks of manufacturers that GSCM practices are implemented out of altruism (Blanchard, 2010).

One common outcome in GSCM practices is cost reduction Eltayeb et al 2010b; Rahman et al 2017) and strong financial performance (Green et al., 2012). According to Green et al (2012), GSCM practices are associated with waste elimination and such minimisation leads to reduced cost of operation resulting in strong economic performance. Zhu and Sarkis (2004) also argue that there is evidence to suggest that proactive GSCM practices prepare firms for superior longer term performance through development of capabilities for continues improvement. Porter and Van der Linde (1995) posit that the global market demand is shifting towards low pollution and energy efficient production, resources efficient products, with the intend to reduce cost of production and also to open up new market segments resulting in increased profitability. For example the market for environmentally friendly goods is over $200 billion, because business customers want reduced hazard (GEMI, 2001).

5.3 GSCM Practices and Social Performance

Despite the popularity of sustainability performance literature, the relationship between GSCM practices and social performance is examined by a limited study. Social sustainability performance like other sustainability dimensions indicators has been argued by some previous studies to have no relationship with GSCM practices (Hart and Ahuja, 1996; King and Lenox, 2002). However Zailani et al (2016), Luthra et al (2016), have all strongly argued a positive relationship between GSCM practices and social sustainability performance. Social sustainability as described by (GRI) is concerned with the impact an organisation has on the social system within which it operates (GRI, 2013). Luthra et al (2016) posit that social performance indicates improvement and maintenance of quality of standards of life without compromising the environment and overexploitation of the natural resources. Green practices such as green purchasing, green design, green production green marketing have been identified as imperative issues for social sustainability (Govindan et al., 2015; Luthra et al., 2016). Social sustainability metrics such as reduction in environmental risk, contribution to environmental protection, corporate image and reduction in work place accidents are achieved as a result of implementation of GSCM practices (Luthra et al., 2016). For example fourteen employees of Foxconn, a major manufacturer in China supplying major companies such as Apple, Dell, HP, Motorola, Nokia, Sony, attempted suicide between January and November 2010 because of poor working condition. This therefore indicated that production of goods, business growth and profit agenda should not happen at the expense of wellbeing of workers and communities (Geng et al 2017).

5.4 GSCM Practices and Competitive Advantage

Competitive advantage is defined as the extent to which a firm is able to create and maintain defensible position over its competitors. It includes capabilities that enable a firm to differentiate itself from its competitors (Li et al., 2006). Several studies have been conducted in the past to investigate the relationship between GSCM practices and competitive advantage (Rao, 2002; Zhu and Sarkis, 2004). However Masoumik et al (2014) indicate that no consensus exists within extant literature concerning the positive impacts of GSCM practices on competitive advantage. While most literature show no significant relationship because they associate the relationship with involving trade-offs

between social benefit and private costs (porter and Class der Linde, 1995), other studies emphasis on positive relationship (Li et al., 2006; Masoumik et al., 2014). Conceptualisation of competitive advantage over the years has been based on the work by (Porter, 1980) who suggested two generic strategies a firm can adopt to achieve competitive advantage: cost leadership and differentiations.

Cost leadership is achieved when a firm carries out activities in the value chain at a price lower than its competitors. The same way applies when a firm strives to achieve service leader through differentiating their product by providing unique services to the customers with the aim to achieve competitive advantage (Aggarwal and Ming, 2013). Porter (1985) further argued that pursuing the cost leadership and differentiations simultaneously is unlikely to produce sustainable advantage and a firm that tries would risk being ''struck-in-the-middle'' (Aggarwal and Ming, 2013; Laari at el., 2017). This assertion by Porter has been challenged by (Laari et al., 2017), they argue that there is no uniquely low cost position and thus firms have to pursue both strategies at the same time in order to gain competitive advantage.

The natural resources based view (NRBV) developed by Hart (1995) is the theory that explains the role of GSCM practices in generating competitive advantage (Masoumik et al 2014). According to this theory, implementing GSCM practices would lead to competitive advantage in terms of lower costs, improved reputation of the firm, and long term growth. For example according to (Porter and van der Linde, 1995) Raytheon a company based in America was compelled by the Montreal Protocol and the USA clean Air Act to eliminate ozone depleting chlorofluorocarbon (CFCs) used for cleaning printed electronic circuit boards. After adopting semiaqueous, terpene-based cleaning agent that could be reused, it proved to result in an increased in average product quality thereby securing them competitive advantage over their competitors.

6. Conclusions

Business organisations today face huge pressure than ever before to be more proactive environmentally in their production process to help protect the natural environment. Therefore many businesses are using GSCM practices as a machinery to achieve sustainability performance and securing competitive advantage (Porter and Van der Linde, 1995; LI et al., 2006; Laari et al., 2017). However despite the many studies conducted on green supply chain management practices the results have come out inconclusive and this lack of knowledge convergence has called for further studies to be conducted into this phenomenon using empirical data (Geng et al 2017). This study also found lack of unity in conceptualising GSCM practices and sustainability performance.

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Identifying Green Logistics Best Practices Leading to the Effective usage of Pharmaceuticals: A Case STudy of Thailand's Public Hospitals

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Abstract

Purpose

Pharmaceuticals are a key input into healthcare operations and so their effective management is vital. This issue is of key importance in Thailand and is aligned with the Thailand's 2nd National Logistics and Supply Chain Research Strategies (2012-2016) focusing on healthcare green logistics. Pharmaceuticals in hospitals account for more than 50% of the total hospital purchasing budget. Moreover, the overuse of medicine was generally found to be prevalent in Thai hospitals despite serious financial concerns. The aim of this study was twofold: Phase (i) to investigate the movement and lifecycle of pharmaceuticals within Thai hospital sites and Phase (ii) identify the GL practices that effectively control/minimize the use of pharmaceuticals.

Research Approach

Using a case research method six hospitals were examined, to give coverage of the different types/sizes, locations and a range of environmental performance issues. Hospital visits were undertaken during January to July 2014, to obtain data by using a multi-method approach: interviews, documentation reviews and in situ observation. Purposive respondent sampling was undertaken to ensure that data was collected from staff with experience of pharmaceutical management and a bespoke form of content analysis used for the data review before further cross-case analysis.

Findings and Originality

The result of Phase (i) revealed that pharmaceutical flows appeared to be sophisticated and problematic, caused by issues such as limited budget allocation, ineffective governmental processes, and the over-prescribing of medicine for chronic patients. The findings also identified effective GL practices such as: (i) prescribing medicines for only 1-2 months for some patient conditions/drug types and increasing the frequency of follow-up reviews, (ii) conducting a medicines return programme and (iii) having a clearly defined system of pharmaceutical product review. The outcomes of the study proposed key practices to support a Sustainable Health System at both policy and hospital levels. Within this were: (i) a representation of stakeholder views, (ii) the provision of healthcare education and communication, (iii) addressing self-health management issues and (iv) planned system review and improvement. The design and execution of such a system should be grounded in Thailand's Sufficiency Economy Philosophy (SEP) concept.

Research Impacts

In the GL research paradigm public healthcare, developing nations, human elements and life-cycle products have received limited attention; this study therefore contributes to the reduction of these gaps. The SEP concept was highly recommended by the United Nations, instead of Sustainable Development, in addressing GL practices in Thai culture to promote sustainable health standards and this underpins the focus and the originality/impact of this study.

Practical Impacts

This study recommends that staff in Thai hospitals focus on effective pharmaceutical management to contribute to the sustainability of good GL practices (as identified) and to the design and delivery of a Sustainable Health System in Thailand. The study presents guidance and support to do this.

Introduction

Pharmaceuticals are a key hospital resources in terms of medication and budget spent. In Thailand there are two key national policies which support the increased rationalisation of medicines use (Sumpradit et al. 2012), and to address green logistics (GL), but how this is actually achieved operationally is unknown at present. As reported in various studies, improving logistics efficiency in Thai hospitals is often obstructed particularly by the government systems/policies (e.g. the use of a paper-based system and several approval processes), poor supervision, financial crises, and overuse/irrational use of medicines (NaRanong and NaRanong 2011; Singkarin 2011; Kaplan et al. 2012; Rattanaumpawan 2015). Such barriers need to be addressed and overcome which requires a need for restructure the approach to and execution of medicines management (focusing on both human and physical elements that impact directly on this) at both national and hospital levels to meet this national agenda. One approach that can be considered to effectively manage medicines, is to focus on four main streams of logistics including people, resource, information and finance were observed (Bisson et al. 1993; Tseng et al. 2005). This study will to investigate the movement and lifecycle of pharmaceuticals within Thai hospital sites and identify the GL practices that effectively control/minimize use of pharmaceuticals. In doing so it will also reflect on management culture, policy and regulation and stakeholder influence on this supply chain.

Literature Review

The definition of Medicine as used in this study refers to a substance, especially in the form of a liquid or a pill that is a treatment for illness or injury (Cambridge Dictionary 2017). The words “medicine” and “drug” are used interchangeably (WHO 2016: p. 8). In Thailand, all public hospitals are governed by the Ministry of Public Health (MOPH), and in the main receive pharmaceutical products from the Government Pharmaceutical Organization (GPO). The hospital pharmacy has the following responsibilities: (i) interacting with the prescriber (doctor) to promote the rational prescribing and use of drugs, (ii) selecting drugs and dosage regimens, and (iii) monitoring patient compliance and therapeutic response to drugs (WHO 1994). Below is the summarised medicines management in Thailand, as the analysis report of WHO (2016: pp. 8-14):

Thailand has a remarkable health delivery system which over 90% of essential medicines has been provided in public hospitals with very small levels of stock out. Each hospital can submit the order the required medicines to suppliers by itself. However, no national standardized formulas for stocking/purchasing medicines (both types and volumes)

has been addressed yet. Thus the compliance with the national Essential Medicines List can be questioned. Currently, the medicine management system is totally electronic, controlled by the hospital. Sharing information between hospitals and GPO/MOPH/NHSO1 is still limited.

In promoting rational, safe and cost effective use of medicines, it should be introduced in both undergraduate and postgraduate curricula, as well as more monitoring on e.g. existing patient records. All hospitals providing an annual report on drug consumption for MOPH, to identifying high cost medicines and % budget spent on non-essential medicine listed drugs. Moreover, the national standard treatment guidelines (STGs) should be developed, and able to access online.

From the analysis of WHO, the over/irrational use of medicines occurs because of using medicines for reasons other than those indicated in the prescribing literature (Lessenger and Feinberg 2008). There are four causes of this event: (i) lack of knowledge, (ii) patient-physician relationship in terms of monetary cost, (iii) poor availability of proper alternative medicines and (iv) weak supervision of regulatory bodies (Yousefi et al. 2012). Such irrational prescribing has led to healthcare challenges such as rapidly increasing antimicrobial resistance (due to over-use of antibiotics) (Holloway and Dijk 2011), the scale of which has received international recognition (Carlet et al. 2012) and (iv) costing the hospital more than the use of expensive drugs (Price et al. 1986).

In 2012 the MOPH therefore introduced the policy, “Reduce cost of medicine and medical supply by 10%” (Ministry of Public Health 2013). This is supported by such goals as: (i) establishing joint procurement to increase purchasing negotiation; and (ii) implementing the standard cost accounting system to effectively monitor cost. To increase efficiency of medicine stock management and improve the rational use of medicine, the MOPH (2012) has set several policies: such as reduce stock reservation (turnover rate) to be less than 3 months, and select uses ‘unit dose’ or ‘daily dose’ systems. Reducing medicine usage is recommended in the case of overuse or irrational use as mentioned. Clearly, there is neither clear guideline/measurement indicators for reducing use of medicine, nor green practice for medicine (Punpeng 2011). Some alternative therapies/practices, like practising mindfulness that reduces stress, pain and blood pressure, appeared to be effectively reducing medicine, healthcare cost and improving health (Schneider et al. 2012). Hospitals can also focus on more physical and tangible factors such as increasing medicines vigilance and recycling (Xie and Breen 2012) to rotate stock to reduce waste and obsolescence and instigate savings via improved inventory management. Lastly, nearly-expired and deteriorated medicines that have a shelf life longer than 6-7 months can be exchanged with suppliers (Visuttikhun 2012). Visuttikhun also suggested that to reduce expired items and shortage, the hospital should provide more frequent checking on shelf-life and distribution, reduce the volume reserved (e.g. on wards), focus on first-expired first-out (FIFO), and periodically record nearly-expired items to remind staff to use them in order.

Methodology

This research aims to (i) investigate the movement and lifecycle of pharmaceuticals within Thai hospital sites and (ii) identify the GL practices that effectively control/minimize the use of pharmaceuticals. To answer this main question, four sub-questions were formulated and delivered to:

[1] National Health Security Office

How should we measure the best Green Logistics practices of pharmaceutical management?

How do hospitals manage this resource, from purchase planning through to waste disposal?

What practices support/facilitate excellence in GL performance in Thai public hospitals?

What barriers are identified which undermine effective GL practices and performance in Thai public hospitals?

In a complex organization like healthcare facilities, Bisson et al. (1993) recommends using various tools for data collection which include documentation, interviewing and observation. Thus, these tools were used to record and understand the medicines management from purchasing through waste disposal. Six case hospitals agreed to participate in this study (called “A”, “B”, “C”, “D”, “E” and “F”). These sites were different types/sizes, locations and had a range of environmental performance issues. All names of case hospitals and their locations (provinces) remain anonymous. The site visits tool place in January to July 2014 to obtain data. Purposive respondent sampling was undertaken to ensure that data was collected from staff with experience of pharmaceutical management. A large volume of data obtained was managed by ‘content analysis’ method which helped to examine and select key information (UTEXAS 2011). The selected data can then be analysed and compared with the criterion, and identified the performance – using ‘cross case analysis’ method (Miles and Huberman 1994: p. 190).

Findings

How should we measure the best Green Logistics practices of pharmaceutical management?

The concept of best practice refers a technique or method or process delivers a more effective outcome than any others (Frontex RDU 2012: p.19). Therefore, good practices must be able to (i) reduce the amount of resource used/waste generated/other environmental impacts, and/or (ii) increase cost reduction/improved revenue, and/or (iii) offer well-beings, and/or (iv) provide fast logistical movement (McKinnon 2010; Singkarin 2011). More detail on this is presented in the literature above.

How do hospitals manage this resource, from purchase planning through to waste disposal?

To answer the second research question, this section examines the close-loop pharmaceutical logistics within the hospitals. The findings indicated that case hospitals mostly use a centralized administration system in which the Director has the highest authority followed by the board of committee. An overview of this closed-loop system is presented in Figure 1.

It was found that most public hospitals often purchase resources twice a year or quarterly. However, this led the large amount of financial investment and over-stock, generated financial crisis and wastage medicines. Therefore, the MOPH requires a more frequent purchasing, every 1-2 months. However, larger-sized hospitals, like “E” Hospital conducts purchasing every week, with the “E” pharmacy issuing 50 purchasing order (POs) a week or 2,000 POs a year. From purchasing to making payment, the electronic system such as e-purchasing and e-payment is not allowed in the government system as mentioned by all interviewees.

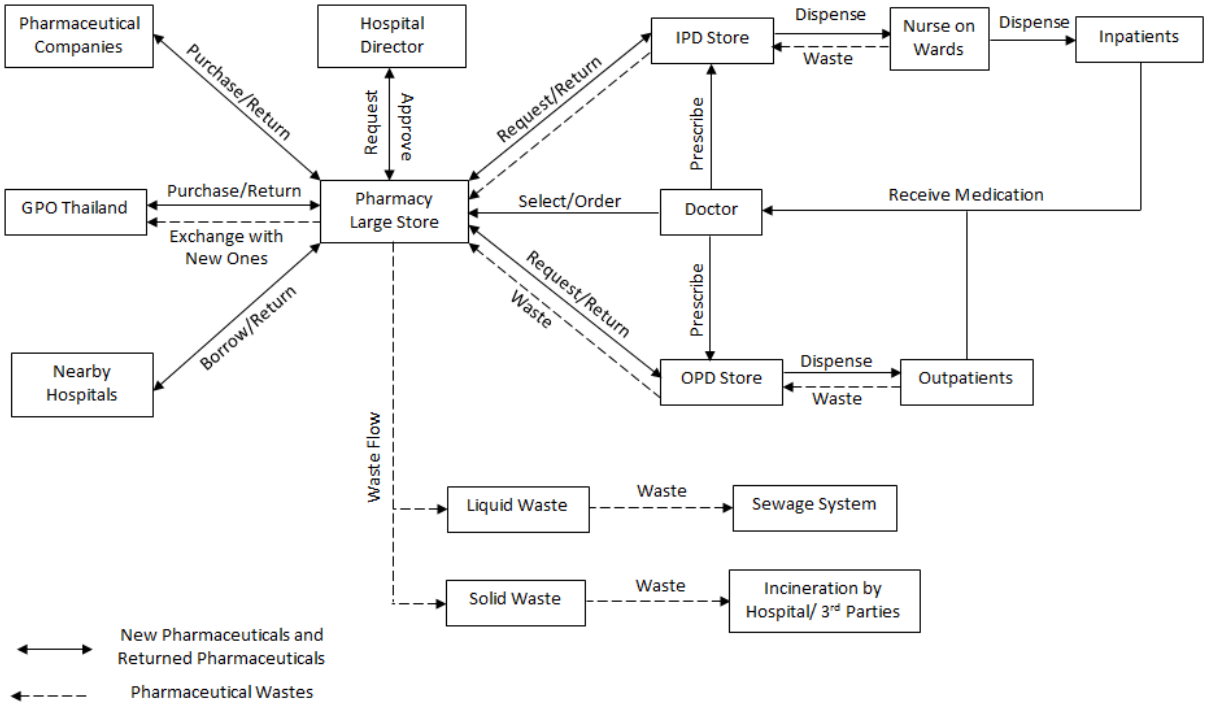


Figure 1: Diagram of Medicines Management of Thailand's Public Hospitals.

Source: Adapted from Ninsananda (2013).

Therefore, this contrasts with the report of WHO (2016: pp. 8-14). Paper-based system is highly time-consuming. Regularly, the required items are moved from mentioning stock to (i) inpatient store (IPD store) to distribute to all wards, clinic, etc. as their requisitions, and to (ii) outpatient store (OPD store) to dispense to outpatients.

Medicine waste is hazardous and consists of four categories: medicines left over; nearly expired medicines; deteriorated medicines; and expired medicines. Pills and capsules have to be disposed via thermal processes or safe landfill, while liquids need to be diluted before being discharged into hospital sewage systems. While the GPO receives expired medicines in exchanging with new ones, private vendors require products with at least 4-6 months lifetime. Before the formal disposal of pharmaceutical waste, it must be approved by the Regional Revenue Department and Provincial Health Office. This is because this resource has high value, which the approval can be taken several months.

What practices support/facilitate excellence in GL performance in Thai public hospitals?

There are general practices adopted for effective stock management, including adopting FIFO (first-expired first-out), information systems, and unit dose systems. FIFO means items with a shorter lifetime will be used or removed first from stock. Unit dose systems dispense medicines for inpatients according to the meal rather than on a daily basis, which gives better control through having fewer medicines left from wards. "A", "D", "E" and "F" hospitals can meet 1-2 months with more frequent monitoring of stock. Also, the doctors are advised not to over-prescribe medicines and have asked for more cooperation.

To meet necessary cost reduction (10%), several practices were adopted: (i) conducting a joint procurement; (ii) adopting antibiotic smart use (ASU program); (iii) adopting a returned medicine programme and (iv) holding only one item for each generic drug name. Adopting an ASU programme can reduce drug resistance and cost of expensive antibiotics. Sites "B", "C", "D" and "F" undertook a returned medicines programmes of patients with chronic conditions.

The evidence collated from the study shows that only site "D" was successful in minimizing medicines usage (by 5.67% which converts to 29,588 Baht (see Figure 2).

Environmental Practice	"A" Hosp (60 Bed)	"B" Hosp (90 Bed)	"C" Hosp (150 Bed)	"D" Hosp (30 Bed)	"E" Hosp (528 Bed)	"F" Hosp (40 Bed)
1st Outcome: Turnover rate is 1-2 month	1.5 Month	3-3.5 Months	3 Months	1 Month	1.5 Month	1.2 Month
Summary	Success	Failure	(Discuss)	Success	Success	Success
2nd Outcome: A volume use of medicines	Increased (15.78%), per bed (174,731 B)	Increased (44.38%), per bed (213,793 B)	Increased (58.36%), per bed (208,154 B)	**Decreased (5.67%), per bed (29,588 B)**	Increased (from interview)	Increased (8.89%), per bed (215,661 B)
Summary	Failure	Failure	Failure	Success	Failure	Failure
3rd Outcome: A volume of returned medicine per year	No Practice	2011: 133,488 B, 2012: No Data, 2013: 123,668 B	More than 100,000 Baht a year (from interview)	About 200,000 Baht a year (from interview)	No Practice	Year 2011: 33,210 B Year 2012: 34,919 B Year 2013: 73,622 B
Summary	No Practice	(Discuss)	Success	Success	(Discuss)	Success

Figure 2: Outcomes of Adopting Medicine Practices (All site analysis). Source: by Author.

What barriers are identified which undermine effective GL practices and performance in Thai public hospitals?

The most important barrier was found to be hospital personnel. The findings indicated a reluctance to reduce ordering and stockpiling as this could adversely impact on medical treatment. Presently, there are neither strong guidelines nor evidence to confirm the benefit of reducing medicines, or suggestions of how to affect it. On top of that, physicians do not want to change their habits in prescribing medicines ("A", "B" and "F" Hospitals). Some of them had never been informed about the financial situation, and were rarely asked for cooperation.

The policy of the MOPH that requires purchasing every 1-2 months to improve finance liquidity was obstructed by physicians who often prescribe long-term medicine for 4-5 months. In consequence, an imbalance between stocking and using rates emerged; and led a resource shortage and internal conflicts among physicians and pharmacists. "C" maintained a 3-month turnover rate because of the need to distribute this resource to nearby hospitals rarely faces shortage and conflict issues.

Discussions

The study of integrating Green Logistics (GL) in Healthcare settings, including medicine, was suggested by the Thailand's 2nd National Logistics and Supply Chain Research Strategies (2012-2016). Previously, the MOPH (Punpeng 2011) had developed the best green practices for hospitals, but this work had its limitations: an incomplete view of the close-loop system, unclear measurement indicators and no specific practices for medicines. Poor understanding of the above areas can highly affect the effective addressing GL practices. The authors chose to deliberately focus on these gaps within this study. As reported above, authors such as Ninsananda (2013) have presented a picture of medicines flow/logistics within hospitals, but the close-loop view was absent from this study. The outputs of this study presented an adapted and more comprehensive overview of this process (identifying system design and participants), as shown in Figure 1. Previous studies focusing on the effective use of medicine (e.g. Ministry of Public

Health 2012; Schneider et al. 2012) tended to examine a single area such as rational prescribing and practicing mindfulness. Clearly an integrated view of a sustainable health system was lacking. By adopting a holistic approach to GL practice identification in supporting medicines management is a more effective lens within which to examine this important area of Thai healthcare. Such an approach encompasses the hospital as a business, hospital staff, patients and community, body and soul development, and reduces potential negative impact on the environment (reduction of chemicals in circulation).

Conclusions

This study demonstrates that Public hospitals in Thailand still face the problem of irrational use/overuse of medicines. To improve this situation, the life cycle of medicines should be understood by hospital personnel and every effort made to demonstrate good green logistics practice within this supply chain. The findings within this study clearly outline deficiencies within public hospital sites such as ineffective communication between key users of this system (physicians, pharmacists, and patients) which undermines collegiality and cooperation, and (ii) ineffective systems/policies (no clear guidance and control) leading to poor medicines management. Whilst a gloomy picture it is not damning as there was evidence of effective GL practice in place also such as prescribing medicines for only 1-2 months for some patient conditions/drug types and increasing the frequency of patient follow-ups. Such practices aim to contribute to the sustainability of good GL practices and to the design and delivery of a Sustainable Health System in Thailand at both policy and hospital levels. Further enhancements of this study would include greater collaboration with the Thai Pharmacy Council to extend this study to a wider audience, with the aim of presenting generalizable outcomes.

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Hospital Logistics

Investigating the laundry logistics system of small-sized public hospital: Can the efficiency of operations be improved under the constraints of Thailand's administrative culture?

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Abstract

Purpose

All internal logistics systems contribute to the overall success of healthcare service delivery; laundry management (as a closed loop logistics system) is a critical system which facilitates patient recovery and rehabilitation. Studies indicate that applying efficiency measures/improvement tools in such systems, can deliver financial savings and strengthening of in-house competencies (Banerjea-Brodeur et al. 1998; Golden et al. 2008). This study focuses on the review and improvement of laundry management systems in a Thailand Hospital and the organizational culture underpinning this. This hospital was awarded the highest level of hospital accreditation (high level of quality and environmental compliance within this site). Despite this, problems existed at a very basic level with the laundry management, which can undermine patient dignity and respect and increase risk infection and health complications. This study contributes to the Thai healthcare agenda, a core mission of which is to "Develop efficient and equitable integrated health service system for both normal situation and emergency with emphasis on basic rights, specialized service and emergency medicine, surveillance system, disease prevention and control and health threats" (MOPH 2003).

Research Approach

The key research methods employed include literature review, in-depth interview, observation, documentation and content analysis. A mixed methods methodology was considered appropriate for this study for a number of reasons including a lack of previous insight into this system and the number of actors involved. To this end a triangulated view of the laundry management system was realized.

Findings and Originality

Delays in the provision of linen and patient clothing (1-4 days bottleneck) were adversely affected by unstructured laundry operations, insufficient personnel, poor job design and worn-out equipment. As a result of this analysis several solutions were steadily implemented which led to: (i) linen shortage was reduced by 12.12% - 28.48%, and (ii) the total cleaning time per cycle was reduced by 130 minutes (45.12%). The impact of the improvement practices in place were perceived to be undermined by cultural factors such as very high internal conflict, the new hospital Director with relatively low power, and limited budget allocated to purchasing linen.

Research Impacts

Very few studies have explored a closed-loop supply chain of hospital laundry management systems, fewer collected data from key users using a mixed methods methodology. Reverse Exchanges (RE), a new theoretical framework, was adopted to examine the laundry processes. This study attempts to this study fill these gaps. Although this research studied one district hospital; the practices can be greatly generalized; and the diagram of laundry operations and this research design can be replicated.

Practical Impacts

Improvement measures have been identified which directly impact on the effectiveness and efficiency of this operation. Whilst this is once case study site analysis, this can offer a positive contribution to the healthcare agenda within this country.

Introduction to Healthcare Laundry Management

The laundry service within a hospital environment is seen as one of various operational supporting activities. The management of this service aims to provide an effective and efficient closed loop logistics service, delivering adequate supply of clean linen whilst conforming to the highest standards of cleanliness and hygiene immediately and constantly available for routine and emergency use (Ranjan 2008; HSHRC 2017). A laundry system in the developed nations can meet this goal, as stated by Fijan & Turk (2012), and there is an increasing interest in the infection controls over the last decades (Dancer 2009; Dancer 2014). Linen in this study refers to all hospital textiles such as patient's clothes and bedding (pillows, sheets etc) (Gajuryal 2014).

Empirical research on such systems in developing countries/economies shows an entirely different level of development. As reported by Sundari (1992), in the study entitled, 'The untold story: how the health care systems in developing countries contribute to maternal mortality' the author claimed that one of the many deficiencies in this closed loop system is the lack of its key resource, clean linen. Interestingly, the unavailability of linen and/or equipment failure resulted in 14% of cancellations and delays of surgical procedures in a developing country, such as Barbados which is a small island of the English-speaking Caribbean (Jonnalagadda et al. 2005) and as a system which has a robust hygiene and infection risk controls as it requires the highest standards of cleanliness, Fijan & Turk (2012) exposed that linen is one of the possible vehicles to spread of infections. So one has to question how hospitals in developing nations achieve this goal and how does organisational culture impact on this objective?

Whilst undertaking a detailed literature review on this area, it became apparent that there are a very limited number of publications, which focus on this closed-loop service. To all intents and purposes this system, purpose, design and execution sits firmly within a number of supply chain camps, relating to Supply Chain Management (SCM), Reverse Logistics (RL), Closed-Loop Logistics (CLL) and Reverse Exchanges (RE). It is the concept of Reverse Exchange that appears to be the most relevant grounding for this study, yet this is an immature area of study within the wider logistics field and hence there are currently no laundry management studies available within it.

Daugherty et al. (2005) asserted that because of high asset values involved the potential impacts on customer service organisations need the capability to effectively handle RL activities, including product returns, remanufacturing, source reduction, material substitution, and waste management (Rogers and Tibben-Lembke 1998). Reverse

Exchanges as a sub-dimension of RL, whilst an immature area of logistics study, moves the concept of returns forward to focus on product exchanges (those which are used as part of a service process for a given period of time, so 'on loan to someone for a specific purpose' but will have to be exchanged within a given period of time or when they are no longer needed). RE has been examined in a number of different sectors and operational foci: medical device exchanges (Xie et al. 2016); service supply chains (Kumar et al. 2016); Internet of Things (Parry et al. 2016); public service SCM (Esain et al. 2016) and customer motivation (Yuan et al. 2016). RE can be applied to a laundry management service when considering the provision of bed linen per patient and gowns/pyjamas etc per patient. These items are used by the patient for a given duration and then returned to be cleaned and reallocated. The patient in this instance may not require a further product from laundry (leaving the hospital) or may require further products (in-patient). The concept of RE as applied to healthcare operation can be different from the generic understanding of RL as it is more person/patient centric. This is most certainly the case in laundry operations. Other products requisition from this service will however be more bulk product provision (towels etc for general ward stocks).

Most of the papers, which are available on laundry management, focus on aspects such as: cost per unit (of products or the service?), user satisfaction, hygiene, and occupational health and safety. Authors such as Boonthanomwong (2014) and Bamroongchoo (2011), Boonthanomwong (2014) compared the unit costs of an in-house laundry service at the Police General Hospital versus outsourcing to a 3rd party, revealing no significant difference. There are a minority of these studies which examine the operational improvement of laundry management. Kullasar (2006) explored the key strategies in employed in laundry management at Khon Kaen Hospital (a Central Hospital). His results demonstrated that the local requisition of stock by wards (as opposed to a requisition system under centralized control) led to wasteful deployment of resources. This study also revealed that by adopting a 'one stop service' system which was managed by a centralised Laundry, could reduce operating time from 9 to 5 hours per day. However within this study, unclear improvement solutions were provided, and very limited information from all levels in the organization was explicitly presented. Due to the lack of focus on the area of laundry management and its direct contribution to a number of prevalent agendas: healthcare design and delivery; patient safety; patient dignity and respect; infection risk and control and operational improvement, therefore this hospital system is ripe for further exploration.

Research Methodology

The fieldwork research method is mainly employed to observe sophisticate system, like laundry services, and using tools such as interview, observations and documentations for data collection (Johl and Renganathan 2010). A hospital visit was taken during 1st February, 2016 and 15th May, 2016 with the permission of the Hospital Director and the Dean of Khon Kaen Business School, University of Khon Kaen. The tools above were used to collect data regarding laundry management and standards, personnel perception and understanding, statistical data, failure identification and root cause analysis and problem resolution. Identified solutions once in place were monitored and measured for efficacy and impact. Due to internal politics within the hospital, only 5 out of 14 departments volunteered to be involved in this phase of the study: (i) Male Medicine Ward, (ii) Female Medicine Ward, (iii) Orthopedic Surgery, (iv) ICU and Pediatric, and (v) Central Sterilization Unit. After that the outcomes were evaluated by a number of key metrics: speed of task (minutes), volume of linen (a piece of linen or kilogram), percentage of shortage, user's satisfaction and cost.

Results (i) – Operational site analysis Hospital "A"

This study focuses on the review and improvement of laundry management systems in a Thailand Hospital and the organizational culture underpinning this. In order to do this a detailed analysis of the current laundry management operations was undertaken on this site based on site visit and supporting documentary analysis.

Hospital "A" is a City hospital (or general hospital) located in the North-East of Thailand, and is governed by the Ministry of Public Health (MOPH). In the year 2016 (February-May), which this study was conducted, the hospital had 14 physicians and 134 other personnel including pharmacist, nurse, and medical technologist. A City hospital provides several specific services containing pediatrics, rehabilitation, medicine and obstetrics and gynecology (MOPH 2013). With the bed size of 120, this hospital has an average daily patient capacity of 361 cases (outpatient) and 134 cases (inpatient). The laundry service is managed by the Administration Department, which is directly controlled by the Director. The laundry is located at the back of the hospital, and has 5 personnel (1 head, 3 full-time personnel, and 1 part-time staff). It services 14 different departments. Table 1 presents the volumes of linen used by key departments during December 2015 to February 2016. According to the hospital records, approximately 277.26 to 301.14 kilograms of dirty linen was managed on a daily basis.

Table 1: Volume of Used Linen by User Departments.

Department	Volume of Used Linen (Kg)			Total (kg)	Percentage
	Dec 15	Jan 16	Feb 16		
1. Operating Theatre	2,566	2,265	2,301	7,132	27.84
2. Male Medicine Ward	1,511	1,387	1,601	4,499	17.56
3. Female Medicine Ward	1,366	1,282	1,483	4,131	16.13
4. Orthopedic Surgery	747	982	931	2,660	10.38
5. ICU and Pediatric	948	775	931	2,654	10.36
6. Delivery Room	794	714	560	2,068	8.07
7. Emergency Department	457	459	451	1,367	5.34
Total	**8,389**	**7,864**	**8,258**	**24,511**	**95.68**

Source: Hospital "A".

The actual volumes of used linen varied by date. Between 13th to the 19th March 2016, the trend increased from Sunday (201 kg) to touch the highest point on Friday (444 kg) and fell on Saturday to reach 254 kg. This trend appeared to be a normal weekly occurrence. "A" often faced the greatest shortage on Thursday and Friday where the required volume are relatively high. On examining the types of linen exchanges and laundered, 88.40% or 7,500 kg per month was uninfected linen, called general linens, whilst the rest 11.60% or 981.50 kg was infected (contaminated with blood and other bodily fluids (WHO 1999)) .

Interviews with staff and scrutiny of the hospital documentation and site visit analysis yielded the following problems in laundry stock availability:

Limited capability to respond to stock requests – both the Hospital Deputy Director and Head of Laundry commented on this issues. For example, out of within 23 requisitions by user departments, the laundry could only successfully respond on 7 occasions. The MOPH hygiene standards advocated hospitals having 4-6 sets of linen, but this laundry has only 1-2 sets, so stock rotation is severely restricted. It means one is with patients, while another is being cleaned or delivered, and there is no/a very small safety stock. This tells that there are huge pressures to quickly launder stock.

Use of Patient's own stock - due to the dearth of stock availability, nurses reluctantly asked patients to wear own clothes (or bring more clothes from home) and uses bed sheet more than a day. This contravenes hygiene policies and has led to increased dissatisfaction and inconvenience in patients, relatives and wards, and led the internal conflicts between user departments and laundry staff.

Extended laundry working hours - Although the government office hours are 08.30 – 16.30 Monday – Friday, the laundry works every day with the working hours of 06.00 – 20.00 because of their high workload.

Lack of financial investment in laundry operations – Hospital "A" received more than million GBP in 2016, however the majority of this budget as allocated to the construction of new building rather than purchasing new linen.

Results (ii) – Laundry management system inefficiencies and solutions

By applying the concept of Reverse Exchanges (RE) to the laundry operation and focusing on the linen exchanges within a given period of time, various causes of inefficiencies as well as alterations were as shown in Table 2. The results indicated that the soaking of linen consumes the greatest time (2-3 days), followed by drying linens in the air (2.5 hours to a day), with one cleaning cycle (from receiving used linen to distributing clean linen to users) taking up to 3 days or more. From interviewing other hospitals, one cycle requires only 3 – 5 hours; thus solving this problem is very important.

From Table 2, several practices were steadily implemented since it needed high cooperation from laundry staff, hospital users, patients and relatives. For instance, staff on the wards and relatives of inpatients were asked to untie the knot of bed sheet before disposing. This is a known general practice which is easily undertaken, but it saved 15-30 minutes per washing cycle. The results of practice improvements show the impact on key departments. For example, before instigating improvements the fulfilment rate for the delivery room was 19.61% but after it was 33.33% of requisition. As a result of which patients no longer need to bring in and wear their own clothes. Improvements were also seen in the fulfillment rates for the Intensive Care Unit and Pediatrics Ward (31.09 % to 59.57%) and in Orthopedic surgery (32.26 % to 59.72 % fulfillment, an improvement of 27.46 %).

Table 2: Laundry management system inefficiencies and solutions.

Cleaning Stage	Minute/Round	Explanation	Solution	Outcome
1.Stocking*	N/A	"A" has 1-2 sets of linen circularly used, which the standards require 4-6 sets.	- There is no solution because it highly involves with budget and politics.	N/A
2.Collecting used linen	35 mins (3 rounds)	All used linens should be sorted from sources, but users did not sort them well.	N/A	N/A

3. Receiving linen

3.1 Weigh linen

3.2 Count linen*

3.3 Sort linen*

3.4 Untie knot of bed sheet* (3 rounds)

10 mins

15 mins

50-65 mins

15-30 mins 3.2-3.4 All dirty linens should not be manually segregated/contacted in the laundry (Siriraj Hospital 2014). But staff still needs to sort/untie them, and remove all small medical devices off before soaking. - Provide ongoing education for nurses, inpatients and their relatives, but found to be ineffective

- Staff on the wards, and relatives of inpatient were asked to untie the knot of bed sheet -Untying the knot saved 15-30 minutes per washing cycle.

4. Washing infected linen

4.1 Soaking linen*

4.2 Washing in 90C water*

2-3 days (in 7 barrels)

90 mins or more (7 rounds) 4.1 To remove stains (e.g. blood and human fluids), the label on a disinfectant product says, taking only 30 minutes per wash cycle. Manual soaking linen increases the risk of splashing body fluids onto the skin or mucous membranes (HPSC 2005). - 4 barrels were removed from the soaking system.

- Washing time of infected linen was reduced to only 40-45 minutes in hot water, and linen was filled in the full capacity of the machine. - Soaking took only 1 day.

- Washing time was reduced more than half.

5. Washing general linen* 45 mins (11 rounds) Large-sized washing machine (200 pounds) was broken. Therefore, at least 180 kg was unwashed a day. - The director of "A" approved that the machine be fixed, when this was reported by researchers not his staff. - It can reduce unwashed linen of 180 kg a day.

6. Shaking linen* 15 mins/round It reduces wrinkles and the drying time. - Shaking was removed. - It saved 15 mins.

7. Drying

7.1 Use drying machine*

7.2 Dry in the sun*

35 mins (12 rounds)

2.5-24 hours - Large-sized drying machine (200 pounds) was broken. Drying takes 3 hours a day and requires 3 persons for hanging linens in the sun. Thick and/or large-sized linens (e.g. blanket and bed sheet) are hung in the sun - The director of "A" approved that the machine be fixed, when this was reported by researchers not his staff. - It saved time in drying linen in the sun.

8. Folding & Packing 2-3 hours/day The quality of clean linen is assessed. N/A N/A

9. Stocking & Linen Delivery 30 mins (5-6 rounds) Linen is distributed according to requirement. N/A N/A

*inefficient practice identified. Source: Hospital "A"

Discussions

It is clearly seen that "A" has several challenges similar to other hospitals in developing nations (Jonnalagadda et al. 2005; Fijan and Turk 2012). In this event, the theoretical grounding of Reverse Exchanges (RE) facilitated the exploration of this laundry management system and more so the exchange of the laundry stock items which were needed to process patients, hence adopting a patient centric focus. Moreover, this study strictly followed the guidelines/practices of such as Siriraj Hospital (2014) and HPSC (2005) which delivers efficient outcomes as in Tables 1 and 2. Inefficiencies were apparent within the system and investigations confirmed multiple causes for this including: (i) insufficient staff and/or (ii) inappropriate duty segregation and control, and/or (iii) high politics. By considering hospital bed-size (120) and the volume of linen (200-450 kg/day), staff levels of 3-5 were found to be sufficient. The most senior management (the Deputy Director) was unaware of problems within the laundry management system; hence no action was taken to resolve issues. Still, having several limitations hinder "A" adopting a 'one stop service' system as suggested by Kullasar (2006).

Conclusions

The aim of this study was to review and improve the laundry management systems in a Thailand Hospital and examine the organizational culture underpinning this. In response to this a hospital practice within this system was improved yielding the results as presented above. The role of organizational culture and the general management of hospital "A" was considered to be a key limitation in the effective management of this operation. Internal conflicts and poor duty segregations resulted in operational inefficiencies (such as a slower cleaning process), which led to patient and staff dissatisfaction, but undermined the efficacy of patient treatment and care, the very ethos of this service operation. Information channels between tiers of the organization was found to be weak and ineffective, so important information was either blocked or badly disseminated. This plus a lack of investment in the laundry operation indicated that the service itself was not performing well as a RE system but also that it was not sustainable in its current form. Hospital management was therefore asked to consider the improvements made in the course of this study and take action accordingly.

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Humanitarian Supply Chains

How does the beer distribution game help us to understand humanitarian supply chains?

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Abstract

This research seeks to establish the effects of variations in material flow under Push and Pull inventory strategies in the humanitarian supply chain. It examines the extent to which the Bullwhip Effect impacts upon a humanitarian supply chain and considers forecasting within the humanitarian supply chain to determine what can be done to mitigate against this effect.

Keywords

Humanitarian; Supply Chain; Bullwhip Effect; Material and Information Flow.

Introduction

This year's conference theme is 'Planning for Uncertainty – Creating Supply Chain and Logistics Systems Resilient to Global Change'. This is quite a pertinent theme given recent political events but it is equally relevant when considering the wide and expanding field of Humanitarian Logistics. By its very definition, planning for humanitarian interventions is full of uncertainty: in terms of the skill sets needed to be effective on the ground; in terms of location, terrain and surviving infrastructure; and in terms of what and where assistance is required, to mention but a few. In a logistic context, planners and practitioners must grapple with uncertainty in designing and operating an appropriate and resilient supply chain with its associated logistic systems. Considerations include how to overcome ethical, cultural and moral challenges; how to deal with bureaucracy, political influences and unrest; how well the humanitarian supply chain functions in terms of delivering 'need' rather than 'want'; and how it influences behaviours to protect the reputation of the organisation and thereby protecting the future flow of donations and other forms of aid.

By taking an inductive approach, this research seeks to use exploratory methods to establish the effects of variations in material flow under Push and Pull inventory strategies in the humanitarian supply chain. It examines the extent to which the Bullwhip Effect impacts upon a humanitarian supply chain and considers forecasting within the humanitarian supply chain to determine what can be done to mitigate against this effect.

Literature Review

The literature which has contributed to this research is drawn from a wide range of sources. In addition to the many articles published in international journals such as the Journal of Humanitarian Logistics and Supply Chain Management and the International Journal of Physical Distribution and Logistics Management, books, operational reports and conference papers have guided this research. The literature has also offered some conflicting views, particularly in the definition of the customer, where, for example, Tatham and Hughes (2011) allude to a 'final customer', while Shiffling and Piecyk (2014) suggest that the customer can be found all along the supply chain. Oloruntoba and Gray (2006) seem to corroborate Christopher and Tatham (2011) but do not go so far as a definition. The literature also confirms some rather uncomfortable truths regarding supply chain ownership and control, the role and influence of donor organisations and the flow of materials and information. Sandwell (2011) is quite explicit when he refers to donors demanding that their aid is directed to a particular beneficiary group, often in a manner that undermines the strategic aid plan. He reflects the frustration experienced by strategic and logistic planners. Meanwhile, Maxwell, et al (2012) reveal perceptions, gaps and challenges regarding corruption in humanitarian assistance, much of which had already been identified on the ground and published in the ODI report by Willetts-King and Harvey (2005). In addition to highlighting the importance of coordination in humanitarian relief operations, Altay (2008) looks at how Non-Governmental Organisations (NGOs) conduct contingency planning in areas of the world where assistance is most likely to be needed; the importance of coordination and the need for efficient passage of information is highlighted by both Akhtar, et al (2015) and Tomasini and Van Wassenhove (2009). 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 control and ownership by Kovacs and Spens (2009), MacLachlin and Larson (2011) and Christopher and Tatham (2011). An aspect of inventory strategy which is more important in the humanitarian supply chain than in the commercial world is that of Push and Pull logistics; Oloruntoba and Kovacs (2015) look at this in some detail and Chandes and Pache (2010) consider this in the wider context of NGO reaction and collective action.

The Challenge

Until recently, humanitarian logistics was not necessarily recognised as a specific, niche discipline; instead, it was viewed by many as an application of commercial, or even military logistic thinking to a humanitarian relief operation. Van Wassenhove (2006) reflects of this situation and notes the 'fire-fighting mentality' (p.476) of certain commercially trained logistic managers who view humanitarian logistics as merely the movement of material and equipment from a point in the developed world to a point of need somewhere in the developing world. Overstreet, et al (2011) recognise that humanitarian logistics, and the design of humanitarian supply chains in particular are fundamentally different from those of commerce, and this is reflected in the development and proliferation of educational courses at institutes, colleges and universities. However, we are not yet at the stage where all humanitarian logisticians and humanitarian operations planners have been educated in this relatively new discipline. Gralla, et al (2015) suggest that there is a case for 'developing the logistic skills of both new and experienced practitioners' (p.115). The majority are schooled in commercial logistics and have to adapt by themselves when presented with humanitarian logistic challenges in the field, a situation acknowledged by the World Food Programme (WFP) Logistic Cluster (2015b) in their 2016-2018 Strategy paper.

The Research

Published academic articles, evaluation reports from past humanitarian logistic operations and observations by the researcher have been used to inform the development of a model similar to the Beer Distribution Game developed by Forrester (1958) to understand where uncertainty is generated in humanitarian supply chains through variations in commodity demand. The primary case studied in this research is the response to the 2014/15 Ebola Crisis in Guinea, Sierra Leone and Liberia.

The humanitarian supply chain is complex in terms of ownership, control and information flow, but importantly, the 'customer' in a commercial supply chain is quite different from the customer in a humanitarian supply chain. The Beer Game, a widely-understood example of illustrating the demand and forecasting fluctuations within a commercial supply chain, is based on the principle that the customer places a demand on the supply chain and that this demand can vary in volume, depending on the appetite of the customer and their ability to fund larger volume purchases. Nienhaus (2002) explains that this demand creates a reaction by the wholesaler, bottler and brewery in the manufacture and distribution of bottled beer and that the game helps determine if, where, and to what degree changes in customer demand creates uncertainty and over- or under-supply in the supply chain.

Starting with the customer and working backwards, it is possible to map logically the four principal elements of the supply chain, reflecting Forrester's Brewery, Bottler, Wholesaler and Retailer. For the purposes of this research, the Donor organisation is viewed as the Brewery, the initial source of the required materials, equipment or funding. The International NGO (INGO) parent organisation, often located in Europe or the USA, is seen as the Bottler, acting strategically as well as operationally, and being the sole point of contact of the Brewery. The country office of the INGO organisation acts as the Wholesaler, often located in the capital city of the stricken country. The Retailer is the local NGO working with subject matter experts at the point of need, and in a position to relay the demand from the expert to their NGO country office. This then leaves the question we started with: who is the customer?

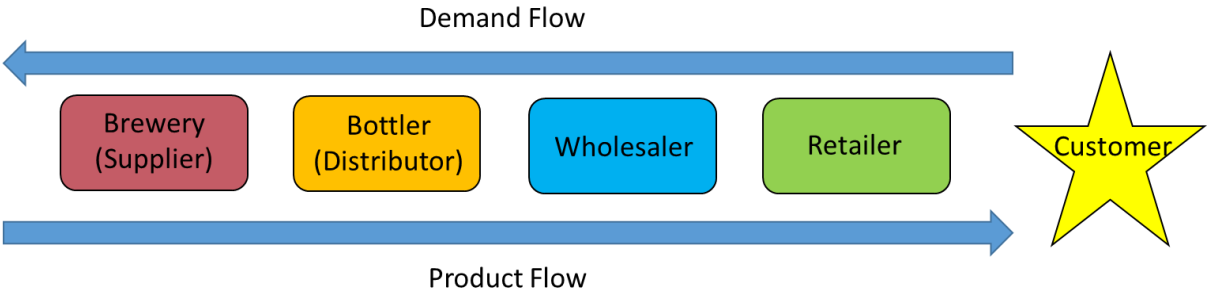


Figure 1. The Elements of the Beer Distribution Game. Adapted from Forrester (1958).

Beaman and Balcik (2008) explain that the key decision-makers within the humanitarian supply chain are the donors who are funding the operation and that many NGOs regard the donor as the customer in the humanitarian supply chain. In commercial supply chains, the end recipient decides what supplies they require, and fulfilment can be easily evaluated by monitoring the receipt of these supplies. However, in humanitarian operations, as supplies are determined by external assessments of the needs of the beneficiary, evaluating fulfilment becomes more difficult, as additional analysis must be undertaken to determine if these needs have been met by the supplies provided.

Importantly, they note that unlike commercial supply chains, humanitarian operations are not judged on their speed and costs, but rather by their impact.

Analysis

The Customer

The first step in developing this model is to analyse and define who the customer is, what role they play and how much influence they have on the humanitarian supply chain. The Beer Game relies on the Lysons and Farrington (2006) definition of the customer as 'simply the recipient of the goods or services that result from all the processes and activities of the supply chain' (p.92) because the customer is the consumer; however, this is not necessarily the case in the humanitarian context. The consumer will be the family left without shelter after the earthquake, the baby suffering from malnutrition or the young man who has contracted Ebola. But these individuals cannot be the customers in the humanitarian version of the Beer Game because while they place a demand on the supply chain, sometimes without knowing it, they cannot influence the meeting of that demand.

If we extrapolate the logic of Nienhaus (2002) that the customer is the individual that places a demand for a specific item, in the humanitarian logistics paradigm the customer must actually be an appropriately experienced or qualified Subject Matter Expert (SME). This is the person on the ground, closest to the disaster, who has oversight of the local needs. This person may be a doctor, nutritionist or other professional capable of determining what aid is actually needed, to whom it must be directed, where, when and in what quantities. This person will be able to inform the supply chain, interact with the supply chain and act as the final link between the supply chain and the actual consumer. Howden (2009) depicts this person in his humanitarian supply chain flows model and refers to it as the person engaged in 'monitoring and evaluation'.

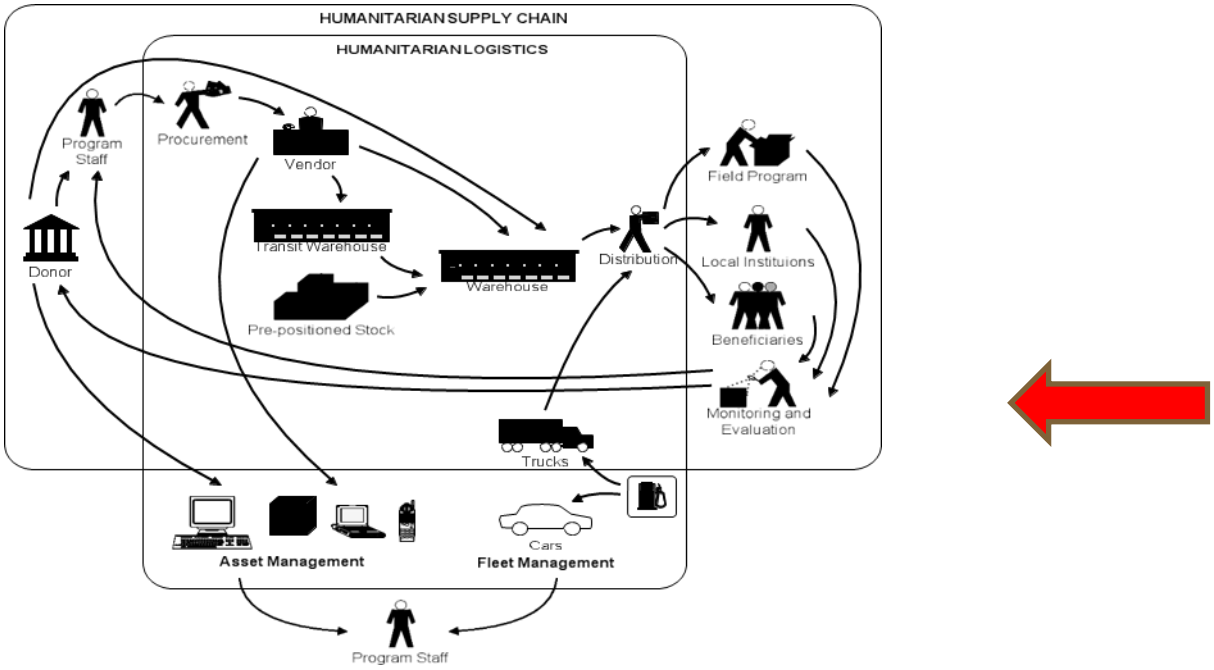


Figure 2. Humanitarian Logistics and Humanitarian Supply Chain Flows. Howden (2009).

Commodity Control Interface

Humanitarian supply chains can become increasingly complex once commodities have crossed the international interface to enter a country receiving aid assistance. When more than one aid agency is involved, a number of individual supply chains are often established, catering for the needs of each specific NGO. MSF (2016) Supply Annex shows that this was the case during the Ebola Crisis. Many donors provide a single commodity which, as Logistics Cluster (2015b) recognises, will run through individual supply chains to the in-country headquarters offices of the lead NGOs. It is at this point that collaborative working starts, and is the point where in-country NGOs come to appreciate the holistic priorities of the aid programme in addition to the priorities of their specific project. In classic PRINCE2 terms, this is the point where project management is superseded by programme management, with the WFP's Logistics Cluster acting in a similar manner to a Programme Board. The interface between the individual NGOs and the collaborative envelope of the Logistics Cluster is where NGOs are most likely to relinquish control over commodities to address priorities outside their sphere of influence.

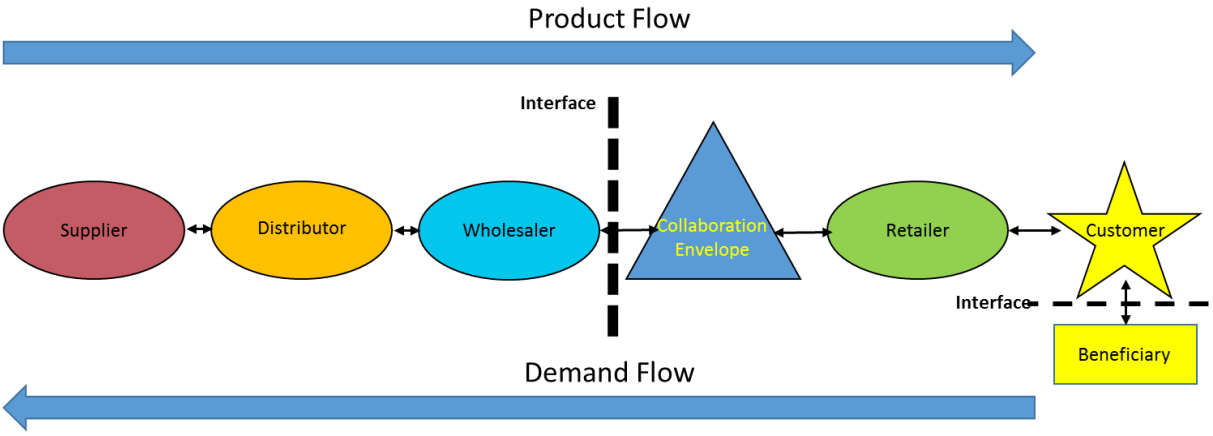


Figure 3. The Commodity Control Interface and the Collaborative Envelope.

Customer / Consumer Interface and the Collaborative Envelope

Even in a simple humanitarian supply chain where there is only one NGO providing all the aid, the customer will be the SME and the consumer, the beneficiary. At this point, the consumer's simple needs of medical aid, food, water and shelter are translated into a complex demand for commodities. Medicines as determined by a health professional; food and water requirements as determined by a nutrition specialist; and shelter as determined by an engineering specialist. These demands inform the supply chain of the exact nature of commodities required by the consumer and these are passed up the supply chain to the entity acting as the 'retailer'. This may be a small storage facility which may not stock the items required and therefore a demand is placed further up the chain, but in the humanitarian supply chain, this is not directly to the 'warehouse'. Between the retailer and warehouse sits the collaborative envelope: a logistics services and supply brokerage where NGOs and other aid agencies come together to coordinate disparate supply chains and collaborate in the resolving of supply chain issues for the many potential

beneficiaries across the programme. As UNICEF (2014) recognises, in this forum, commodities such as rice, nutritional supplements, flour, bottled and bowser water, tarpaulin shelters and tents, disinfectants, blankets, specific medicines and medical supplies, and clothes can break out of individually stove-piped NGO and governmental supply chains and be directed towards the point of greatest need. Clearly, integrating many supply chains in this way can give rise to great complexity, but by providing alternative sources of aid, it can also contribute much to supply chain resilience. However, a pre-requisite for such a complex supply chain to work efficiently as well as effectively, there must be an effective flow of information along the entire supply chain and a supporting flow of information and guidance up to and down from individual NGO and governmental strategic decision makers. WFP (2017) and UNICEF (2014) both testify that the National Ebola Response Centre Logistics Cluster was extremely valuable in acting as the collaborative envelope for the Ebola Crisis operation, but both concur that much more development of the forum and its policies and procedures needs to take place. Indeed, WPF (2017) go as far as to suggest that 'the relevance of these [extant emergency response] policies as a trigger to initiate action has not been sufficiently established' (pp.11).

Humanitarian Supply Chain Complexity

In variance to the Beer Game's simple supply chain, a single humanitarian supply chain sees more than one commodity being supplied in a shared, operationally focused chain, where often, a single, identical commodity type may be supplied by more than one donor. Multiple donors may be supporting a few major NGOs, or a select few donors may be supporting a plethora of NGO organisations. Some donors may themselves be NGOs, for example, WFP.

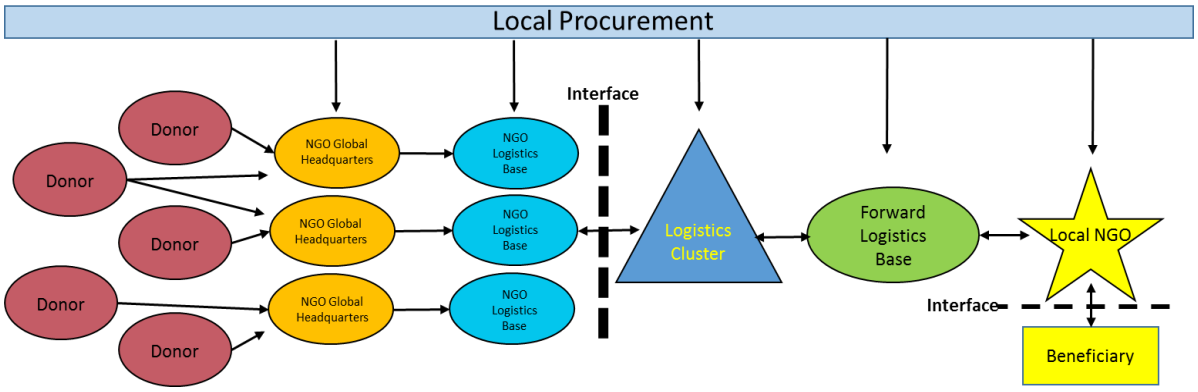


Figure 4. Humanitarian Supply Chain Complexity and Role of Local Procurement.

To ensure that such a surge does not always adversely impact on other operational priorities, the humanitarian supply chain has the advantage of local procurement: the utilisation of financial resources in the theatre of operations to buy in materials, equipment or services. This can also be used to relieve pressure on the supply chain in the event of delays or losses. NGOs will exert strategic control over their in-country offices from their global HQs, and these entities are capable of mechanising local procurement from outside the aid region. Where appropriate, they will facilitate local procurement in-country, normally for commodities to support their own local objectives, but larger NGO and International Governmental Organisations (IGOs) such as USAid and the UK's DfID will also locally

procure in support of pan-programme requirements and the specific needs of smaller NGOs. However, this takes a great deal of coordination and it is in this role that the WFP's Logistic Cluster makes a significant contribution.

Push and Pull inventories

Push logistics as a humanitarian supply chain strategy differs profoundly from the commercial world in that there is no anticipation of demand based on long-term forecasting and inherent uncertainty. Rather, it is based on short-term, if not immediate anticipated demand where certainty is virtually assured: there is an established need. Push strategies tend to be employed early in humanitarian operations to ensure a sufficient volume of urgently required specific material is delivered to the point of need. Push tends to give way to Pull once effective supply chains have been established. The effectiveness of such supply chains is determined by the flow of information as this is the key element of Pull logistics: the ability to inform the supply chain of accurate demand. In the case of the Ebola Response in Sierra Leone, commodities were sent forward from the logistic base at Port Loko to district storage facilities where bulk was broken before being forwarded to points of need. Where items were delivered as part of multi-commodity packs, some commodities were needed and others not. Due to the frenetic work involved in forwarding materials, items which were not required were held in storage by local NGOs 'Just in Case' rather than being immediately back-loaded for redistribution. Some storage facilities began to fill with unnecessary items but the Logistics Cluster was in a position to instigate a reverse supply chain to relief the pressure on such facilities. In February 2015, the logistic effort switched from Push to Pull, and it is clear from Logistics Cluster (2015a) that the NERC Logistics Representative realised the effect of this on storage at Port Loko, and planning began to offset this.

The Bullwhip Effect

Due to the nature of Push logistics, commodities managed this way tend to flow relatively feely along the humanitarian supply chain. Blockages do occur where:

Efficient air consignments are being consolidated;

Customs delays occur at international frontiers;

Breaking bulk occurs at principal logistics bases in preparation for onward distribution;

Delays caused by transport issues and lack of infrastructure arise;

Bureaucratic challenges arise, including corruption and other losses to the supply chain.

However, because the flow is determined and controlled at a point close to the donor, and the supply chain support infrastructure of national ports of entry, warehousing and bulk cargo transportation is managed by the in-country NGO or Logistics Cluster, despite administrative delays intimated above, there is little evidence of the Bullwhip effect. In Push logistics, decision making for the supply of a given commodity is often made at the strategic level of the NGO, either to meet the specific aims of the NGO, or to contribute to the common good; however, the in-country staff must inform and update the global HQ of the extant requirement and the global HQ must have the capability of understanding the crisis situation in supply chain terms and be able to facilitate an effective flow of information. Given the tendency for NGOs to conduct contingency planning at a national, regional and global level and

preposition stocks accordingly, and the ability to procure locally, the supply of individual commodities is rarely an issue. However, WFP (2017) reminds us that the Ebola Crisis presented a significant challenge in this regard.

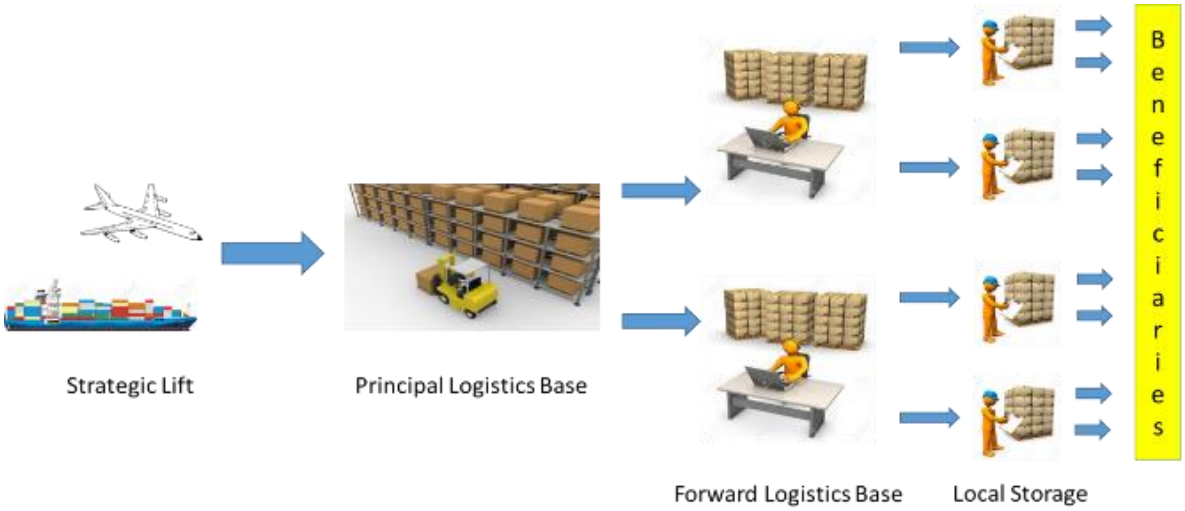


Figure 5. Flow of materials during Push inventory management strategy.

At the point when the inventory management mode switches from Push to Pull logistics, an effect similar to the Bullwhip effect is generated which affects only part of the supply chain. In humanitarian logistics, this switch creates a log-jam at the principal logistic base because commodities being pulled forward tend to move more slowly and in smaller volumes than when they are pushed. At the same time, the reverse supply chain becomes more effective for the redistribution of items required elsewhere, but all the while, donations still arrive in country. This all requires significantly larger 'rear area' storage facilities near the point of entry and a management system to coordinate the arrival of new materials, the redistribution of reserve supply chain commodities and the effective reaction to demands from frontline local agencies. At this point, the ability of the Logistics Cluster to inform strategic planners is critical to influencing the stream of donations. Donations already in the pipeline can be strategically diverted to other emergencies or restock global and regional stockpiles, thereby making more efficient use of strategic lift transport assets and avoiding waste or gratuitous reserve supply chains.

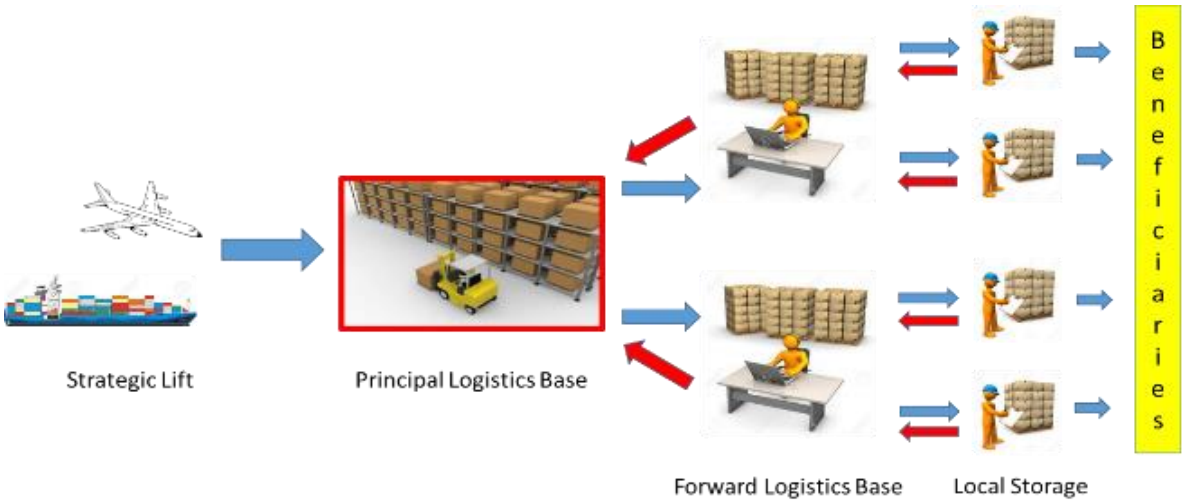


Figure 6. Flow of materials during Pull inventory management strategy.

Discussion

A phenomenon similar to the Bullwhip Effect therefore can occur in humanitarian supply chains but due to the complex system of donations, supply and local procurement, it tends to have less impact. Donor organisations are often well placed to meet demand surges from alternative sources and major NGOs maintain stockpiles on regional and global levels. During the initial, Push logistics phase of an operation, material flows to the point of need as fast as possible, and often the demand will outstrip supply, but this is because there is a finite volume of aid that can be initially delivered due to stock availability, transport limitations, environmental issues and access challenges. Any demand placed by the customer will only be satisfied if it is available and can be transported to the point of need. As a result and irrespective of the demand, the reactive nature of the humanitarian Push inventory supply chain will rarely result in the initiation of the Bullwhip Effect. During the subsequent Pull phase, demand surges that give rise to the Bullwhip Effect can be mitigated by routing commodities efficiently from other donors, through NGOs at international and in-country level to the Logistics Cluster, from where they can be directed to specific forward logistics bases and on to beneficiaries. This, together with the use of local procurement to relieve pressure on the supply chain requires an effective and proactive collaboration envelope, capable of maintaining information flow not just along the supply chain, but vertically between logistic practitioners in-country and strategic logistic planners in NGO and IGO global HQs.

The initiation of a Bullwhip Effect relies upon the creation of a demand on the supply chain. In the Beer Game, this demand is reflected by an order for a single commodity placed by a customer who understands the nature and value of the commodity. The customer will not accept or reorder the commodity if it fails to satisfy or costs too much. The customer is a decision maker who discerns whether they want the item and what they are prepared to pay for the item. The beneficiary of emergency aid performs neither of these functions; rather, it is the local subject matter expert that makes these decisions on behalf of all beneficiaries with his/her sphere of influence. There is, however, another customer role within the supply chain, namely the donor who initially purchases the commodities that enter the supply chain. The role played here, however, is not that of humanitarian supply chain customer, but commercial supply chain customer who disposes of the commodity by passing it to the humanitarian supply chain. There are

moral, prestige and political aspects to this second transaction, but this research contests that the donor is not the humanitarian customer, but the humanitarian supplier.

Conclusion

The Beer Game was developed to allow students to understand the effects of order variations on, and the ability to forecast demand within, a commercial supply chain. While accepting that humanitarian supply chains are profoundly different from those of the commercial world, by understanding the role of each game element, and in particular the role of the customer, it is possible to map the Beer Game across to a humanitarian supply chain. Humanitarian supply chains operate both Push and Pull strategies, depending on the nature and maturity of the relief operation, and the likelihood of the Bullwhip Effect occurring differs in each mode. There is a propensity for it to occur more often in Pull logistics, the mode closest aligned to the commercial philosophy of the Beer Game. By examining the levers available to stakeholders within and outside the collaboration envelope, this research shows that the Bullwhip Effect, where it manifests itself in the humanitarian supply chain, differs from that evident in the Beer Game, but provides understanding of where demand surges may occur and how the effects might be mitigated.

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Logistics Hub

A study on the core problems hindering the development of a Namibian Logistics hub: A focussed group perspective

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Abstract

Purpose:

This study endeavoured to examine the core problems Namibia is facing in achieving its desire to develop a logistics hub. Most sector stakeholders have perceived logistics as important since it was prioritised through the Namibian National Development Plans (NDP_4) of 2012 (National Planning Commission, (2014). The country has since released a Logistics Masters Plan to guide the implementation of the Namibian Logistics Hub (National Planning Commission, 2015). However several of the set projects i.e. Marketing, Efficient

Transport infrastructure, integrated border operations, and strong attractive operations base, have been hampered by slow paced development and lack of implementation. This study gathers and analyses perceptions from a focus group on the core problems hindering the development of an efficient Namibian Logistics Hub.

Research approach:
This research looks into perceptions of a focus group within the Namibian logistics industry. The group was composed of experts and/or organisation representatives that are either directly involved in the logistics hub development or provide services or support towards it. Perceptions of individuals in the focus group were extracted through GOPP- Goal Oriented Project Planning approach that is progressively structured to allow people with similar interests to identify areas of development within their respective sectors (Participatory Methods, 2015).

Findings and Originality:
Through the identification of core objectives, the focus group highlighted numerous barriers and core issues they perceived as hampering the development of the logistics hub. The lists of issues were examined and through a process of prioritising, four (4) core problems were identified namely: 'red tape', lack of resources and capacity, inequality as well as lack of coordination and communication. Originality is achieved through analysis of the core problems and identification of the root causes, areas that have been lacking in previous research on the Namibian Logistics Hub Development.

Research Impact:
The research endeavours to examine problems and causes hampering the development of the Namibian logistics hub. The output will increase academic knowledge in this important area from a developing country's perspective, and lay the foundation for further academic research.

Practical Impact:

In addition to the academic importance, the examination of the core problems hampering development of logistics can help find means to overcome them. This research is practical in nature, and has allowed for scrutiny of the sector.

Keywords: Core Problems of Logistics, Logistics Gateway development, Namibian Logistics Hub, Slow paced development Logistics

Introduction

A logistics hub is defined in simple terms as an ideal point where large volumes of cargo cross to be distributed to destinations that rely on its service. The implementation of hubs in developing countries may therefore stimulate the expansion and/or realisation of infrastructure that usually involves major seaports, road networks and railways in order to equip the location with the means to facilitate trade. The development of a logistics hub and the expected increase in trade can thus boost economic growth for a location that successfully implements and operates it. Namibia through its national development plans has earmarked the country to become a regional logistics hub (NDP_4), and have since developed a logistics hub master plan to guide its implementation (National Planning Commission, 2015). Savage et al. (2014) discussed issues, challenges and opportunities the country had with the aspirations of becoming a logistics hub for the SADC region. The logistics hub master plan catalogues several objectives or programmes including marketing and capacity building initiatives, as well as the capital-intensive infrastructure requirements for a logistics hub (National Planning Commission, 2015). The port of Walvis-bay is the site of the logistics hub initiative aims to have its current capacity tripled from 350000 to 1Mil TEU's / year. Several road network upgrades and expansions have been made to prepare for the expected increase in freight from the port. However, numerous factors have hindered the development of the hub, with the port expansion extended by another 12 months from the expected date of completion (Kaira, 2016), while an economic crisis has recently slowed down the road and railway projects in several parts of the country. Savage et al. (2014) listed 15 barriers to logistics development, with the lack of international standards of customer service, customs procedures, regional harmonisation, and limited management education in the top 5. The findings were supported by a fall in the World Banks Logistics Performance Index (LPI) from 89th in 2012 to 93rd globally in 2014, with customs delays, infrastructure and capacity the biggest contributors to that fall (World Bank, 2016). Since then an increase in transport costs, budget cuts and poor implementation contributed to the delay in logistics development (Mhunduru, 2016). In 2016 the country moved to 79th overall LPI, still below other Southern African Development Community (SADC) countries like Tanzania, Botswana and South Africa. The paper revisits hindrances to Namibian logistics development, by using a focussed group perspective to identify if the challenges have changed in recent times

Literature Review

Clusters, barriers and the supply chain. It is important to consider logistics barriers in the context of clusters and global supply chains. A logistics cluster is a "zone where operators and all activities relating to the transport, logistics and distribution of goods, are gathered together". Clustering and developing network integration processes enable regions or countries to become strategic nodes in global supply chains (Bosona and Gebresenbet 2011). Clusters that are located at borders can act as gateways to a country or region and affect the costs of crossing such borders. Clusters form the nodes of global supply chains which exist to enhance international trade and thereby aid the development of the host countries. It is often suggested that the reduction of tariff barriers is the main stimulator of international trade. Figure 1 illustrates the success of this strategy over the latter years of the 20th century. The

same figure also suggests that this has now run its course, which is a view supported by the World Economic Forum (2012) who claim that reducing supply chain barriers could now increase world GDP more than six times as much as removing tariffs.
Figure 1 Growth of world trade compared to average world tariff levels. Source: Tariffs adapted from Coatsworth and Williamson, 2002 and Mitchel, 1992; referenced in Nenci, 2009; World Bank, World Trade from World Trade Organization report, 2012. International supply chains are an ever more prominent feature of world commerce with manufacturing being accomplished using focused factories within global value chains. The ability of a country to participate in such chains depends on the efficiency of local trade facilitation and logistics services (Hoekman, 2014). For example: “Every extra day it takes in Africa to get a consignment to its destination is equivalent to a 1.5% additional tax” (Freund and Rocha, 2011). So, even if tariffs were zero, high cost or inefficient logistics will prevent firms and regions from reaping the benefits of globalization. The successful development of trade depends on lowering of logistics barriers and the efficiency of a port-centric hub will influence access and may lead to substantial economic benefits. By developing an advanced logistics cluster based around the port of Walvis-bay, Namibia could provide much needed services for corporations, thus encouraging investment for infrastructure improvement, enabling industrial skills capacity building and stimulating trade. This suggests that there is a strong case for the proposed hub but there are some pitfalls for, as Craig (2013) states: “many locations have invested in infrastructure but have failed at being the logistics hub”. There are many potential causes of failure for infrastructure projects (Luke. R., Savage. C.J. et al. 2017) but in the Walvis-bay project the risks fall into three broad categories:

• Build failure – including specification issues • The ability of Namibian industry to fulfil the non-infrastructure requirements needed to develop a successful logistics cluster is extremely suspect (Savage. C.J. 2014).
• The reality of developing countries’ economies benefiting from transport infrastructure investment has been called into doubt, especially where the development precedes the trade demand it seeks to serve (Savage. C.J., Fransman. L. et al. 2014).
Therefore, it is important to identify the specific problems that may prevent or delay the evelopment. According to van Siltaoja (2006), one of the reasons that terminal developments fail or are subject to excessive delays is the “lack of stakeholders’ perceptions in the design process”. Therefore, early identification of stakeholders’ perceptions can be said to be crucial to the success of a cluster development. More recently, Gvozdareva et al.
(2010) suggest that it is essential to detect the stakeholders’ views through surveys and interviews that cover formal questions that include: “What expectations do you have for the project?”, “What benefits would the project provide you with?”, “What are your concerns?” and “Do you in general support or oppose the project?”. These guidelines have been considered for this paper’s data capture and have, in particular, influenced the choice of the
GOPP approach to gather perspectives from a focus group. Methodology and Focus Group This research looks into perceptions of a focus group within the Namibian logistics industry to provide a directed view on the core problems hindering the development of an envisioned logistics hub. Focus Group research is described by Stewart and Shamdasani (2014) as a member of the qualitative research family and it can be used to gather information from a number of individuals within a specified sector, thus providing the perfect foundation for further research where a dearth of information exists. Although literature concerning the selection of participants in a Focus Group is extensive, this study took a straightforward approach by selecting experts representing organisations that are directly or indirectly involved in the development of a Namibian logistics hub. A collective view and possible reasons or facts from members provides a good platform to gain insights into experiences for a particular sector. In a developing economy, such as Namibia, where organisations still operate in silos (Savage et al. 2013), platforms to share ideas, knowledge and experiences becomes essential. Hennink (2007) alluded to the growing use of focus group research in developing economies, where members within a group are motivated to respond or contribute based on personal experience and/or influence from others. The focus group method where debates, personal views and the defences thereof can be observed, thus distinguishes itself from the conventional interview data collection

environment. Stewart and Shamdasani, (2014) mentioned criteria for using focus groups that involved exploring a topic or collecting group narratives for later use in research activities. The narratives or views are collected through a facilitated process that involves a moderator or facilitator that is said to play a key role in the quality of data collected during a focus group session. Perceptions from the focus groups were extracted through GOPP-Goal Oriented Project Planning approach that is progressively structured to allow groups with similar interests to identify areas of development within their respective sectors (Participatory Methods, 2015). The GOPP approach was designed to produce a project concept or objective within a focussed group setting, by producing a logical framework approach (LFA). The revised LFA steps for modern environments, as mentioned by Couillard et al. (2009), includes a problem/situational analysis, stakeholder analysis, option identification and selection, amongst others. The approach provided the necessary tools to
gather sufficient information from the members to discuss the core problems hindering the logistics hub development. Analysis of the collected data within the GOPP is a phased approach, where firstly all members are asked to list focus areas for the sector and then to highlight the core problems. The core problems are then converted into problem trees that gives clearer views on the causes and provides grounds for further discussion.
The study further draws on national policies and plans related to the sector development to examine the core problems the Namibian Logistics Hub development is facing.
Findings
Emerging countries with serious plans to develop their economy through logistics activities should have numerous policies with clearly thought through objectives to ensure a systematic approach towards implementation. Namibia has endeavoured to meet these requirements by developing a Logistics Hub Master Plan that comprehensively provides clear objectives with action plans. Other Logistics hub aspiring countries like Thailand (Suthiwartnarueput, 2007) and Laos (Regmi & Hanaoka, 2013) both had master plans to guide their implementations, with the former already operating as a key hub among ASEAN countries. However even with guidelines and actions to follow, hindrances and problems do arise that could severely delay logistics hub development. Savage et al. (2014) refers to these as “barriers to logistics development”, and shows how logistics skills are essential in overcoming them. This study draws on recent stakeholder perceptions of core problems to logistics development to compare with previous findings to establish if the current focus to overcome them appears to be correct. The stakeholders’ perceptions were gathered through a 3-phase approach that started by asking all members to list 5 key areas that they deemed important for the logistics and transport sector in Namibia. The focus areas could have been theme based or be a possible gap or issue that needs attention within the sector. The areas were grouped according to similarity and/or summarized under a collective statement or description agreed by the group. The focus areas were further grouped and classified as of higher importance if more than 50% of the focus group has listed it. Table 1 below shows the list of areas based on the level of importance.
Table 1 List of focus areas by focus group

Listed by more than 50% of focus group members	Listed by less than 50% of focus group members
1 Collective Marketing Strategies	1 Enabling Political Framework
2 Funding Formula for Transport Infrastructure	
2 Policy Implementation and Evaluation	

3 Collaboration Systems 3 Climate Change Mitigation
4 Corridor and Logistics hub
development
4 Sustainable Low Carbon Sector
5 Customer service 5 Dedicated Public Transport Funding
6 Incentives to attract and retain
experts
6 SADC Namibia Standardisation
7 Regulatory Framework 7 Increase Public transport Capacity
8 Research and Development
9 Road Safety
10 Capacitating/Education/Training

The first approach allowed for the identification of focus areas that are important for logistics and transport development, and thereby paved the way to highlight the core problems that hinder its implementation or progress. The focus group highlighted a need to focus on having clear policy guidelines, with implemented regulatory frameworks. Additionally, it was mentioned that an enabling political environment is needed. This ties in well with the aspects of policy and framework implementation. Savage, (2014) confirms this as one of the requirements to establishing successful logistics clusters. Another requirement is the capacity and skills needed to operate a cluster; the focus group raised the issues of capacity and training together with incentives to attract and retain experts that are important to the development of the sector. Luke et al. (2016) elaborated on the effects of skilled labour shortages to supply chain sustainability in southern Africa. Successful logistics clusters like Singapore are testament to the importance of streamlining work permit processes to attract qualified staff within its workforce (Yeoh, 2013). The group further raised collective marketing and collaboration systems as a key to development, with the element of operating in silos still prominent according to the group. There could be several reasons why stakeholders do not opt to share or collaborate to improve operations. Savage et al. (2013) mentioned the lack of understanding, fear of working with competitors and the nature of business focusing on profitability as possible explanations. The latter may still be true for the sector as less than 50% of the focus group mentioning environmental sustainability through a low carbon sector and mitigating climate change. Very few stakeholders seem to consider the benefits through collaboration like the reduction in costs, improving of service and gaining a competitive advantage (Lambert, 1996). Another prominent factor is customer service. Most of the members mentioned this as being key to marketing for the logistics hub to attract foreign investors. Unfortunately, previous research has put lack of international standards of customer service as a top barrier to logistics development (Savage et al. 2014). Table 2 below shows previous barriers to logistics development within Namibia, ranked on surveys conducted each year. Customs procedures/clearance seem to have ranked highly across the years, either being ranked top or second on the list. The focus group still confirms it as a key area with reference to Southern African Development Community (SADC) and Namibia Standardisation that is required to ease trade within the region. Integration and standardisation within a region like SADC and Southern African Customs Union (SACU), can reduce costs and allow countries to overcome smaller market and have access to diverse markets. Southern African economies have shown growth compared globally, however intra-regional trade have faltered or has not seen significant improvements (World Bank, 2014). The difficulty in achieving policy

consensus and its implementation have contributed to the limited trade experienced with the region.

Table 2 Barrier surveys from 2013-2015 (Savage et al. 2015)

Barriers	2013	2014	2015
Customs procedures/clearance	1	2	1
Corruption	3	8	2
Attitude (Siloism, narrow mindedness, reluctance to take responsibility for own actions, willingness to work etc.)	4	5	3
High fuel costs	2	10	4
Safety	6	13	5
Harmonization of regional (&SADC) trade procedures	5	4	6
High road and rail transport rates	11	7	7
Nepotism in appointments and contract awards	7	14	8
Limited management education	13	3	9
Port capacity	9	15	10
Lack of integration of parastatals with industry	8	6	11
Limited driver/operator training	10	11	12
Lack of international standards of customer service	14	1	13
Lack of government awareness (of logistics needs)	12	9	14
Work permits & conditions (for non Namibians)	15	12	15

The second phase in the focus group required the stakeholders to identify the four core problems the industry is facing. The number was pre-determined as part of the focus group objective to develop projects to address the core problems at the start of the session. As in the first phase, the problems were grouped. Table 3, shows the groupings identified by the focus group with the problems highlighted being considered to as the priority.

Table 3 Problems to logistics development from focus group members

Problems hindering logistics and transport	
1 Reinventing the wheel with little implementation	11 Discontinuity and lack of follow-up
2 Bureaucracy	12 Inequality
3 Education systems affecting all levels	13 Labour Market Iron Curtain
4 Underutilising of strengths	14 Missing Regulation
5 Attitude	15 Low Population Density
6 Lack of Planning	16 Lack of resources and capacity
7 Skills Gap	17 Innovation Deficit Gap
8 Lack of Coordination/Communication	18 Red Tape
9 Sources of Funding unsure	
10 Policy inconsistency	

As the data collection in this study did not rank the problems, the results were listed and was further discussed if there are similarity to previous barriers.

'Red Tape' was listed as one of the principal issues hindering the country's logistics ambitions. It is described as an excessive system of bureaucracy, strict regulations and redundant decision-making processes which makes it difficult to implement a politically supported system. This may seem contrary to the lack of regulation listed as another problem. Developing countries are often influenced by historical or colonial systems and

infrastructure and may end up with outdated policies and regulation. Namibia has the old cape gauge railway that inhibits trade with regional countries through rail, while the governance structures have not been updated until recently (Burn, 2016). It is thus important for the country to address the issues surrounding policy and regulation to create an environment that is conducive for development.

Conclusion

The findings highlight several factors that hinder the development of a Namibian Logistics Hub, with the core issues being: “red tape”, inequality, and the lack of capacity and coordination. Although the obvious factors like infrastructure and investments are needed for the implementation of a gateway or hub, the core issues suggested through the findings emphasise the lack of systems and processes plus the need for clear documentation of policy and frameworks. Further discussion shows that Namibia’s aspirations to become a logistics hub for the region needs a coordinated effort, which is difficult to achieve. The need for collaboration systems were prominent within focus areas suggested, however it remains a problem for the sector. The literature review established the need for cooperation within clusters to add value to supply chains and provide an area with the means to compete globally. In order for a country or region to achieve a “logistics hub” status, efficient trade and customer service should be the order of the day. Improving efficiency to gain access to a market remains an important determinant of success. An aspiring logistics hub without ease of access or value-added service may find it difficult to attract international trade routes. The findings allude to the need for collective marketing strategies that are important. This assumes that all stakeholders within a collective need to provide attractive options to lure global supply chains to a region. The findings show one of the core problems is a lack of capacity and resources. This may become a huge problem in the future, as emerging economies may find this difficult to overcome. History has shown that qualified individuals looking to gain international exposure are often employed by multinational enterprises in developed countries. Three closely-related problems affecting Namibia’s logistics industry are the Skills gap, Education and training at all levels and difficulty to enter the labour market. The development and operations of a successful logistics hub requires critical human resources. Kiessling & Harvey (2014) have stated that skills for efficient logistics management should be based on global knowledge. This requires an element of experience and exposure to international trade facilitation and global supply management systems. This very much ties in with one of the areas mentioned by the majority of the focus group, to implement incentives to attract and retain experts. The country does seem to make it difficult for entry into the labour market, delaying work permits.

A new finding among the focus group was the problem of inequality. This has not featured in previous barrier research on the country, but did occur during research into stakeholder perceptions of the Walvis-bay development (Savage, Bamford et al. 2014). Inequality in this study relates to economic and income aspects and is an important issue as the country has been ranked among the highest under the Gini coefficient index (World Bank, 2014). Inequality impacts on social groups and can contribute to the lack of education obtainable in the majority of a country. This could explain why, in relation to research into the barriers and problems to logistics development in Namibia, the lack of education and skills appears as a key constraint.

There are a number of core problems hindering the development of a Namibian logistics hub that will need to be addressed if the country is to succeed in reaching this vision. The problems, including social and political aspects, need high level intervention to provide an

enabling environment. Education and capacity building across the entire sector is needed to provide the appropriate future human resources. This will necessitate re-examining or dissecting policies and procedures to promote development Concerns of “red tape” that slow down progress needs to be addressed as a matter of urgency and should be done in a coordinated effort with all stakeholders. If the problems are not systematically addressed with clear solutions, the country may face further delays in establishing a logistics hub for the region, and may lose out to other regional logistics aspiring nations.

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Logistics in Manufacturing

Plant logistics in the automotive industry: A case study

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Introduction

Today's increasing competition in the automotive industry has put unprecedented pressure on manufacturers to find ways to improve their plants' efficiency. At the same time, the increased demand, the mass customisation trend and the high product variety pose a real challenge for reliable and efficient operations (Parkin et al., 2017; Holweg et al., 2009). Plant logistics and material flow processes are a critical part of the manufacturing operations. Any inefficiency in feeding the lines due disruptions, errors or delays has a significant negative impact on the performance of the whole manufacturing system (Boysen et al., 2015).

Plant logistics and material flows concepts such as the supermarket concept, the mixed-production lines and the material supply systems have been extensively investigated in the automotive sector (Boysen et al., 2015; Jainury et al., 2014; Dörnhöfer et al., 2016). The supermarket concept for example is found to offer great advantages into the assembly plants such as fast and flexible logistics processes (Battini et al., 2013; Emde and Boysen, 2012). Mixed-production lines operations and the potential problems that may emerge (e.g. workforce assignment) as well as the material supply systems that feed the production lines have been also closely reviewed (Jin et al., 2008; Dormer et al., 2015) with researchers highlighting the positive impact of hybrid supply systems (Caputo and Pelagagge, 2010; Limere et al., 2012).

However, to the best of the authors' knowledge, no research has explored so far the internal returns area where empty packages are picked up from the production lines, disposed to another in-plant area and prepared for returns. This is an important area because any delays in picking up the empty boxes cause delays in the production schedule as the loaded boxes cannot replace the empty ones. Also, delays in the offloading processes in the returns area cause bottleneck into the area and the transport vehicles are waiting in long queues instead of feeding the lines. Overall, internal returns area can be money and time costly if inefficiency occurs.

In this research we aim to increase our understanding of the role of the plant material flows and specifically to find out how to best manage them in order to improve plant's efficiency. The assembly plant of the case study company is explored (which from now will be referred as Car Co.) and it consists of the supermarket area, the production lines and the returns area between which the material flows take place (Figure 1). The Car Co. operates a functional supermarket and uses a hybrid supply system to feed the lines so, the focus is given on the returns area which was critical to be further explored because of the inefficiency incidents (e.g. forklifts accidents, long queues in the area). Areas of improvement were identified and a practical solution has been suggested. The investigation in the returns area performs a dual function, both for the literature and for the Car Co.

The remainder of the paper is organised as follows. An overview of the related literature follows in order to master the knowledge about the logistics processes into the automotive assembly plants and outline the research gap in the literature. Then the research work and the analysis conducted are described. This is followed by the findings and a critical discussion of them. Finally, the conclusions take place.

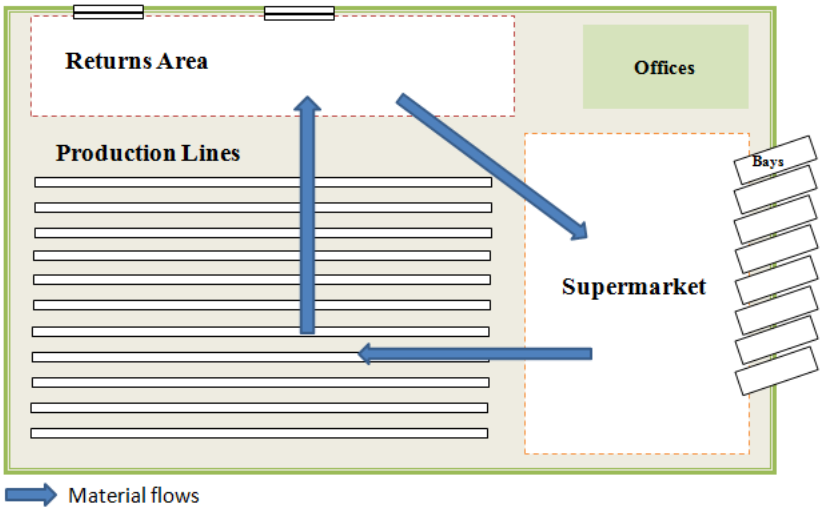


Figure 3: Plant layout of the Car Co.

Literature Review

Plant logistics in the automotive industry have received attention in the literature. They consist of the external, the in-house and the reverse logistics and these are closely related as they affect each other's performance. External logistics refers to the orders' call and to the transport logistics from the suppliers to the Original Equipment Manufacturer (OEM). In-house logistics refers to the parts storage and packaging in the supermarket and to the parts transportation to the production lines (material supply systems). Reverse logistics refers to the transport of empty boxes from the production lines to another station into the plant (internal returns) and to the process whereby empty boxes go back to the suppliers (external returns) (Boysen et al., 2015).

In the external logistics, a just-in-time (JIT) strategy is applied and the parts are delivered to the OEM just when they are needed. This is a great logistics challenge and many researchers have developed various approaches in order to investigate and optimise the parts delivery to the OEMs (Dinsdale and Bennett, 2015; Du et al., 2007; Chuah and Yingling, 2005).

In-house logistics, which refers to the production lines, the supermarket area and the material supply systems, has gained considerable attention by researchers mainly because of the complex operations involved (Boysen et al., 2015; Jainury et al., 2014; Dörnhöfer et al., 2016). In the production lines, line balancing, model sequencing, production scheduling and workforce assignment are the four main problems that have received attention (Thomopoulos, 1967; Jin et al., 2008; Dormer et al., 2015; Battaia et al., 2015) and various approaches to solve them have been developed like heuristics and programming methods. Regarding the supermarkets management which is another important part of the in-house logistics, Battini et al. (2013) carried out a useful piece of work in which they explicitly defined the concept of supermarkets and after a detailed analysis of the existing literature they outlined

the problems emerging when implementing the supermarket concept. Location planning, vehicle routing of tugger-trains, scheduling and loading of tugger-train are the main problems. However, numerous researchers have been trying to address them with frameworks and supporting tools (Emde and Boysen, 2012; Vaidyanathan et al., 1999; Golz et al., 2011). The material supply systems problem has also received particular attention in the literature.

After a systematic investigation, three basic systems were identified: the line stocking, the kitting and the minomi system (Battini et al., 2009; Hanson, 2010). Past research has tried to investigate and compare the performance of the material supply systems aiming to decide which the most efficient system to adopt is. Caputo and Pelagagge (2010) and Limere et al. (2012) concluded that the best system to adopt is a hybrid system in which some part will be kitted while some other will be stored to the line. In this hybrid system the advantages of both the line stocking and the kitting system can be exploited while the disadvantages can be eliminated. This is line with reached by Hanson and Brolin (2013), Hua and Jonson (2010) and Sali et al. (2014) who formulated the conditions under which OEM should be applying line stocking or kitting.

Regarding the reverse logistics little attention has been given by researchers (Carter and Ellram, 1998; Rogers and Tibben-Lembke, 2001) and often from a purely theoretical standpoint. A theoretical description of internal returns processes carried out by Boysen et al. (2015) and during this analysis they identified a research gap in the literature about this topic. In fact, to the author's knowledge and after a careful investigation of the literature, there is no other practically examination of the internal returns system into the automotive assembly plants.

Methodology

A mixed methods choice has been made in this research using both qualitative and quantitative data. Firstly, five semi-structured interviews took place with the operations/planning managers and front-line material flow engineers in order to map the overall material flows into the plant. The interviews took place in the final assembly plant of the Car Co. and lasted ten hours in total. Data about the layout, the processes, the material flows as well as from the returns area, (also called tunnel area) was collected. Then, quantitative data in the returns area collected through observations that lasted 24 hours. With a simulation analysis, the current environment was investigated and three areas of improvements were identified. Three more interviews with the operations/planning managers took place in order to assess the "feasibility" of the potential scenarios for efficiency improvements in the areas that identified before. Extra data about layout and process constraints were collected and a final solution was developed and further explored to test if improvements have been achieved.

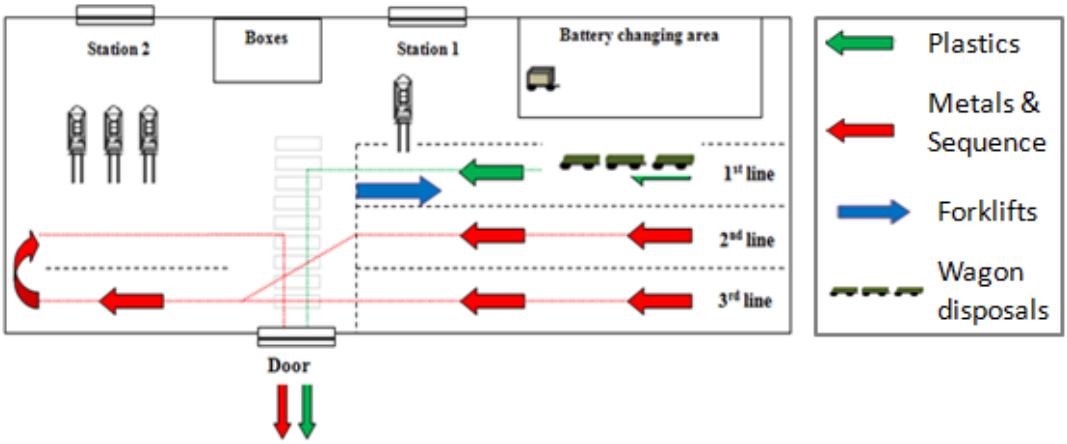


Figure 4: Tunnel area layout and processes occur

In the tunnel area, tugger trains loaded with empty plastic boxes follow the 1st line and wait in the queue in order to be offloaded by forklifts in Station 1 (see Figure 2). Tugger trains loaded with empty metal and sequence boxes follow the 2nd or the 3rd line and wait in queues to be offloaded by forklifts in Station 2 (see Figure 2). Data about the tugger trains arrivals to the tunnel area, the tugger trains process time for offloading, the departure rates, the tugger trains' characteristics and the layout characteristics and plan were collected and analysed. Also, any additional movements by other transport vehicles performed in the returns area have been collected. As shown in Figure 1, in the tunnel area not only the tugger trains are offloaded, but two additional processes take place: the upstream movement of forklifts which move to the supermarket area so as to transport special or heavy boxes and the wagons' disposal in the 1st line in order tugger trains to change their battery. These two additional processes cause delays and severe traffic congestion especially in the area around the door in which numerous different routes are crossed.

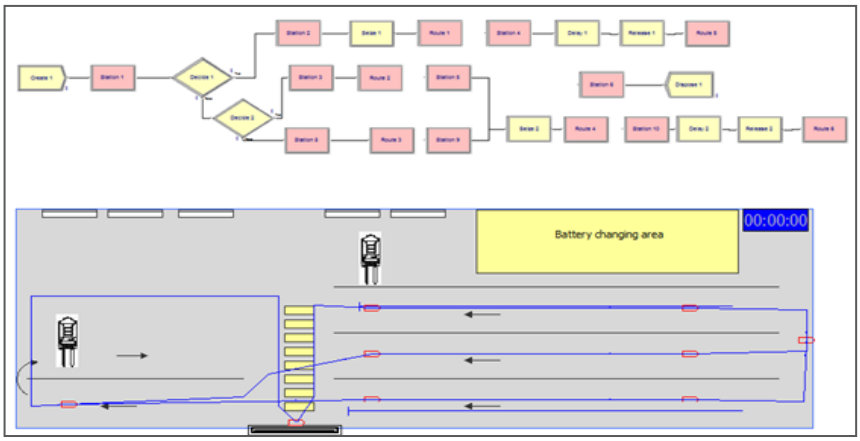


Figure 5: Simulation model in the tunnel area

A further analysis of the data collected performed in order to build the simulation model (using Arena software), which represents the current environment in the tunnel area (Figure 3). Tugger trains are considered to be the entities of the system which arrive in the tunnel area with the distribution; 0.36 + EXPO (0.225). Then, the model distinguishes the tugger trains based on the material that they carry. The 33% of the tugger trains is loaded with plastics while the rest 67% is loaded with sequence and metals. Tugger trains with plastics will take the 1st line while the others will take the 2nd and the 3rd line. Regarding the sequence and metals, the model sends the 50% of them in the 2nd line and the other 50% in the 3rd line. Also, the time needed in order tugger trains to take the lines is at around 17 seconds. Forklifts are considered to be the resources of the system. Their capacity is two in station 1 and three in station 2. The offloading process time in station 1 is 18.5 + ERLA (9.72, 3) and in station 2 is TRIA (14.5, 30, 60.5). After the offloading process, tugger trains exit from the door. Tugger trains from station 1 need on average 11 seconds to exit, while the tugger trains from station 2 need on average 18 seconds to exit.

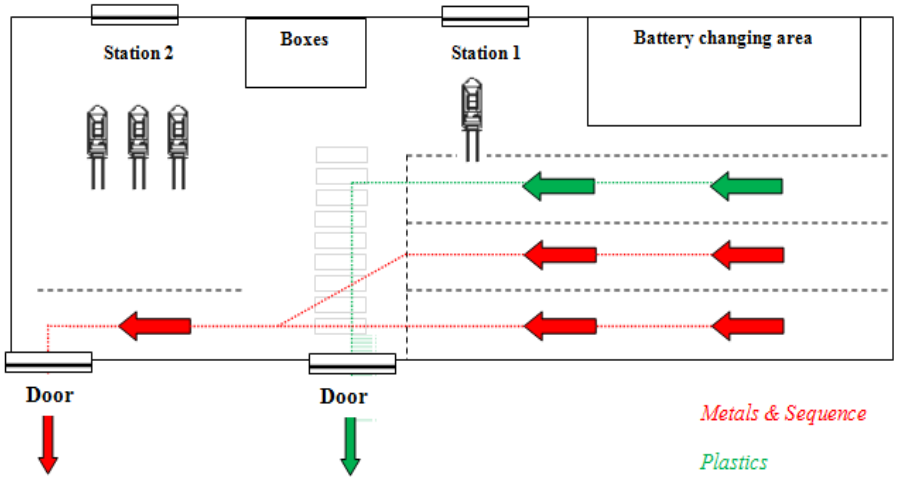


Figure 6: Potential Scenario for the tunnel area

After the simulation analysis of the current environment, three interviews took place in the Car Co. in order to decide upon a practical scenario for efficiency improvements. It was suggested to add one more door in the area in order for tugger trains with metals and sequence to exit from the new door reducing this way the number of routes crossed in front of the existing door (see Figure 4). A new simulation model was developed in order to test if improvements achieved. Both simulation models run for 24 hours and 100 times in order to achieve accuracy of the results. They were also verified and validated in order to ensure that the model has been built right and that it is fit for purpose. Tests running and animation inspection took place in the simulation model for verification reasons and conceptual as well as operational validity processes took place by presenting the model to the managers of the Car Co. and by comparing the simulation results with the outcomes from the real data analysis.

Results

The interviews with the operations/planning managers and front-line material flow engineers, regarding the overall material flows into the plant, revealed that the supermarket area is a functional area which offer flexibility and the hybrid material supply system (line stocking, sequencing and minomi systems) used, offers great advantages in terms of space management. Table 1 below summarises the main findings of the analysis focused on the internal returns area.

	Current layout Observation results *disruptions included	Current layout Simulation results *disruptions not included	Alternative scenario Simulation results
Average no. of tugger trains offloaded per day	2561	2586	2601
Average no. of tugger trains waiting in the queue for Station 1	2	1	1
Average no. of tugger trains waiting in the queue for Station 2	6	6	5
Average throughput from the existing door per hour	106 tugger trains/hour	108 tugger trains/hour	36 tugger trains/hour
Average throughput from the new door per hour	-	-	73 tugger trains/hour

Table 5: Outcomes from the overall analysis

The simulation model of the current layout presents a more efficient system than the system currently in place, as more tugger trains are offloaded per day and simultaneously the queues are shorter than before. This is because the disruptions have not been included in the simulation model. So, if the tunnel operated without the wagons disposals in the battery area (which cause manoeuvres) and without the extra movement by the forklifts, there would be less traffic congestion and delays would be reduced.

Efficiency improvements were achieved also with the alternative scenario. First of all, there is a 0.6% increase in the number of tugger trains offloaded per day. The traffic congestion has been reduced and the processes are performed faster than before. Also, there is a small reduction in the average number of tugger trains waiting in queues. However, the most significant implication of this scenario is the change in the average throughput exit door per day. In the current environment, a considerable number of tugger trains exit through the existing door per hour (almost 106 tugger trains per hour). This causes delays, traffic and accidents. The additional new door changes the average throughputs. In the alternative scenario, 36 tugger trains per hour will exit through the existing door and 73 tugger trains per hour will exit the new door. This reduction is significant for two reasons: firstly, it reduces the traffic around the existing door and secondly adequate space for an increased demand in the area is created.

Discussion

Car Co. operates a functional supermarket, which comes with a number of advantages such as time, flexible logistics processes that have been already identified in the literature (Battini et al., 2013; Golz et al., 2011; Emde and Boysen, 2012). The company uses a hybrid material supply system in order to feed the production lines. A combination of line stocking, sequencing as well as minomi systems helps increasing the efficiency of the plant and this is in line with previous research on the benefits of hybrid systems (Caputo and Pelagagge, 2010; Limere et al., 2012).

The interviews with company's managers revealed that the internal returns area is an area where there are opportunities for improvements. This is an unexplored area in the literature despite its significant impact to the overall system's performance (Boysen et al., 2015; Carter and Ellram, 1998). More specifically, our research showed that the upstream movement by forklifts and wagons' disposal in the lines negatively affect the system by reducing its capacity, creating complex material flow processes and by maximising the probability for delays and accidents. However, these disruptions cannot easily be addressed because of the current layout and the material flow system of the plant. After presenting to the managers different alternative scenarios, one solution (adding one more way out in the area) was identified and further developed in accordance with the layout and the processes constraints.

Conclusions

In conclusion, this paper investigates the material flows processes into the automotive assembly plants and areas of efficiency improvements are explored. The current environment of the case study company was analysed, using the simulation technique and it was found that inefficiency is caused by bottleneck in the area around the exit door, traffic congestion and disruptions. Further analysis of the findings resulted in the development of a potential solution to reduce the congestion and to achieve efficiency improvements. A new simulation model was developed and the outcomes confirmed that by reducing the traffic congestion, major improvements could be achieved in terms of system's capacity and efficiency. The implementation of the solution developed should improve the material flows into the final assembly plant of the Car Co. and health and safety incidents could be addressed as well.

This work has both research and practical implications. Regarding the research implications, a methodology to understand how to improve the material flows into an automotive assembly plant has been provided. Moreover, the research gap in the literature about the internal returns processes has been filled and knowledge in the internal returns area has been reflected using empirical data from the case study company. It has been also proved that the simulation approach is an appropriate method to apply in the automotive industry in order to explore issues related to the in-plant material flows. Regarding the practical impact, a simulation model which can be used with adaptations (e.g. changes in the number of resources) in the returns area of the automotive assembly plants has been developed and a realistic solution with minor layout changes has been proposed and simulated to prove that efficiency improvements can be achieved.

One of the limitations of this research is related to the data collected in order to build the simulation model. Specifically, the quantitative data in the tunnel area collected from one day, so it lacked the ability to study change and development phases during the quantitative data collection and analysis. Another limitation is the use of only one case study in order to investigate the plant logistics and material flows. Finally, the human factor (e.g. tugger trains drivers behaviour) and how it may affect system's performance have not investigated in the current work. More research into the returns processes need to be conducted in the future because of their strategic importance and their link with the overall logistics and material flow processes into the automotive assembly plants.

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The real cost of poor quality BOM in manufacturing.

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Introduction

The researchers initial focus was to look at inventory but it quickly emerged that the confidence in the quality of the BOM and related data was low. The researcher's hypothesis was that the causes of the inaccuracies were not properly understood. The second hypothesis was that by demonstrating the cost impact it would help show that the many small inaccuracies in BOMs were not simply an administrative nuisance. The research design used quantitative analysis for determining the cost of BOM error and qualitative analysis for identification of the causal factors of BOM error within the organisation, with some supporting quantitative analysis for the root cause of a specific BOM errors. The research set out to examine a single case study, the researcher's company, to provide the detail for the quantitative and qualitative analysis. After the completion of the initial research the authors, in reviewing the findings, focused on a specific outcome which when considered with previous research revealed a potentially more significant causal factor. This paper looks first, at the initial research and its broad conclusions, which cannot be generalised as it is based on a single case study. Second, the paper then previous research and experiences to develop a second more generalisable conclusion.

Literature review

Types of BOM

The initial stages of the literature research looked at BOM design. Best practice has largely remained unchanged from the 1990's with a range of configurations providing differing solutions to take account of slightly different manufacturing or planning needs Goodinson, (2017). The literature looked at 11 different types, listed below with a brief description below and analysed in Table 1

BOM structure Feature to provide	Traditional	MBOM	GBOM	VBOM	SBOM	Design BOM	A/D BOM	PBOM	BOMfr	BOO/ OBOM	BOMO
Can information be provided for production planning?	✔	✘	✘	✔	✔	✘	✔	✘	✘	✘	✔
Does the structure support reporting for build specifications?	✔	✔	✘	✔	✘	✘	✔	✘	✔	✔	✔
Does structure support supply of route cards or shop orders?	✔	✔	✘	✔	✘	✘	✔	✘	✔	✔	✔
Does structure provide data for reference to drawings?	✔	✔	✔	✔	✔	✘	✔	✘	✔	✘	✔
Can actual material content be included in BOM?	✔	✔	✘	✘	✔	✔	✔	✘	✔	✘	✔
Can BOM structure apply variable use of materials (e.g. rolls)?	✘	✔	✔	✔	✔	✔	✘	✔	✘	✘	✘
Can routing processes be applied to BOM as per actual process?	✔	✘	✘	✘	✘	✘	✔	✘	✔	✔	✔
Can machine/process set un times be added to BOM?	✔	✔	✘	✘	✔	✘	✘	✔	✔	✔	✔
If the process route is in more than one department/cell can levels be accommodated?	✔	✘	✔	✔	✔	✘	✔	✘	✔	✔	✔
Can non-value added activity be included in BOM?	✔	✘	✘	✘	✔	✘	✔	✘	✔	✔	✔
Will stockim points be visible in BOM structure?	✔	✔	✘	✘	✔	✘	✔	✔	✘	✘	✔
Does the BOM support tracking of item in production?	✔	✔	✘	✘	✘	✘	✔	✘	✔	✔	✔
Does BOM structure provide simple BOM change management?	✘	✔	✔	✘	✘	✔	✘	✔	✘	✘	✘
Does structure support high item variety?	✔	✔	✘	✔	✔	✔	✔	✔	✔	✘	✔
Does BOM structure limit end item variation?	✘	✔	✘	✘	✔	✘	✘	✘	✘	✘	✘
Can BOM structure manage materials forecast?	✔	✔	✔	✔	✔	✘	✘	✔	✘	✘	✔

Table 1 BOM options and advantages and disadvantages

Traditional BOM – Classic form of BOM described by Vollmann, Berry, & Whybark, (1998) and used in most basic BOM training.

Generic BOM (GBOM) – described by Aydin & Gungor, (2005) where the BOM describes the structure of a group of products rather than an individual SKU.

Modular BOM (MBOM) – described by Jiao & Tseng, (2000) where major elements are described as modules, which are managed separately and only configured when the product is ordered.

Variant BOM (VBOM) – described by Jiao & Tseng, (2000) is a variant of the MBOM where similar modules are grouped.

Super BOM (SBOM) – described by Jiao & Tseng, (2000) is a combination of a Modular BOM with an Add / Delete function.

Add/Delete BOM (A/DBOM) – described by Stonebraker, (1996) is an adaption of the SBOM, where items are selected from an existing list.

Percentage BOM (PBOM) – described by Jiao & Tseng, (2000) and lists all parts but with a percentage to enable proportional forecasting.

Bill of Manufacture (BOMfr) – described by Jiao & Tseng, (2000) these structures combine materials and manufacturing routing information.

Bill of Operations (BOO) / Operations BOM (OBOM) / Bill of Materials and Operations (BOMO) – described by Jiao & Tseng, (2000) and Stonebraker, (1996) is a combination of materials and routing information.

The analysis of the BOM types shown in Table 1 which shows whether the features are considered desired or a drawback, overall conclusion by (Goodinson, 2017) was:

'…The conclusion from the ten BOM structure options reviewed in the literature are that there are benefits and drawbacks for any BOM architecture used. The critical aspects of the BOM utilisation and format of information required from the BOM. For [The Company], the BOM structures have been assessed in table 1 against [The company] specific requirements…'

The choice of type of BOM and its relation to the potential causes of poor quality within BOMs are shown to be closely related, as articulated by van Veen & Wortmann, (1987), who identified that using Generic BOM (GBOM) could reduce the maintenance workload and thus would be a positive contribution to the reduction in errors. Goodinson, (2017) points out that early authors such as Stonebraker, (1996) suggest that it simplifies planning because it separates the combinations into Modular BOMs. However, Jiao & Tseng, (2000) notes that the purpose of Modular BOMs is to facilitate planning via product feature groups. This approach is supported by Ptak & Smith, (2011) who give utilise the MBOM as a building block for their planning techniques like Demand Driven MRP.

The challenge of BOM quality

The literature has been quite clear about the importance of the accuracy of the BOM in the 3rd edition of "Orlickys - Materials Requirements Planning" revised by (Ptak & Smith, 2011) the messages remain the same as originally espoused by Possl and Orlickys who wrote the original in 1975. BOM is typically referred to as the foundation of any planning system from the paper by (Clement, Sari, & Colrick, 1992) '…no one would construct a building with weak materials and risk collapse…'

The literature review identifies that both during the creation, maintenance and through the formal and informal change management processes there are many areas where errors can and are introduced. These were examined considering the business processes employed, the technology used to manage the tasks and the organisation, i.e. the people skill, training and education when performing tasks using the technology when completing the prescribed process.

The causal factors questions were developed from the established Oli Wright ABCD Checklist. There were 43 potential causal factors for error introduction identified from the body of the literature,. These are shown in the mind map in Figure 1, they have been categorised into three major groups, Process (Pink – Top Right), Organisation (Green- Left) and Technology (Yellow / Pink – Bottom Right), a subsequent ranking process identified 6 key factors which are shown in Blue.

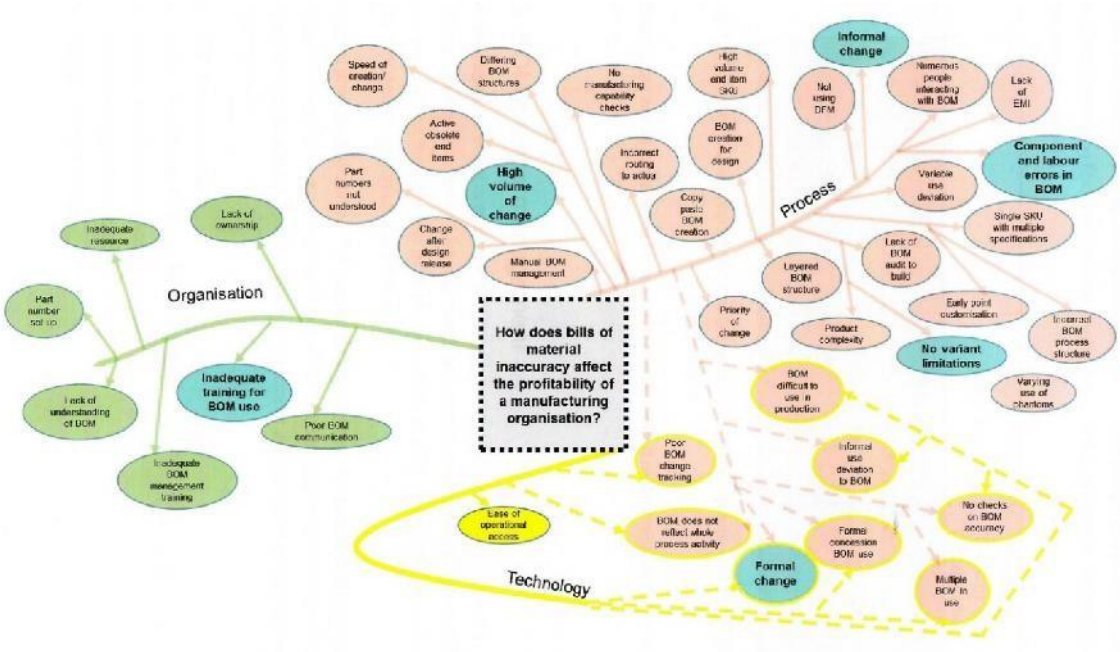


Figure 1 Mind map of the 42 causal factors identified in the research literature

The research work

The research examined three factors: Data analysis of the financial account, analysis of BOM errors and impact and the causal factors survey. The key steps in each are summarised below.

Data analysis of financial account

The analysis of stock adjustments over a 12-month period were examined in detail to determine the impact. The adjustments were compared with financial reports which identified accounting variances.

Analysis of BOMs errors and impact

The researcher first, accessed [the Company] BOM controller's problem log and examined specific manufacturing problems identified by the production staff. Then, conducted a thorough examination of the BOM to identify root cause. The researcher examined the BOM issues relating to the labour and materials costs and the effect of inaccuracies on decision making. Finally, the researcher analysed the resources used between 2014 to 2016 to manage and control the Engineering Change Management processes (both formal and informal) and the effect on the BOM process outcomes.

Causal factors survey

The researcher's survey questionnaire was designed to gather data on: the production community, the qualification and experience levels, their understanding of BOM processes and procedures and their attitudes to training and education. The survey group was selected to ensure a representative sample of staff associated with manufacturing processes and in particular the BOM.

Results/analysis

Data analysis of financial account

The financial balance sheet identifies the materials and labour content of the products, when the accounts are reconciled if errors are present in the BOM then there will be a variance. The variances for the Financial Year 2016 is shown in Table 2. There was a 4% variance, nearly £600k, the materials and labour BOM processes had not planned for this, from a financial perspective it is lost revenue as the additional materials and labour used was not planned or costed in the initial products profit model.

	BOM Value	Percentage of Product Cost
BOM Material Content	£7,348,591	50.5% (100% = £14,551,666)
BOM Labour Content	£2,502,886	17.2%
Materials Variance	£473,952	3.2%
Labour Variance	£137,219	0.9%

Table 2 – BOM Cost apportionment and variance

The materials for these products represents over 50% of the product costs and emphases the importance of the BOM accuracy for the effectively planning of the business. In simple terms, the materials variance represents £474k reduction in the profit. In addition, the detailed analysis of stock adjustments, typically driven by inaccuracies in both stock control and BOM errors, showed that the total material variance of £703,564. The comparison of stock

adjustment data to the financial balance sheet identified an additional loss of £229,612 over a 12-month accounting period. Increasing the overall material variance to 5.5% which reduces the profit.

Analysis of BOMs errors and impact

The research conducted a detailed analysis of BOMs errors based on the production problem log. Four examples of errors are summarised below.

Aftermarket project – A project was required to create 51 new end items with the objective of resolving some existing packaging issues. Due to pressure to make the products available to the market, all the products were released prior to the completion of the BOM introduction process. The result was that many of the products were set up without the packaging being correctly identified. When challenged the reason given was that the products needed to be released even though the BOM creation processes had not be completed. Two specific errors resulted, first an obsolete component was re-instated and second the sales prices for the new range of products was released based on incomplete BOMs and thus under-priced.

Glass Door – The problem log showed that a production supervisor has reported that the machining of a glass door for an oven actually took 30 mins, whereas the BOM showed two minutes machining time. The part was identified as a candidate for outsourcing, which had been rejected as the internal costs of machining were significantly lower.

	Qty per	Cost per	UOM	BOM Product Cost	Actual Product Cost
Materials	0.96	£5.25	M2	£5.06	£5.04
Labour (Cut / CNC	4.00	£0.2348	Minutes	£0.94	£7.05
Internal Total				£6.00	£12.09
External Quote				£18.58	£18.58
External to inhouse BOM				£12.58	
External to inhouse actual					£6.49

Table 3 Internal and external costings for outsource candidate.

Table 3 shows the initial and revised costings, which shows that although the outsource was still more expensive that the reduction required by the vendor was only 34% not 67%. The net result was that for each unit £6.09 additional variance was added to the labour cost.

Spares project - A project was launched to create a range of spares for the aftermarket. The items were to be simple service packages of parts with single level BOMs. The BOMs included components, packaging and instructions. The

project identified 146 end items. On completion of the project the analysis showed the following results showing that only 31.5% were correct.

	No of BOM's	Percentage
Correct BOM's	46	31.5%
Incorrect BOM's	59	40.4%
Duplicated BOMs	12	8.2%
Obsolete Items not available as spares	24	16.4%
Incomplete BOM data	5	3.4%

Table 4 – Spares project BOM quality analysis

End item assembly - In this case, the BOM specification an item was not made available to the production team. The build line was only supplied with the single level BOM; however, the unique specification required was detailed in a sub-assembly BOM, which identified whether x or y was to be used. The only difference was length and the operator would select for the best fit. The build line was issued the items x and y based on the BOMs, the result was a random consumption error for items x and y dependant on the operator's choice.

All these examples show at various levels a systemic lack of understanding of the role of the BOM within the Design, planning and manufacturing processes. The conclusion is that there is a general lack of understanding of BOM structures as evidenced by the analysis of the problem log examples above.

Causal factors survey

The research showed that over a wide range of factors in all 43 factors were identified. After an analysis and ranking to identify likelihood and severity within the research company, six were identified as the most likely and the most severe during the literature research. These six are listed below; Informal change occurrence High volume of changes Formal change occurrence

Unlimited variants availability

Inadequate training for BOM

Component and / or labour errors in BOM

The case research showed evidence of the occurrence of most of the causal factors.

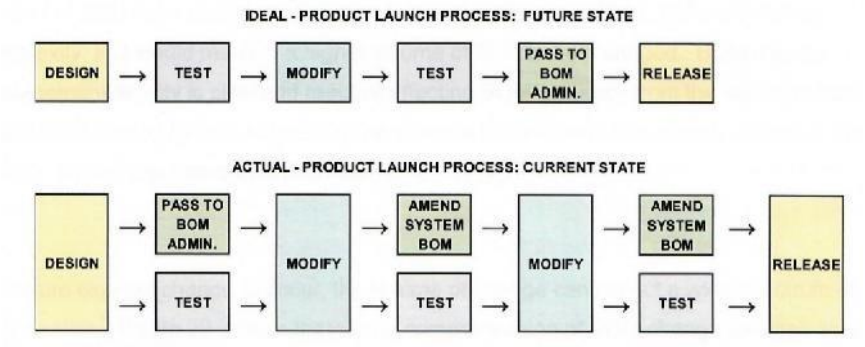


Figure 2. Product Launch Process: ideal and actual (Page 89)

Part of the research documented the business process flow, shown in Figure 2. When it was documented it became clear that the current process relies on an iterative design process, which creates multiple updates and thus additional workload and opportunities for errors. The research concluded that the business process design was one of the contributory factors that may introduce errors into the BOM. Discussion with management showed that the organisation was aware that the current process was not best practice, but it was felt that it facilitated meeting customer deadlines.

Discussion and conclusions

The research evaluated the general direction of product development which is migrating towards a more automotive style, with annual product updates to maintain market leadership and respond to trends set by competitors. This pressure and the need to managing 'batch / annual' model refresh to provide increasing customer choice'. This is moving the business to needing configuration type order management. The current BOM structures are not set-up to manage this type of environment. The recommendations from the research identified that the business should move towards Modular BOM to facilitate better future control of the BOMs. The management team did not see an immediate ROI in making what would be a significant investment in the BOM processes and procedures as the organisation was currently profitable and managed to achieve a good margin on the products in-spite a known level of variance in the products. The finance view was that the cost of poor BOM quality was an acceptable cost leading to the research conclusion by (Goodinson, 2017):

'…There is no burning platform Kotter, (2012) to suggest people need to change – workforce is employed, customers continue to purchase product, profit is made by [the company] and activities continue as usual despite request to change, despite [the company] losing market share…'

BOM understanding

The research by Goodinson, (2017) appears to confirm MRP authors like Possl, (1995) and the more current Ptak & Smith, (2011) predictions based on their own research (Ptak & Smith, 2011):

'…put forward a lack of familiarity, minimal/no training and volume of change requirements builds inaccuracy into data. A central group that becomes familiar with information, are adequately trained Goddard, (2005) and manage changes in a timely process could co-ordinate improvement….'

This is supported by (Ford, 2013): '…BOM accuracy is the most critical element and foundation of a manufacturing organisation…'

The case study provides evidence that errors were introduced through poor processes, poor organisations and dated technology. Analysis of each example demonstrates that there was an inherent lack of knowledge / understanding of the importance of the BOM creation and maintenance processes throughout the organisation both in the BOM management group and on the shop floor. Even though the organisation had a positive attitude to training and the provision of training resources. To support this the research cites two survey questions which articulate the prevalent attitude. Survey question "management views education and training as a positive approach and commit to education and training all necessary people before introducing new processes, tools or equipment." (Goodinson, 2017)

The response was that 49.4% held a positive view with only 17.9% feeling the statement was not true. Survey question "The company has committed adequate resources, time and finances to education and training" (Goodinson, 2017)

The response was that 40% held a positive view with only 22.4% feeling the statement was not true. The research also cites two additional survey questions examining the organisations attitude to training and understanding of the BOM processes.

Survey question "workforce understand BOM content, structure and manufacturing processes" (Goodinson, 2017)

The response was more evenly split with 31.5% agreeing that the workforce understood with 32.5% believing that there was a lack of understanding in BOM processes.

Survey Question "Production personnel have been educated and training in using BOM, reports from

BOM and manufacturing processes" (Goodinson, 2017)

The response here is similar with 29.2% agreeing that the workforce has received education / training while 30.3% believing that there was a lack of understanding in BOM processes.

The final piece of evidence in the research points to an attitude within the organisation, which was demonstrated by quotes from the Test Engineer during the survey: "The people that need to know" he was referring to the engineering personnel and thus excluding the shop floor operators, also stating that "training focus is on job training in BOM use, as opposed to education of what a BOM is and how to use it. Staff show how to use system without necessary showing why they do what they do." Conclusion

We can bring these facts and finding together and draw a larger conclusion that whilst the organisation may hold the correct attitudes to training and education espoused by the literature the execution is somewhat different, driven by a lack of understanding of who needs to know as well as a lack of understanding by those that need to know. Also without the 'burning platform' driving organisational and process change the status quo will remain. The findings showed the need for training, but although there was a focus on training, it was not understood that non-skilled operators needed to understand basic manufacturing principles that they would not have had the opportunity to learn from their education even where it up to A level. A similar observation was made by (Relph & Newton, 2014):

'…Research conducted from 2004 to 2006 also shows that there are gaps between the skill levels (measured by education and experience) of the software salesman, company manager and the planner using the MRP on a day to day basis. The distinguishing difference was the education level rather than the experience level. A possible interpretation is that the Managers are peers of the MRP sales staff and will conceptually understand some of the difficulties and nuances of MRP management. However, it is also possible that the Planners many not share this understanding…'

This suggests that unless attention has been given to all levels of training when new systems are implemented, then the eventual users will not understand what they are being asked to do. The case study identified by (Relph & Milner, 2015) of a training programme at Morrisons demonstrates that when attention is paid to understanding the education level of the user through testing knowledge prior to commencing training, that there is a positive result:

'…All planners were asked to complete a test to determine their knowledge of supply chain planning principles. The planners were tested again at the conclusion of the training and an average improvement of 10 per cent of their first test score was achieved…' (Relph & Milner, 2015)

A key part of training on use of BOM in MRP Planning systems is showing the significance of collection of data and input to the system. One of the authors experience when introducing MRP to an automotive SME supplier, was that despite employee training on the use of the system and data input there were significant issues with data accuracy resulting in issues with inaccuracies in all areas of stock. To try to understand and resolve the MRP data problems, a brown paper exercise to document the process flow was instigated. Every type of record used, which included, MRP reports and all manual records (formal and informal) were represented on the paper flow. This became a very visual representation of the volume of data being recorded and the duplication of information. This highlighted to the staff that although there was some data entry to the MRP system, different production shifts and different operators used a variety of manual recording methods (formal logs as well as informal personal records). It also emerged that the production staff's belief was that the MRP system "didn't work", and as a result preferred manually recording data. This process highlighted to all involved the volume of different recording methods being used and when the actual data was compared very little tallied across the individual recordings. This then demonstrated to production at all levels the reason why accurate data recording was so critical to the process. Once understood, training the production staff on how their individual recording could be entered to the MRP system gave them the confidence to input to, and use the MRP system. The key to the breakthrough was the understanding of why it was so important. This very visual and easy to follow paper process flow resulted in a significant increase in employee understanding of the mechanics of the data recording of the MRP. Over a three-month period, this exercise saw a steady improvement in data entry to the MRP system, reducing stock errors. As data accuracy increased so the trust in the MRP system increased culminating in an effective control system.

The paper draws two key conclusions. First, it concludes that whilst organisations may operate under stress due to poor quality data unless the cost implications are significant or the organisation is threatened then without these burning platforms, as observed by (Kotter, 2012) when describing his eight-step transformation process, the pressure to take the first step in transformation is unlikely, this is confirmed in by the case research described in this paper. Second, it concludes that the true cost of poor quality, even after a detailed research project as described in this paper, remains elusive and understated. The hidden cost related to; poor quality materials, materials shortages, production disruption all cannot be truly evaluated or attributed to the quality of the BOM data. This results in

production and administrative staff remain under stress, not helped because their lack of insight in to the real cause of their daily problems they encounter. These problems are often dismissed as ‘business as usual’ problems of manufacture. This is a classic example of “not knowing what they don’t know”, because, if they knew what to do and how to articulate to the remaining organisation, then despite the lack of a burning platform the organisation would have the wherewithal to solve the problems.

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Logistics systems planning

TOWARDS SUPPLY SPACE MANAGEMENT AND OPEN DIGITAL ECOSYSTEM

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Abstract

Customers want more. Contemporary manufacturing and suppliers deliver goods and services vertically through multiple supply chain processes. Ownership of these processes is usually in broker sector of trade and logistic operators. For customer this means that last mile configuration level is low and every single service is available only separately. Question of last mile seems to remain unsolved. This paper argues that in future business environment is based increasingly on ecosystem platforms which enable new distributions service models and business opportunities e.g. in logistics sector. The empirical component of the study includes the development of a novel construction of open platform ecosystem. The research follows constructive research method, which is one of the sub-methods of action research family. The results show what new business potential and customer value open platform ecosystem, which we call Supply Space, generates.

Keywords: Open ecosystem, open platform, organisational theory, customer orientation, constructive method, practical development, digitalization, innovation process

1. Introduction

Purpose of this research is to develop sustainable, innovative and customer centric business environment with global scalability together with Finnish stakeholders. This ecosystem goal will be constructed and implemented in open and digital business platform in organisational theory context. Any willing company can utilize open data from the platform over business sectors to create new disruptive services and business concepts development and implementation. We are going towards Supply Space is our suggestion.

This paper envisions the future business environment and logistics in the context of changing world where benchmarking with contemporary logistics performance is not necessary or even applicable regardless of continuous development of supply chains. Old conventions no longer work in the new world and new business models and innovation in logistics are needed (Ballou 1999; Christopher 1998; Harrison et al. 2003; Lukka 2003; Gattorna 1996, 2009; Simchi-Levi et al. 2003).

The hypothesis and constructed solution are founded on the principles of platform economy.

From scientific perspective this research is based on Constructive research method (Kasanen,

Lukka & Siitonen 1993; Lukka, 2000, 2003, 2005), which is one of sub methods of Action Research (Kaplan, 1998). Following the constructive method process the contributions of this innovation case study (Yin 1989; Scapens 1990; Pihlanto 1994; Lukka 2003) are:

To construct a model of future open ecosystem enabled by concept hypothesis of modular logistics and supply space management.

Process of innovation (Burgelman & Sayles 1986; Dougherty & Heller 1994; Henderson & Clark 1990; Miller & Friesen 1982; Taylor 1998; Drazin & Schoonhoven 1996; Rogers 2003; Chesbrough 2003; Greve 2003) on open ecosystem development.

Implications to organisational theory. New constructed model is positioned to existing organizational theory (e.g Williamson 1975, 1985, 1991, 1993 1996; Adler 2001; Möller et al. 2005), how it relates and how it can be defined through them.

The practical purpose is to develop and implement an open ecosystem platform that allows the utilization of real-time big data over business sector boundaries, creating a new horizontal value generation and business potential alongside with traditional vertical supply chain profitability potential and to introduce first business concepts utilizing new platform.

The paper is arranged following the logic of the constructive method. The first section reviews constructive methodology applied to ecosystem development process. This process combines research and practical innovation in unique way. Theoretical background for development is based on organisational theory and supply chain management doctrine. Secondly, the case context and construction development are introduced. After that practical application of the construction is evaluated. Finally, theoretical contributions, conclusions and further research opportunities are discussed.

Since global down shift in economy in 2008 new business initiatives have been sought after in whole Europe. First step forward was to envision and review probability of future trends and scenarios.

Methodology and theoretical background

2.1. Organisational theory

Networks can be generally categorised into physical, economic and social networks and by purpose to potential and strategic networks. Potential network means co-operation between actors that has formed without a specific purpose or goal, but can provide future benefits. On contrast strategic network has been created for special purpose or goal, such as more efficient resource utilisation.

Networks can be divided by their purpose and structure into three groups (Barbasi 2002): centralised, multicentre and dispread (Figure 1). Network structure affects the spreading, combination and creation of information and skills within the network (Möller et al. 2005).

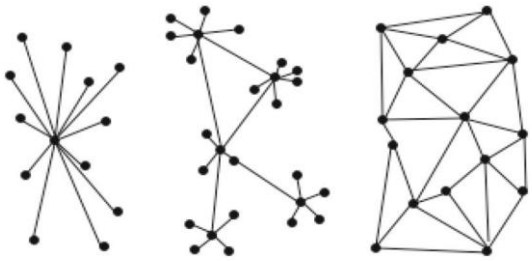


Figure 1: Centralized, multicentre and dispread networktypes (based on Barbasi 2002, Möller et al. 2005)

According to Adler three network types exist; community/trust, market/value, and hierarchy/authority Network models and their relations have been described in different ways Williamson (1991), Ouchi's (1980). Adler (2001) submits, to map institutions in three dimensions according to the salience of community/trust, market/price, and hiearchy/authority modes (Figure 2).

Three-dimensional representation visualizes that the various modes combine in different settings. In the absence of trust, market coordination takes the form of spot markets. However, trust can be combined with the value mechanism in the form of "relational contracts" (Macneil 1980). Hierarchy often appears in a low-trust form. However, hierarchy can be combined with trust, as in the “representative," "dynamic," and "enabling" types of bureaucracy. Market and hierarchy too are often combined, as reflected in the mix of incentives and authority typically found in employment relations, in relations between divisions and headquarters within large multidivisional firms, and in relations between firms and their suppliers. Sometimes this market/hierarchy mix takes a low-trust form, but sometimes trust is an important third ingredient. Within firms, high-trust hybrids can be found in "collaborative" multidivisional corporations characterized by high levels of interdivisional and interlevel trust. (Adler 2001)

Trust is a complex, multifaceted phenomenon; the complementarities between the components of each of its four key dimensions enable trust to function as a highly effective coordinating mechanism. Groups whose cohesion is based primarily on mutual trust are capable of extraordinary feats. Trust is therefore usefully seen as a third coordination mechanism that can be combined in varying degrees with value and authority (Adler 2001)



Figure 2: Alternative Conceptualizations of Organizational modes (Adler 2001)

2.2. Constructive research approach

Innovation has been identified as key factor for enterprise success (Drucker 1954, 1974; Deshpandé et al. 1993; Chesbrough 2003) Because innovation is seen as a significant thing also by the society, have researchers been interested in issues related to performing innovation actions. For example how and when organisations are ready to develop and implement innovation (Abrahamson 1991). One strong assumption is that large and established companies will actually hold back strong emergence of innovative actions (Burgelman & Sayles 1986; Dougherty & Heller 1994; Henderson & Clark 1990; Miller & Friesen 1982; Taylor 1998). The views on innovation in large enterprises can even be seen as straying from the path of organisational conduct. From the organizational theory point of view however the most interesting question is probably not why enterprises make innovation but the fact that innovations are so scarce (Greve 2003).

Development process theory claims that innovation is based on information and successful acquisition and leadership of innovative employees (Cohen & Levinthal 1990; Leonard-Barton 1995; Nonaka & Takeuchi 1995). Because development and implementation of innovation require them to be tightly linked to organisational and business strategy, they have to overcome several barriers to get accepted. In every step the successfulness of innovation is reliant to the support received from organisation leadership (Doughery & Heller 1994; Greve 2003), in other words organisational commitment and leadership form the basis of successful innovation.

From research point of view construction process can be seen as heuristic. According to heuristic operation model the development process is not necessarily defined in detail nor could it be programmed according to any rule sets (Moustakis 1990). Instead all the problems or unexpected developments had to be solved as they appeared (Wisner & Kuorinka 1988).

Innovation has received much more attention in the field of business research. Innovation has been closely tied to learning and innovation has generally been thought to be something only innovative and able companies can do.

Innovations come in different forms; they can be technological innovations that can open new areas of economy and social operations, or at least improve existing ones. They might start a wave of mimicking and technology based competition that reorganises basic structures of production. In this way innovations are important not only to organisations but more broadly to whole society. From business research methods constructive research approach is seen as most innovative. Construction of problem solving model is considered as creative and heuristic in nature that has very little methodological guidelines related to it (Gummerson 1991, 2000; Hopwood 1978; Kaplan 1993, 1998; Kasanen & Lukka & Siitonen 1993; Lukka 2000, 2003, 2005; Pihlanto 1994; Scapens & Theobold 2002; Tamminen 1992).

Strong empiricism and demand for innovation affected greatly the selection of research methodology (Ittner & Larcker 2001). Constructive research approach was selected. Constructive method is seen as a one the forms of case research and generally means a model for problem solving through schematics, plan, organisation, machine etc. (Kasanen et. al 1991, 1993). In methodological framework of economy, constructive research approach is relevant for this research because it focuses in the development of new innovative construction and its application to solve real life problem (Kasanen et al. 1991, 1993; Lukka 1999, 2000, 2003, 2005). In addition to building a construction for real life problem scenarios, a core element of constructive research approach is the implementation attempt of the construction to test its feasibility. This requires close cooperation between practical operators and the researchers that is expected to include empirical learning. Furthermore the research and construction are connected to existing theoretical knowledge and attention is given for reflection of empiric findings against this knowledge to produce theoretical contributions. Theoretical connection options of constructive are development of new theory, improvement of an old theory or more modestly illustration of a theory (Keating 1995; Lukka 2000, 2003, 2005; Lukka & Kasanen 1995). Ideal result from constructive research method is solving an observed real life problem with the new developed and implemented construction, which produces great contribution both in practical and theoretical perspectives (Lukka 2000).

Construction is an abstract concept that has in principle unlimited possible outcomes. These outcomes include; models, diagrams, plans, organisational structures, commercial products and information technology models. Characteristic quality for construction is that they are not found but developed and innovated instead. Through developing constructions that differs from existing something completely new is developed: Constructions develop new reality in themselves.

Development through constructive research method and subsequently created construction are linked to theory and theoretical contribution. Selection of constructive research approach implies setting two types of goals, practical relevancy and theoretical contribution

2.3. Process of innovation

In order to initiate cooperation, it is necessary to create a joint project with the researchers and the company or other organisation, and to work in close cooperation throughout the project. The customer's representation should also be taken into consideration. This is a critical stage in the startup of cooperation and the establishment of common goals (Hyötyläinen, 2013). The activities will then be in close cooperation within the framework of a real-world practice (Lukka, 2000, 2003).

This joint project has its own challenges. The project team must have diversified competence in order to represent different viewpoints and influence the resulting decisions and solutions (Checkland, 2000). There is a need to combine business competence and research competence, or practical knowledge and theoretical knowledge (see Eekels & Roozenburg, 1991). Understanding the environment and the key development needs and development factors is also necessary. Furthermore, the company needs project planning competence and leadership ability to allocate sufficient resources for the joint project and to budget the activities. Correspondingly, the research plan must be based on a sufficient amount of theoretical and methodological competence in order for the researchers to be able to assess the theoretical significance of the solution. Theoretical competence also involves perception of research problems (Kasanen et al., 1993).

The first task is related to the identification of the change factors in the environment. The environmental factors are also taken into consideration in the design science approach (Hevner et al., 2004; Hevner 2007). This model emphasises the challenges and development needs of the environment. The desired states with regard to the environment have also been added to Figure 5. The task can be to create the desired states in the future of the company or companies. This is a key principle of a joint project, takes place within the interaction of the researchers and the company personnel. Research may play an important role in this. The task of research is to provide researched information in order to assist in the determination of the desired states of the companies and their descriptions. This requires applicable concepts, models and design rules (van Aken 2004; Hevner et al. 2004).

Another task concerns the identification and definition of problems and objectives. This is not necessarily always easy or straightforward, as many different viewpoints and objectives are related to problem situations (Checkland, 2000). Holmström et al. (2009) state, that it is often the case that the issues are very ambiguous and poorly known. They emphasise the challenges that by their nature are sets of problems. It is often the case that the researchers should carry out a sufficient analysis of the company and its cooperation partners in order to identify the core problems and choose and specify the key objectives (Lukka 2003; Hyötyläinen 2013).

The next step is the innovation process (discovery process): an important stage before the actual creation of the constructions. Kasanen et al. (1993) are of the opinion that this is a creative, innovative and heuristic process. At this stage, you must first be able to perceive the preliminary construction outlines. The constructions to be tested must be selected from these. At this stage, testing takes place virtually (Yrjölä 2003). Small-scale piloting can also be carried out at this stage.

The innovation process requires learning how to create new construction outlines and how they can be verified. The learning and innovation process is a social, complex and cumulative process that requires collective cooperation (Lazonick 2005). The innovation process is, however, an uncertain process, as learning does not occur at once; it is a process of a cumulative nature, with the earlier decisions still in effect. The innovation process requires individuals to be aware of their own values and attitudes and those of the project team members. It requires creative and innovative individuals capable of jointly processing and innovating new kinds of construction outlines when working in the project team, where learning is based on the interactive process of tacit knowledge and codified knowledge (Nonaka 1991). Within the team, the different viewpoints interact with each other, and the team must be able to handle differing viewpoints. This may result in new and structured models (Checkland 2000). The project team must also have sufficient practical skills, theoretical cognitive knowledge, and knowledge of the context (Eekels & Roozenburg, 1991).

Constructions are created and built as a result of the innovation and discovery process, forming solutions for the identified problems and objectives. The constructions created can, for example, be concepts, systems, models, tools, or design rules. They can also be all of these (Lukka, 2003; van Aken, 2004; Gregor & Jones, 2007).

The next step is to test the constructions and solutions and possibly to deploy them. Kasanen et al. (1993) are of the opinion that constructions and solutions can be assessed using two different methods. A weak market test is one in which one or more company executives are prepared to deploy the new constructions. A strong market test is on which the result of a unit has improved after the constructions were deployed.

Development and implementation of an open ecosystem platform

3.1. Case background

Today people want more. More value, more services and quality, more information and more possibilities for control over everything even if those possibilities are left unused. With the advent of Y-generation and increase in digitalization values of humans of post-modern era are dramatically more diverse.

For business post-modern era means more demanding customers. Customers want prestige and satisfying services at the same time, preferably from the same source for increased convenience. Because we know that customer satisfaction leads to customer loyalty which correlates indisputably to profitable business, these demands need to be addressed (Kohli & Jaworski 1990; Anderson et al. 1997; Ricci 2004).

Demanding customers create business challenges to which contemporary business logics cannot answer. At the same time the possibilities of digitalization are not yet even fully understood or exploited. These challenges can however be seen as opportunities for new business creation.

Like future scenarios have predicted a dramatic changes in business environment are underway, which lead to a conclusion that business mind set and paradigm changes seem inevitable.

In Finland the crossroad for economic development, through traditional doctrines and paradigms, was when Finland and Europe sank into economic recession late 2008. Government faced the reality that big changes in National economic system were required. One of the consequences was redirection of funding to new agendas, for building new kind of economic initiatives to create new growth. Situation was challenging because at the same time big savings in state budget had to be made.

“Cuts (in funding) spell significant changes in our innovation funding and operation methodology of Tekes. Biggest effect is networking and cooperation between universities, research facilities and private businesses.”

“Whole program operation has to be re-thought and to make sure that Tekes supports business ecosystems in the best possible way.” (Chief Executive Officer Tekes2 11.6.2015)

[2] Tekes is the most important publicly funded expert organisation for financing research, development and innovation in Finland. We boost wide-ranging innovation activities in research communities, industry and service sectors.

”Throughout history technological advances have driven nations into prosperity – and right now is that time when visionary, ambitious and focused, research development and innovation initiatives take Finland into an economical growth path” (Chief Executive Officer VTT3 17.12.2015)

One project that helped to forward this agenda was EPISIS4 - European policies and instruments to support service innovation – project promoted the development of service innovation at policy, strategy and operational levels through transnational cooperation between policymakers and innovation agencies. The project took place in 2009-2012, and it was coordinated by Tekes

Project contribution on logistics was to research on European policies to support service innovation that lists most significant barriers for logistics market. These were Infrastructure constraints, whether transport or digital, hinder the abilities of logistics operators to innovate and bring new service offerings to market. Environmental protection, above all the imperative to reduce greenhouse gas emissions, represented a massive challenge to the freight logistics sector, as well as driving change, as we have seen. The explosion of e-commerce and e-business operations raises the importance of information exchange and associated system interoperability. This is needed to underpin continued development and innovation in logistics, including moves to more flexible market models, e.g. procurement platforms and portals for outsourcing services. Need to reconcile a very board swathe of regulations which engage logistics operations, some national, some European in origin, with industry development and innovation. There is an increasing complexity of logistics and associated services, including a response to e-commerce and e-business opportunities. Some (not all) of this challenges a sector, which has employed lower skilled personnel in core freight activities, and now needs higher qualified personnel to meet new demands. While EPISIS formulated challenges in logistic sector, futurology envisioned future possibilities5.

Following the suggestions for new innovation the discussion continued between government, research institutes and companies at Finnish national level. Many creative and potential visions has been drafted one of which was open ecosystem initiative for consumer driven services and service logistics.

First step was to envision big picture of future scenario (Figure 3). Finnish geographical logistics environment is challenging for profitable business management with long distances and relatively narrow material flows. However by changing the mind set the challenges of a small market can be seen as revolutionary opportunities. Finnish strategic R&D initiative, late 2016, is called “Open Ecosystem of Consumer driven services”.

[3] VTT Technical Research Centre of Finland Ltd is the leading research and technology company in the Nordic countries

[4] EPISIS partners include DASTI, the Danish Agency for Science, Technology and Innovation from Denmark, PT-DLR1 from Germany, Vinnova from Sweden and BIS, the Department for Business, Innovation and Skills, from the UK. EPISIS was funded by the European Commission under the PRO INNO Europe initiative.

[5] “World full of change creates huge amount of new possibilities for innovation and new business concepts. Finland has a possibility to create not only a centre for commerce and logistics, but also a centre for innovation and reformation. Even the largest operators cannot do it by themselves. National and international cooperation should be realized as a model of actualisation.

Possibilities for future innovation and business concepts should be recognized today so that long run business infrastructural investments could be considered as early as possible. Worst case scenario is to do nothing. High skill level could enable the growth to a hub of innovation actions and global future.” (Mika Aaltonen, Head of Future Research, Aalto University 2015)

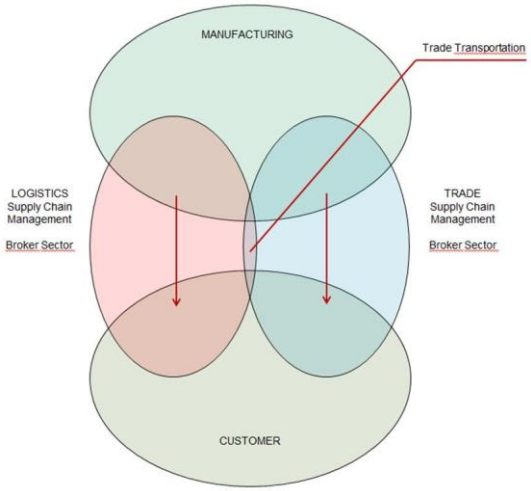


Figure 3: Market in Finland 2016 when innovation process begins, broker sector and supply chain management serving manufacturing and customers. Price mechanism coordinating competing suppliers and anonymous buyers (Adler 2001).

Meanwhile many innovative actors of industry and trade sectors have become aware of challenges and opportunities, leading towards business paradigm change in Finland. This vision is based on widely developing platform economy principles. E.g. Accenture technology vision is one example of these principles (Figure 4). Actors represent main industry sectors; manufacturing, commerce, logistics and service sectors that have committed and believe that platform driven business is the most value generating and disruptive opportunity for the future business environment.

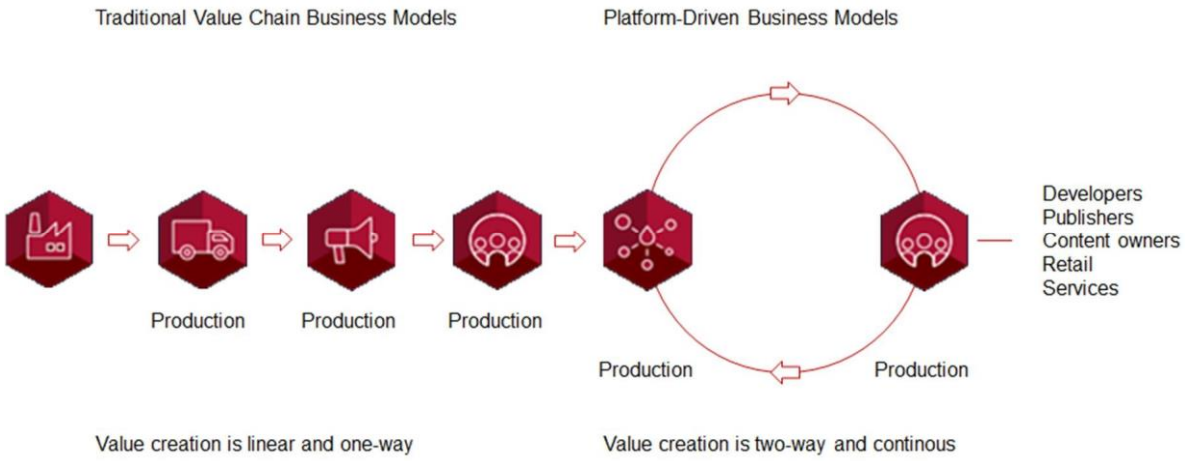


Figure 4: From traditional value chains to platform driven business models (Accenture technology vision 2016)

3.2. Synthesis of business environment of the future

Customers want more and better services. Contemporary manufacturing and suppliers deliver goods and services vertically through multiple supply chain processes. Ownership of these processes is usually in broker sector of trade

and logistic operators. Control of vertical customer distribution processes are not centrally managed but are separate and independent from other operations.

For customer this means that last mile configuration level is low and every single service is available only separately. Question of last mile seems to remain unsolved. This observation is the reason why supply chain is perceived as inadequate when high service level and customer satisfaction are the targets.

E-commerce is increasing enabled by digitalisation, but logistics seems to be a restricting factor in this development. However consumers would like to get all the services wanted at the same time as conveniently as possible.

Desired outcome is to increase service level on broker sector. This requires more transparency and horizontal cooperation. From customer perspective it's not relevant issue how services configuration is increased or who is the service operator on broker sector (e.g. trade, logistics)

Transparency and horizontal cooperation can be achieved through utilizing big data in distribution control over business sectors crossing traditional broker boundaries. Because consumer wants better service level; to get everything quickly, reliably, cost effective, with high quality and everything at the same time, one of the targets should be to reconfigure separate services physically as close to the end user as possible. In our hypothesis supply chains are more like a large broker resource pool than formal and process oriented. Control and operation of the resources pool will be based on crowdsourcing principles. To fully benefit from crowdsourcing principles physical enablers are required. We believe that multileveled modularity in freight systems, cargo spaces and parcels are necessary and require development work.

Rapid development in digitalization seems to drive disruptive business opportunities for intelligent and agile actors challenging present trade and logistic broker sectors. We illustrate this development as a merge of trade and logistic sectors as one digitalised resource pool for demanding customers.

3.3. Creating construction hypothesis of future business ecosystem and logic

Our hypothesis of future business environment is based on a synthesis of multiple fragmented contributions concerning future challenges and opportunities. Contributors are researchers, business actors and society stakeholders. Hypothesis is seen to offer lot of potential for many companies and organisations that have already committed and took action on behalf of this initiative.

Initiative was named as "Open Ecosystem of Consumer driven services". The purpose is to develop market oriented platform on which services are drastically more customer oriented. Which leads to better service level from customer perspective and competition is genuinely based on customer will. (Figure 5)

This is illustrated as hypothesis of future ecosystem where broker sector is more open than in supply chain centric paradigm. In first draft the new logistics construction is based on platform economy and new business environment. In this construction the platform is open which means market oriented and virtual operation mode where data is openly shared based on commonly accepted principles. Which data and on what terms and conditions it is open is key question in platform standard construction process.

Platform is illustrated to exist virtually which means there is no room for separate operator or physical database. It's only a standardized data stream between actors connected to this new environment. Therefore platform core can be seen void of actor and thus can be characterized virtual in our suggestion.

All physical elements and actions are performed within systems managed by connecting actors. Connecting actors can be whoever like in open market economy there are no limits or restrictions on who can connect to open environment (e.g. companies small/big, network, integrator, competitor, stakeholder etc.). Virtuality becomes concrete when execution of platform activities is shared among platform actors. Considering the qualities of open platform it is perceivable that existing platform models are not applicable since they impose limits through restricting control points to free market economy. Potential technological enabler could be for example scalable blockchain protocols like in Bitcoin.

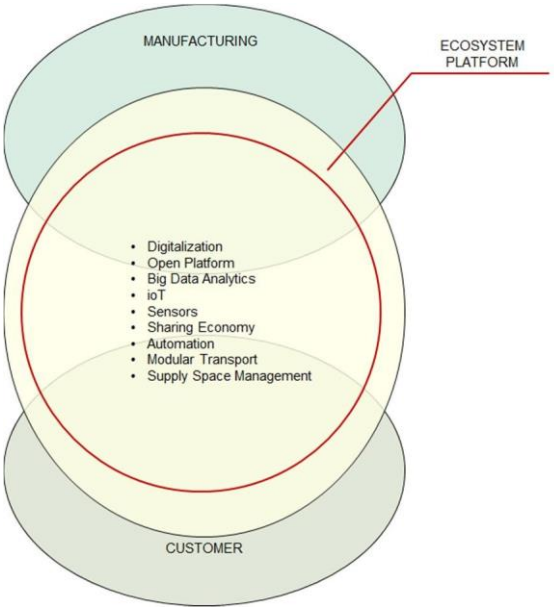


Figure 5: Open Ecosystem of Consumer driven services

3.4. Networking and collaboration over business sectors and cross disciplinary research

After envisioning the future business environment successful development and implementation requires business actor commitment, project management and leadership. Big challenge is that commitment from single business sector is not adequate. Instead commitment has to come from all related business sectors which are in this case

manufacturing, trade, logistics and sector. Initiative moved into next phase when capable actor emerged to advance development process. (Figure 6)

“It’s unique opportunity to be elected to lead well prepared initiative that has support from both academic and business communities. I believe that open ecosystems are going to diffuse markets on every aspects of consumer life” (R&D project coordinator 29.03.2017)

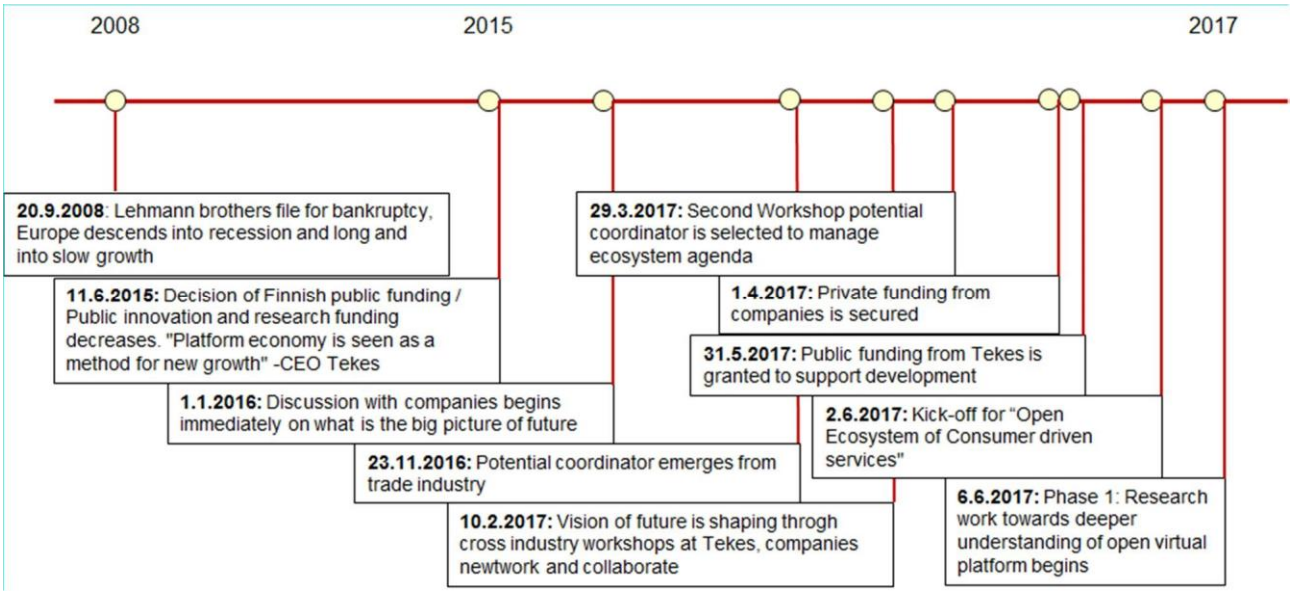


Figure 6. The roadmap of open ecosystem initiative

Theoretical contribution

4.1. The construction of future open ecosystem

According to constructive research approach the developed construction can be understood as one of the contributions of the research if it works in its original environment and produces addition to knowledge in relation to existing literature (Lukka 2000). Developed construction in this research will be new way to network and exchange information to create new business opportunities in concrete way. Fundamental parts of the construction are standardised protocol for information transfer between connectors and the platform. Additionally construction develops the way organisations network with each other and defines the paradigm for open market based on the platform itself. Implementation process will define the success of the construction for business. From the constructive research point of view this implementation can be seen as a required market test that proves the validity of the construction for science. Process of constructing will advance heuristically and pragmatically. Our ecosystem platform construction is defined as Supply Space.

(Figure 7)

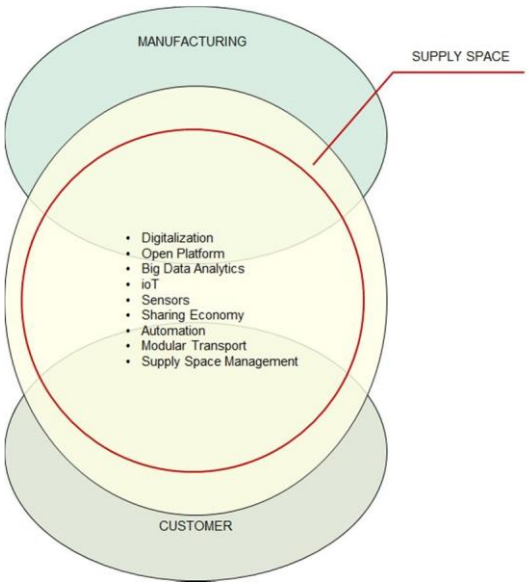


Figure 7: The Construction: Supply Space

Open ecosystem can be defined as a market network where resources available over business sectors create one resource pool utilized by business intelligence enabled by platform driven data. Ecosystem is seen as actors connected to the platform through boundary resources and the platform content is the data streams between the actors. The boundary resources and data stream formats are defined by the standard developed in open innovation process.

Block chain technology is a probable enabler in this standard definition process. Openness can be defined from two perspectives: The ecosystem is open to any actor and physically the platform is open and virtual without any physical central actor or system. Connecting actors are responsible of connection, data processing, information usage in business and data sharing, themselves supported by their own information system. If added value is not recognized by business intelligence the actor has no reason to be part of the platform.

Access to ecosystem is free for all operators willing to share information and to operate by ecosystem standard - We call this Supply Space. Supply Space can be understood as demand based creation of virtual supply chain operations enabled by open information in digital environment and agile non-agreement based resources. This can be achieved through principles sharing economy.

4.2. Process of innovation on open platform development

Research process descriptions have been created for the constructive research approach (e.g. Kasanen et al., 1993; Lukka, 2003). Kasanen et al. (1993) distinguish six different stages of constructive research: (1) finding a problem that is relevant and interesting from the perspective of research; (2) obtaining advance understanding of the research subject; (3) the innovation stage, constructing the solution model; (4) testing the functionality of the solution, i.e. validating the construction; (5) showing the connections to theories used in the solution and proving the solution”s scientific novelty value; and (6) examination of the solution”s area of application. In addition to this, Lukka (2003)

mentions scientific reporting. These stages do not, however, comment on the research and development process and its practical research innovation process.

This R&D process is unique and we will observe how constructive method stages are carried out and if there is something to contribute to process of innovation.

4.3. Implications to organisational theory.

Our implication is to find out how the new ecosystem platform is positioned in Adler's threedimensional organisational theory mode (Adler 2001). The contribution is how organisational modes exist in constructed supply space platform and how new construction aligned with Adlers theoretical framework. Second contribution is to observe how network types relate to new developed ecosystem construction. (Figure 8)

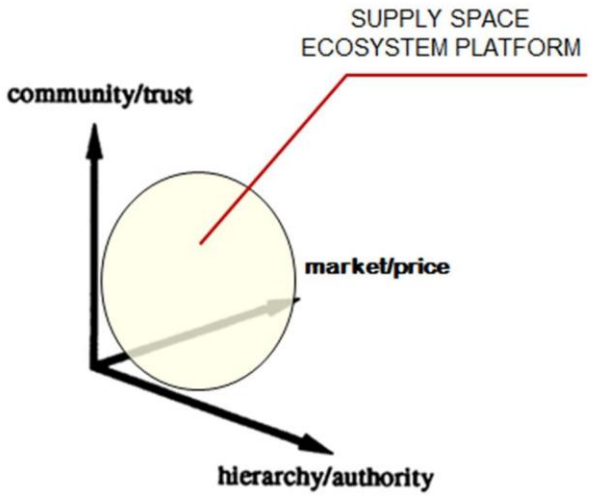


Figure 8: Supply Space as organisational mode

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Network design and costing

Supply chain costing: a systematic literature review

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Introduction

Strategic decisions in the supply chain such as externalisation of function, investment in green technology, automatization of warehouse are based on two main criteria: adding value to the customer and reducing the overall cost. Although other parameters are considered for the decision-making process, cost information is preponderant. It provides managers with valuable information that help delineate pricing policies, define the product design and provide an overview of the supply chain performance. Indeed, the total cost of a product define its final price and hence its profitability. Understanding the truly incurred cost helps maintain a level of firm's profitability and growth (Baykasoglu and Kaplanoglu, 2008). Having the visibility of where and how costs arise helps keep the costs under control but also designate the processes or operations that need reengineering in order to be cost-effective and in alignment with the competition (Schulze et al., 2012). Therefore, understanding the occurrence of the costs and the causality between cost object and the cost drivers, allow assessment of the true cost of a product and the drivers of overheads. It provides an insight into the actual performance of the system. However, these goals can only be achieved if the cost estimation is accurate, studies show that inconsistent cost calculation mislead strategic decisions (Tsai and Hung, 2009) and compromised the bottom-line and the firms growth (Khataie et al., 2011).

The impact of inaccurate costing technique was well apprehended, which lead to the elaboration of various costing models for the supply chain. The disparities in the application of cost accounting methods, make it difficult for practitioners to adopt a cost-effective method that reflects resource consumption and allows an accurate performance assessment. For instance, the choice of Activity- Based-Costing (ABC) over the Target Costing (TC) in the procurement function have various justifications in the literature. Hence, this study discusses the applications of different costing techniques in supply chain management context over the last decade, answering what are the main dimensions that influence the selection of costing approaches in the supply chain? The paper also introduce a new taxonomy for supply chain costing methods based on two key dimensions : sector and decision level. The present paper constitutes a part of a larger study that provides a larger taxonomy based on five key dimensions.

Literature Review

ABC

After its apparition in the late 80s, ABC moved from the concept stage to the application stage (Kaplan & Johnson, 1988). It presented an efficient alternative to Traditional Cost Accounting (TCA) that no longer copped with the complexity of modern organisation and the multi-level supply chains (Comelli et al., 2008).The distortion of information from the TCA lead to a rapid acceptance of the ABC that presented a granular level of details a clearer vision of resource consumption and better decision-making initiatives (Baykasoglu and Kaplanoglu, 2008).

The corpus of literature agree on the effective and profitable role played by ABC (Askarany et al., 2010). ABC identified value-adding activities and detected the inefficiencies in the studied process, it also assisted quantifying costs associated to intangible service like quality (Masschelein et al., 2012).

ABC is a bi-dimensional system based on a cost assignment and a performance measurement dimension (Hung, 2011). It is also referred to as cost control tool, that enabled an in-depth investigation of the incurred activities and their associated costs, hence contributing in performance improvement (Khataie et al., 2010). Tsai et al., (2013) classify the benefits into four categories: accurate identification of product cost, precise information about value added and non- value-added costs, direct allotment of costs to products and consuming resources processes, and identification of nonvalue-adding costs. The ABC technique was also advocated as an assistant tool for decision making providing a backward vision in different functions of the supply chain such as production management, distribution, logistics, product design, and process engineering (Schulze et al., 2012). Khataie et al., (2009) apply the ABC in procurement function as to decide which orders to accept or reject, by understanding the profitability of the orders and the capacity needed. It is also applied for pricing decisions, product mix costing, facilitating joint product mix (Askarany et al., 2010), estimation of cash flow (Comelli et al., 2008), or make or buy decision (Tsai et al., 2013). ABC is utilised to track the environmental costs of final products and to estimate the environment costs of different pollutants per unit (Tsai et al., 2012). The technique endorses policy making about environmental waste and CO2 emissions. It is applied for quality improvement and justify the investment in green manufacturing technologies (Tsai and Tien, 2011), and improving technologies like traceability system but also in product design and profitability analysis (Bevilacqua et al., 2009). Similarly Torabi and Hassini, (2008) promote the application of ABC in combination with Total Cost of Ownership as to ensure an effective procurement, production planning and distribution. Despite the substantial benefits of ABC, it has also been criticised for being time-consuming, dependant on questionable assumptions and not determining the true cost (Khataie et al., 2010). In addition to difficulties of implementation when activities are not specific to components but to relationships with suppliers (Agndal and Nilsson, 2007).

LIFE-CYCLE COSTING (LCC)

Life cycle costing approach was developed in the 60s and came from a managerial-economic field. It is usually confused with the life-cycle assessment (LCA). Several authors that addressed the life-cycling approach started by differentiating life-cycle assessment from life-cycle costing (Dobon et al., 2011; Krozer, 2008) while the first is applied for environmental assessment, the latter is used for economic valuation. Two approaches were defined for LCC: the first approach was based on valuation of environmental attributes in pecuniary terms. The second approach reflected the companies risk associated to regulations and liabilities dictated by the client (Krozer, 2008). LCC was initially designed for procurement purposes (Korpi et al., 2008) and was associated with different terminology such as total cost of ownership, whole life-costing and life-cycle cost analysis (Ilg et al., 2016). LCC provided managers with a solid basis for decision-making process, by selecting alternative products and investments economically and environmentally efficient. LCC assisted in predicting future costs in an uncertain environment and forecasting maintenance costs and operations during the life cycle of a product. Additionally, it contributed in improving the reverse supply chain design by investigating the inventory cost of green electronic products (Wee et al., 2011), decreasing production costs and selecting the right sourcing strategy (Rivera and Azapagic, 2016). LCC has not been used as a stand-alone technique but has been integrated with different financial techniques like the Net Present Value (NPV), Internal Rate Return (IRR) and Annual Equivalent Value (Swaffield and McDonald, 2008). Furthermore, it was combined with other accounting techniques such as ABC and Target Costing (Ilg et al., 2016).

TARGET COSTING (TC)

The notion of TC started with Toyota in 1965 was farther applied in Japanese companies (Anderson and Dekker, 2009). The technique was known under different names such as “cost planning”, “cost project” or “design to cost”. Extant literature about TC is characterised by the corpus of review papers that focused on providing a clear definition of the concept and providing motives to adopt the TC over other strategic accounting methods. Conversely, case studies focused on how the method increased the bottom-line by amending the design of the product at the engineering phase and not until the product is completely conceived. The technique enabled to design a low cost new product that offered a fair return to different actors of the supply chain (Anderson and Dekker, 2009), and participated in redesigning an existing product (Rattray et al., 2007). Pennanen et al., (2011) argue that the design shapes the target cost but rather emphasise that the cost should be defined prior to the design, based on the customer’s demand in the construction industry. The technique can be divided into three different approaches based on the nature of the customer demand: Price-based, Value-based approach and Activity based costing management based approach. Furthermore, being a cost reduction technique TC is a strategic approach for profit planning. It contributed into designing a better process, removing costly waste and eradicating excess or defaults. The frameworks of implementation were provided principally in the automotive context, where the nature of the relationship with the supplier shape the design in addition to the customer demand (Baharudin and Jusoh, 2015). Everaert et al., (2006) provide theories that ascertained the success of the method in the electronics and transportation equipment industries. Similar to previous methods, TC encountered barriers for its implementation: Lack of understanding of relevance, production detail, limitation on the integration of sophisticated Accounting cost Data information system (Gordon, 2006).

OPEN BOOK ACCOUNTING (OBA)

OBA technique was developed in late 1990s and was based on the information exchange between supplier and buyer with the nature of data exchanged ranging from financial to non-financial data (Alenius et al., 2015). It does not solely focus on cost data and cost reduction patterns (Xu, 2011). It also helps strengthen the relationship between the different partners, monitor the uncertainties raising from inter-organisational transactions (Romano and Formentini, 2012). It is designed as a solid tool for decision-making regarding product, business process and purchasing decisions patterns (Kumra et al., 2012). Agndal and Nilsson, (2008) identify 17 decision-making activities where OBA contributed, and were classified into three main categories: supplier selection, pre-production decisions and full speed decisions. The technique provided the clarity and transparency needed to detect the inefficiencies in the buyer-supplier relation, but did not involve joint cost management activities (Moller et al., 2011). Literature argues if the technique is considered as cost management technique or not (Agndal and Nilsson, 2008; Alenius et al., 2015), but the dimensions of it practices are well defined and are based on: the nature of data disclosed, the purpose and the conditions of the data disclosure. Besides its utility for decision making, including pricing set up and relationship monitoring, OBA is regarded as catalyst of the Inter-Organisational Cost Management implementation. Although, some studies argue that the lack of its implementation is due to the negative supplier relationship satisfaction and the apprehension of opportunistic behaviour of the buyer from sharing sensitive data (Windolph and Moeller, 2012).

Methodology

A Systematic Literature Review(SLR) is undergone in order to ensure transparency, validity and auditability and avoid the bias of traditional review (Booth et al, 2012). The systematic review is more popular in the science and healthcare field, its use extended to management field over the last years. It minimises the potential bias since the inclusion and exclusion criteria are well defined, and the conclusions are grounded in data (Booth, 2012). Based on the process elaborated by Tranfield et al., (2004)this SLR will be based on four steps protocol: locating studies, selecting and evaluating studies, extracting and synthetizing the studies, reporting and using the finding.

The search was conducted on different scientific databases, namely Google scholar, Emerald, Science Direct, Scopus, Francis and Taylor and Summon. A list of identified keywords and noun strings were set using Boolean operators like “supply chain costing”, Costing AND Supply chain”, Activity-Based-Costing OR ABC”, etc. The search criteria were defined before an initial screening; where only full English written articles are kept, books chapters are discarded, grey literature (thesis, technical reports and magazines) removed and only peer-reviewed studies: journal and conference papers are retained in order to maintain a high quality review (Denyer and Tranfield, 2009). The scope of the research was confined to operations management, managerial accounting and business economics, and life span limited to the last decade from 2006 to 2016, in order to capture the recent trends in supply chain costs. The first screening consisted on reading the abstract and introduction as to determine the suitability of the article and its relevance to supply chain costing. A second screening is conducted and it this case the full article is read. Articles that don’t answer the research question were removed.

Pertinent articles were cross- referenced as to ensure that no relevant article was missed. A Total of 152 articles was retained. The protocol can be summarised in the graph below.

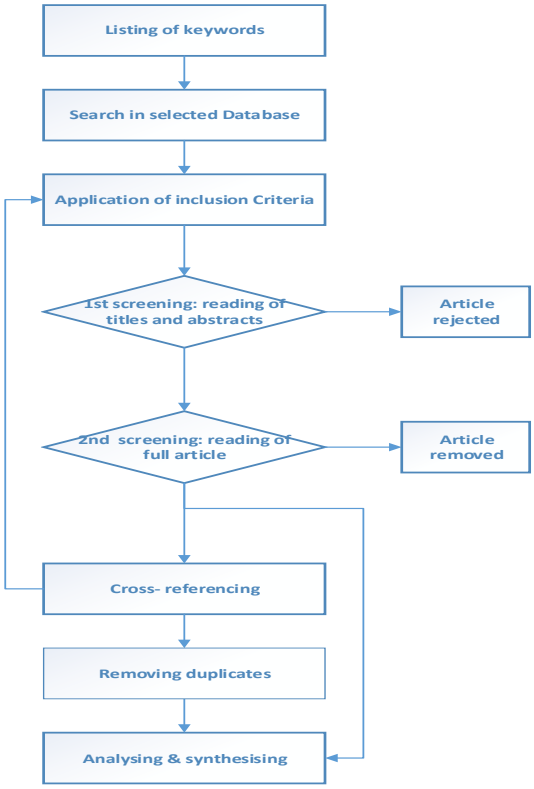


Figure 7: Systematic review process

Findings

The literature has shown that selection of a particular accounting technique is dependent on different dimensions. In this paper two dimensions are addressed: decision-level and sector.

Dimension1: Decision-making

Cost information support in strategic decisions such as outsourcing a function, adopting a new solution, reengineering system for cost minimisation, or assessing the performance of a particular process or activity. These managerial decisions have been classified into four main categories: performance measurement, cost minimisation, investments and comparative tool.

1-Performance measurement

Specific accounting techniques are applied by managers in order to measure the performance of the current supply chain in its entirety or focus on a peculiar function of the supply chain. The performance can be measured in different ways: by establishing a of diagnosis tool of the supply chain, assessing the supplier-buyer relationship and assisting in the selection of the supplier and evaluating the benefits from implementing a costing technique (Figure2).

* Assessing the supplier-buyer relationship

Cost accounting techniques were applied in order to assess the supplier relationship in the supply chain and evaluate the profitability of the "partnership". One costing method was particularly outstanding when evaluating the buyer-supplier relationship: the Open- Book Accounting. OBA allowed to reinforce the relationship since it is based on trust between the two parties (Kumra et al., 2012). It realised considerable saving when the parties are willing to disclose real cost data and avoiding opportunistic behaviour (Moller and Isbruch, 2010). It was also shown, that the application of the OBA depended on the relational context and if trust and commitment are respected, the implementation was more likely (Windolph and Moeller, 2012). OBA was also used as a management tool for interdependencies in first-tier supplier relationship which in turns influence the 2nd and 3rd tier (Alenius et al., 2015)

* Diagnosis of the Supply Chain

The application of costing techniques assessed the performance of the system, by enabling an overview of the current system. ABC is the most recurrent technique, that have been used as diagnosis tool in different scenarios. ABC was used to assess the supply chain in the healthcare and detect the inefficiencies of the system and gain more visibility on the physical and informational flow (Chabrol et al, 2006). The method was also used to evaluate the production planning, in combination with financial metrics and enabled an estimation of the cash flow. Comelli et al., (2008) also applied the ABC as to evaluate the current state of the supply chain that would help design a future system. In the construction supply chain, Korpunen et al., (2010) also used the ABC to evaluate the current state, which enabled clarity over costs and defined a cost structure that would optimise the procurement function. In addition to the ABC, other cost accounting techniques were used for the same purpose. Egilmez (2014) used a life-cycle costing in order to assess the sustainability of the food supply chain, considering it's the source of considerable environmental waste.

* Evaluating the benefits

In this section, the authors advocate the use of particular technique and how it helped realise benefits along the supply chain. ABC is presented as an alternative method for improving the performance of the supply chain in terms of costs (Yanpirat and Choatheitmanut, 2014). It is also referred to the ABC as an appropriate methodology that inform about the profitability of order fulfilment and the adoption of outsourcing policy (Khataie et al., 2009; Tsai and Lai, 2007). Another aspect of evaluating the benefits of accounting techniques, was from showing that the non-consideration of certain costs like the life cycle costs in the procurement in the construction industry has serious financial risk that lead to increased maintenance cost and run over the allocated budget. (Swaffield and McDonald, 2008). ABC also underlined the cost emanating from marginalising the inefficiencies occurring between supplier-buyer, when establishing new contracts that resulted in additional costs. Thus helped improve the total joint profit and the perception of the fair arguments when the ineffectiveness results from the buyer (Masschelein et al., 2012).

*Implementation

This part shed light on the implementation of the cost accounting techniques and explains the popularity of certain techniques over others. Literature presented guidance on the implementation of the ABC within the supply chain in different contexts. (Gordon, 2006) and Pennanen et al.,(2011) provided details on Target costing implementation in

the construction and electronics industry respectively. However, Everaert et al., (2006) provided with guidance to the implementation of TC but in the logistics function. Rattray (2007) studied the scope of implementation of the target costing in New Zealand, as the method was only popular on its birthplace: Japan. The implementation of the life cycle costing was discussed by Lindholm and Suomala, (2007) who showed the convenience of the technique to short life products that have varying cost through their life cycle. On the other hand the implementation of the ABC was extensively discussed both theoretically and practically, some studies suggested a way to improve the implementation through simulation (Baykasoglu and Kaplanoglu, 2008; Liu and Pan, 2007). Another technique that gained credence for the implementation is the OBA. Several authors discussed its implementation in real life case studies (Suomala et al., 2010). Kumra et al., (2012) specified the nature of data disclosed for its implementation. However, pinpointed the difficulties in implementing the ABC specially to indirect purchasing costs, when long term relationships between buyer-supplier take place. Askarany et al., (2010) assessed the level of implementation of ABC in New Zealand for large firms and small and medium companies. They distinguish between the level of adoption and the likeliness of adoption. Baharudin and Jusoh, (2015) discussed the TC implementation and Compared the practices in Malaysia.

2-Cost minimisation

The first purpose for adopting a more accurate cost accounting system is to realise relevant cost reductions. Different Costing were adopted specifically to satisfy this managerial aim. ABC was used to identify cost saving opportunities in construction industry (Schulze et al., 2012). The adoption of IOCM approach and the implementation of its techniques such as Target Costing and Open Book allow cost minimisation by better management of the buyer-supplier relationship. (Agndal and Nilsson, 2009) and strengthening the interfirm cooperation (Xu, 2011). The savings from the application of OBA is emphasised and it has proven to contribute actively in reducing the purchasing price. (Agndal and Nilsson, 2010). LCC was also perceived as cost minimisation tool, targeting savings at the environmental level, by reducing cost pollution control through a reduction of CO2 emissions in a green supply chain (Krozer, 2008). It also used to manage the supplier relationship and supplier selection (Ebrahimipour et al., 2016) and when introducing availability-based contracts. (Settanni and Emblemsv?g, 2010).

3-Comparative tool

Some studies combined two or more accounting techniques in order to compare the performance of each technique and underline both the benefits and shortage of each technique. Target costing and traditional costing were compared, shedding light about the shortcoming of the latter. Accounting techniques represented a comparative tool when comparing the implementation of a new technology, like the example of communicative packaging proposed by (Dobon et al., 2011), by applying the life cycle costing and comparing the saving.LCC was also used as a benchmark tool for the short life cycle products and perishable items, like in the olive production, where the economic performance of the production of organic olive is assessed against the normal olive(Mohamad et al., 2014).

4-Investments

Before mobilising large amount for capitals, managers request valid arguments that justify the expense and request a visualisation of the potential return. The application of accounting management techniques endorsed capital investments in the supply chain. Investments in sustainable technology and sophisticated equipment were not easy to prove by a traditional costing approach. ABC was used to support capital investments in the green manufacturing systems allowing a pollution reduction and value investment enhancement(Tsai et al., 2011). ABC was also in combination with and Theory Of Constraints techniques to uphold the adoption of green manufacturing technologies in mix-product supply chain (Tsai et al., 2013).

Another type of investment was addressed by the literature, Authors that advocate the use of technique and showed the benefit's from adoption are encouraging investing and adopting a specific costing technique, for instance Agndal and Nilsson, (2008) provided seventeen reasons and pre-production decisions for managers to integrate an open book accounting system.

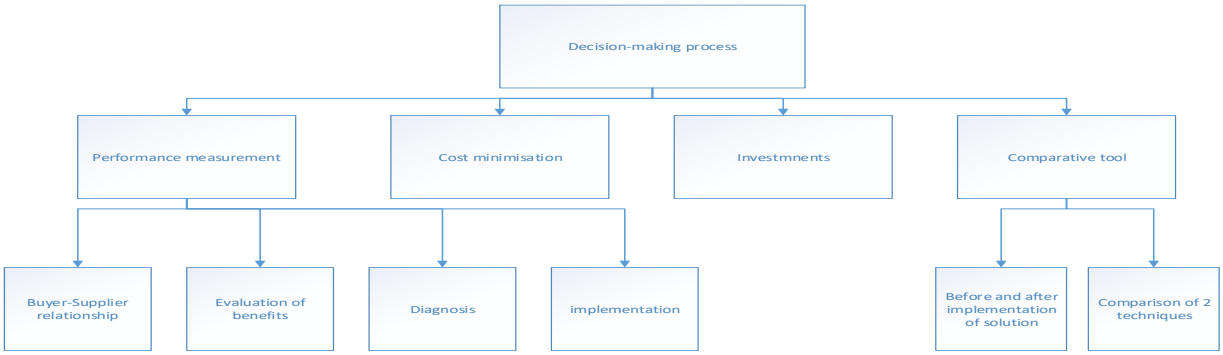


Figure 8: Breakdown of decision-making activities according to the literature

Dimension 2: Sector

A second dimension that affects the selection of cost accounting technique in the supply chain context is the sector. Some sectors are characterised by the simplicity of the activities and processes involved while some others are more complicate and require sophisticated costing models. The cost structure is morphed according to the involved industry. (Abduh et al., 2012) underline the difference between the cost structure in the manufacturing environment and the construction industry. From the literature and based on the four studied accounting models and their application to specific sectors. It revealed a preference of techniques in some sectors. The application of life cycle costing was focused on food supply chain and construction related projects. (Fu et al., 2007; Swaffield and McDonald, 2008). The application in this particular sector fits the foundation of the technique that aims to measure the cost from the acquisition until the disposal of a good , the life span construction projects are limited and shelf-life of agri-food goods are shorter. ABC has been applied in different industries but gained credence in the manufacturing sector where processes are complex, the connections with supply chain management are intrinsic and the level of details required meets the granularity of the technique (Comelli et al., 2008).

The application of Target costing was concentrated in electronics industry, where the variety of the components is and their quality is ample and meets different levels of the customers' requirement, hence setting a target cost based on the ability of the customer to pay the target price make TC an appropriate costing models for electronics (Pennanen et al., 2011). OBA has been more discussed in the automotive sector that requires a strong cooperation between buyer and supplier an joint efforts for controlling the costs incurred in the industry (Moller and Isbruch, 2010) but also have been applied in retail (Alenius et al., 2015)

Conclusion

Through the present analysis and the subsequent categorisation of the literature from 2006 to 2016, most of the articles have addressed the SCC topic from a cost accounting perspective. Cost accounting approach was either applied to the entire supply chain or limited to the application of a specific function within the supply chain. The selection of a technique seems to be subject to two main dimensions: the decision-making and the sector to which the Supply Chain is affiliated. The decision level is the main dimension suggested in the literature when explaining the selection of an approach. The decisions ranged from assessing the performance, realising a cost minimisation, comparing the performance of two systems, and justifying capital investments. The decision level provides the manager with a solid base for strategic decisions, depending on the desired purpose, making it easier to opt for one technique rather than another, avoiding the cost of an implementation not serving their best interests. The second dimension: sector was implicitly addressed, the analysis of the sector application of each method showed that some techniques are more appropriate than others depending on the industry, that has a specific cost structure. While it is important to announce the purpose behind the adoption of a technique, it is also critical to define the other dimensions that affect this choice. Some studies implicitly recall one or more of the other dimensions. For space constraint, the other dimensions were not addressed and the cost accounting techniques limited to four techniques.

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GLOBAL SUPPLY CHAIN NETWORK DESIGN: A LITERATURE REVIEW AND RESEARCH AGENDA

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Introduction

Trade barriers reduction, widespread application of ICT and improvement of technological solutions led in the last decades to a progressive growth in trading across countries borders (Hausman et al., 2010), thus stressing the relevance of global supply chain network design (GSCND).

Addressing global business perspective requires firms to handle a distribution system capable of moving goods effectively and efficiently in multi-country and multi-culture environments (Zinn and Grosse, 1990). As globalisation firstly involved production issues, companies implemented offshoring solutions in order to benefit from lower labour cost in developing countries (Ferdows, 1997). Then, the focus shifted to commercial (Kotabe and Murray, 1990) or logistics issues (Cooper, 1993) to increase garrison on foreign markets. Companies could improve cost and service performances through plants or warehouses dedicated to specific countries, also enhancing physical and informative flows management (Zeng, 2003). Finally, other aspects influence internationalisation choices, such as infrastructure development, government and political factors or taxes and duties (MacCarthy and Atthirawong, 2003). For instance, opening a warehouse abroad is a decision strictly related to establishing a commercial subsidiary in the exporting country and more in general to trade channel design (Marchet et al., 2016). Moreover, a warehouse could manage finished or semi-finished products, according to the postponement level adopted by the company (postponement boundary) (Lee, 2010). In addition, transport-related issues – such as innovative solutions (e.g. railway connection between China and Europe) or ports selection – need to be taken into account. Different duty rates chargeable to components and finished products may affect the postponement boundary decision, as well as financial issues (Henkow and Norrman, 2011; Häntsch and Huchzermeier, 2016), while growing dispersion of supply chain nodes influences the geographical distribution of value-added activities, impacting on value creation and capture phenomena (Seppala et al., 2014).

In light of these considerations, when designing global supply chains a mere logistics perspective may be reductive, since GSCND involves multiple aspects referring to different areas (Choi et al., 2012). Enlarging the subjects concurring to SC configuration requires an in-depth analysis of the factors affecting cost and service level. Previous reviews addressed different aspects of the design of global production and distribution networks, mainly focusing on quantitative issues (Olhager et al., 2015). First, Meixell and Gargeya (2005) reviewed former analytical models for designing global supply chains, highlighting a widespread optimisation approach among scholars. Then, Olhager et al. (2015) released an updated review, including other research methodologies than mathematical modelling.

To date, the growing interest towards the topic has led to a further increase in the number of contributions and highlighted the need for critically review the extant literature in order to include global specificities and establish a research agenda for the near future starting from the highlighted gaps.

Literature Review

Methodology and general overview of the analysed papers

The review is based on 123 papers published between 1985 and 2017. Interestingly, most of the papers under examination are relatively recent, thus attesting the rising attention the research community has shown towards these issues. Grouping results by decades, papers published in the current decade overcome those published in the last decade by 70%.

The considered papers have been published in 50 different peer-reviewed journals, including management, operations and supply chain management journals. International Journal of Physical Distribution & Logistics Management (14 contributions), International Journal of Logistics Management (7), European Journal of Operational Research (7), International Journal of Production Economics (7) are the four journals offering more contributions.

When analysing the papers from a methodological viewpoint, the classification proposed by Mangiaracina et al. (2015) was adopted. Overall, 44% (54 out of 123) of the analysed papers have been classified as frameworks or general classifications, while empirical studies (mostly based on surveys or case studies) show a lower frequency (28%) and an increase in popularity since 2000. Among quantitative approaches in the last twenty years, analytical models have been preferred to optimisation models (respectively 22% and 6%). According to contents, four key issues have been identified as particularly relevant in the logistics strategy for GSCND – global operations and postponement boundary, global distribution network design, international transport configuration and global trade channel and entry mode choice – (Figure 1), with global distribution network design being the most popular, followed by global distribution network design and international transport configuration. A relationship can be found between the research methodology adopted and the perspective of analysis. Papers specifically focused on global distribution network design are mainly frameworks or general classification, while quantitative contributions and empirical studies (i.e. mostly based on surveys or case studies) have more rarely been proposed. Conversely, papers dealing with international transport (e.g. transport mode choice, service type choice) are often based on case study or quantitative approach.

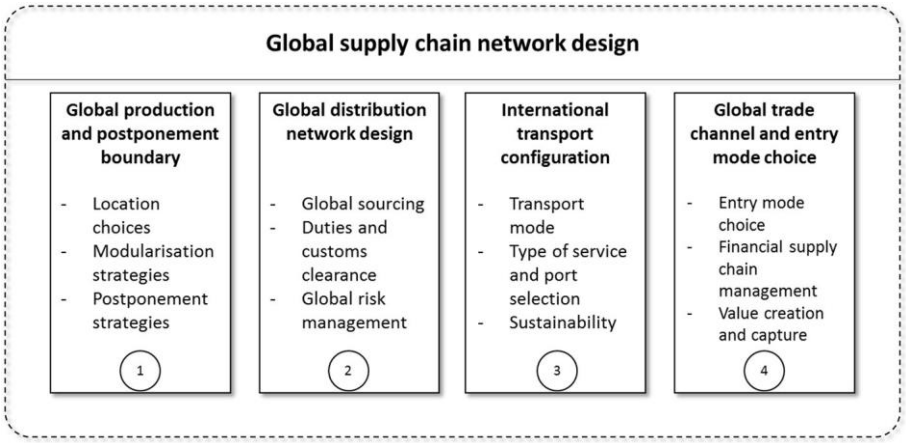


Figure 1. Global supply chain network design: main issues emerged from the analysis

As Carnwell and Daly (2001) suggested, the discussion hereinafter is structured into separated sub-sections, each addressing one of the above-mentioned issues emerged.

Global operations and postponement boundary

Global operations network of a firm is mainly concerned with its own manufacturing network (Pashaei and Olhager, 2017; Demeter, 2017), although some scholars recently pointed out the need for considering also upstream and downstream subjects, e.g. important suppliers and customers (Cheng et al., 2011; Olhager et al., 2015). Operations firstly turned global to exploit proximity to markets, access to low-cost manufacturing and access to skills and knowledge (Ferdows, 1997). Location choices are strictly affected by specific factors, such as costs, infrastructure, labour characteristics, government and political and economic factors (MacCarthy and Atthirawong, 2003).

Looking at global operations as a network of factories and connections, it is required to shed a light on postponement issues (Pashaei and Olhager, 2017). The traditional view asserts that postponement centres around delaying activities in a supply chain until real information about the markets is available, while underpinning that warehouses are often the place where final assembly, labelling and packaging are processed (Yang and Burns, 2003; Garcia-Dastugue and Lambert, 2007). Different types of postponement strategies have been considered in the context of marketing and logistics, as well supply chain management (Van Hoek, 2001; Araujo Ferreira et al., 2015). Zinn and Bowersox (1988) discussed the connection between production and logistics issues, developing a scheme for postponement strategies structured into different options, according to both the manufacturing activity (labeling, packaging, assembling, manufacturing) to be postponed and the delayed movement of inventories along the supply chain (termed as time postponement). Then, several authors addressed postponement by providing different strategies to combine three basic pillars: form, time and place postponement (Pagh and Cooper, 1998; Van Hoek et al., 1998; Ernst and Kamrad, 2000; Yang and Burns, 2003). Some authors suggested distinguishing among up-stream and down-stream postponement (Cooper, 1993; Ernst and Kamrad, 2000), highlighting the differences between manufacturing and assembly/packaging/labelling activities. While in an up-stream (from suppliers to factories) perspective postponement can be referred to in terms of modularisation (Ernst and Kamrad, 2000; Mikkola and SkjottLarsen, 2004), in a strict down-stream one (from factories to customers) Pagh and Cooper (1998) proposed a framework redefining production and logistics postponement. Since postponement helps in coping with uncertainties (Yang et al., 2004a), it is also strongly related to customer order decoupling point (CODP) definition (Van Hoek, 2001; Boone et al., 2007) and it is also consistently mentioned as one of the central features of mass customisation (Van Hoek et al., 1998; Van Hoek, 2001).

Despite postponement has highly been recognised as an important point in the supply chain configuration (Van Hoek, 2001; Boone at al., 2007), few papers deal explicitly with postponement on a global scale (Lee 2010, Choi et al., 2012, Guericke et al., 2012). While addressed as an important topic in the production and inventory management literature, postponement has received low attention in the context of global production and distribution systems, characterised by differences in knowledge level of workers, government regulations, production costs, customs tariffs and international trade agreements (MacCarthy and Atthirawong, 2003; Choi et al., 2012). Given trade agreements and customs duties in place, companies should design postponement strategies so that the right level of product customisation can occur in the market regions, instead of centrally at the factory. According to Lee (2010; “the very question is what should be the portion of product to be built at the factory, and what should be the portion

to be built at the multiple and distributed distribution centres in the market regions. Actually, defining what should be assembled in the factory and what in distribution is termed the postponement boundary problem".

In this way, on a global perspective also a further development of customer order decoupling point is possible, according to the distinction between decoupling point and point of differentiation (Garcia-Dastugue and Lambert, 2007; Boone et al., 2007; Araujo Ferreira et al., 2015).

Global distribution network design

Distribution network design (DND) aims at shaping the structure of a distribution network, determining the number of echelons and, for each echelon, the type, size, number and location of facilities and warehouses (Mangiaracina et al., 2015). These choices may be affected by different contextual factors (e.g. product and demand features) (Ballou, 2001) and have a strong impact on supply chain performance in terms of both logistics cost and customer service level (Lovell et al., 2005; Mangiaracina et al., 2015). Since globalisation has restructured the business world and introduced the concept of global supply chain (Ibrahim et al., 2015), large and small companies started to "think globally" by sourcing from low-cost countries and selling internationally (Ruiz-Torres and Mahmoodi, 2008). Facing global challenges implies carefully managing various factors, such as tariffs, duties, trade barriers, currency exchange rates and corporate income taxes (Vidal and Goetschalckx, 1997; Lowe et al., 2002; Gunasekaran, 2008), but also dissimilarities in the culture, language and laws (Barkema et al., 1993; Srinivasan et al., 2014).

While global sourcing received greater attention in the literature (e.g. Zeng and Rossetti, 2003; Creazza et al., 2010; Bygballe et al., 2012), global distribution have been addressed by few scholars (Cooper, 1993; Olhager et al., 2015).

Previous reviews have been concerned with different aspects of the design of global distribution networks, highlighting a focus on a quantitative approach through the development of mathematical models (Mangiaracina et al., 2015; Olhager et al. 2015). Vidal and Goetschalckx (1997) reviewed selected mixed integer programming models for a global supply chain, updating the review few years later including international characteristics (Goetschalckx et al., 2002). In 2005, Meixell and Gargeya presented their review of 18 decision support models concluding that few models cover the practical problem entirely (Olhager et al., 2015), while Olhager et al. (2015) proposed an updated review including other methodologies than mathematical modelling.

The traditional trade-off between service and cost needs to be enlarged on a global scale (Kruger, 2002; Bygballe et al., 2012). Increasing globalisation lead to longer lead times, together with a higher variability, resulting in greater levels of inventory to provide the same service level (Waters, 2002; Baker, 2007). Furthermore, going global involves other costs than inventories, primary and secondary transport, facilities and handling, information and order processing (Chopra, 2003; Lovell et al., 2005; Creazza et al. 2010), such as customs duties or taxes. According to Henkow and Norrman (2011), the overall system consists of logistics system and fiscal system (including direct, indirect and customs taxes). They proposed a new approach to global supply chain network design, aiming at integrating cash flows into the physical and informational supply chain, named Financial Supply Chain Management (Henkow and Norrman, 2011; Liebl et al. 2016). In this light, it is possible to reconfigure global supply chain in order to cope with factors such as customs clearance and duties (Kang et al., 2015; Mariel and Minner, 2015; Hantsch and Huchzermeier, 2016). New solutions, related to transiting from a third country or recurring to bonded warehouses or

free trade zones (FTZ), have been proposed (Bhatnagar and Viswanathan, 2000; Henkow and Norrman, 2011; Norrman and Henkow, 2014).

Global supply chains are more complex than domestic ones (Dornier et al., 1998; MacCarthy and Atthirawong, 2003; Manuj and Mentzer, 2008) and so they result riskier, due also to qualitative factors such as government stability and infrastructure of a particular country (Meixell and Gargeya, 2005; Ibrahim et al., 2015). Risk management in global supply chain have been obtaining increasing attention in the last years, and several models have been proposed, as well as classification frameworks (Lowe et al., 2002; Manuj and Mentzer, 2008; Colicchia et al., 2011; Hasani and Khosrojerdi, 2016).

In addition, companies started adding sustainability goals to their business objectives (Fahimnia et al., 2015b; Maccarthy et al., 2016); adding environmental considerations to logistics network design may be referred to as "green logistics" and affects decisions related to plants location, assembly facilities and multiple tiers of warehouses (Blanco and Sheffi, 2016).

International transport configuration

The basic ingredients of all network design models are a set of nodes and a set of directed arcs, available to design the network (Chopra, 2003; Blanco and Sheffi, 2016). Transport creates time and place utilities, resulting at the core of supply chain strategy (Ke et al., 2015).

Literature highlights four fundamental trade-offs depending on transport configuration: facility, transport and inventory costs; throughput and number of warehouses; transport mode and inventory costs; demand variability, service level and lead-time (Lovell et al., 2005). Internationalisation does not change logistics tasks and objectives, but forces logistics to find new ways to fulfil them (Kruger, 2002). In a global context, geographical distances increase not only transport costs, but also make it more complicated to solve the trade-off between inventory and physical distribution (Kruger, 2002; Creazza et al., 2010). Addressing the arcs issue, two main decisions need to be taken: which arcs should be activated, and which flows should pass through the supply chain (Blanco and Sheffi, 2016). Additionally, the international transport configuration involves the choice of the most suitable transport mode (mainly ocean container shipping or airfreight), designing infrastructures for freight consolidation and for serving end markets (Kruger, 2002; Zeng and Rossetti, 2003; Melacini et al., 2011). Literature addressed this problem adopting two main perspectives, i.e. global carriers and manufacturers (Creazza et al., 2010; Olhager et al., 2015), highlighting the increasing importance of logistics service providers (Bhatnagar and Viswanathan, 2000; Wu, 2012). As the selection of transport modes has become a strategical decision (Chopra and Meindl, 2012), literature proposed several works about the topic (Ke et al., 2015). Global maritime transport received greater attention in the recent years, and ocean carrier and container port emerged as two key players in global container supply chain (Lee and Song, 2016). Literature emphasized that practitioners claimed for insights into shipment consolidation strategies (Lee and Yang, 2003; Zapfel and Wasner, 2006), proposing solutions related to consolidation hubs (Groothedde et al., 2005; Cheong et al., 2007). Also port selection, driven eventually by coping with customs clearance, has become an important issue in international transport configuration (van der Lugt and W. de Langen, 2005; Halim et al., 2016).

There are also some risk factors to be considered, owing to factors such as the geographic area covered, the transport mode used, political/border factors and environmental issues (Baker, 2007), so that managing flows on a

global scale increases uncertainty. They could be categorised into three groups, according to the three logistics flows in shipping operations: information flow, physical flow and finance flow (Lee and Song, 2016). Schedule's unreliability, port/terminal/transport congestion, oil price variability and freight cost fluctuations represent some of the identified risk factors (Notteboom and Vernimmen, 2009; Ronen, 2011; Chang et al., 2015).

At a time in which firms need to develop risk management actions to manage uncertainty (Tummala and Schoenherr, 2011), also legislation can act as a constraint in the transport configuration: for instance, modal choice has been influenced by the Swiss decision to allow cross-country freight movements by rail only (Lovell et al., 2005). Railway transport is gaining increasing consideration among practitioners, for instance in the geographical connection of Eurasia, since it reduces lead-time (compared to sea freight) at lower cost than air or sea-air freight (Rodemann and Templar, 2014). In addition, sustainability and environmental issues affect international transport configuration (Davarzani et al., 2015; Blanco and Sheffi, 2016). Governments and companies have increased their focus on green logistics (Fahimnia et al., 2015a), and the literature suggests five main variables that drive the environmental impact of logistics: distance, mode, equipment, load and operation (Blanco and Sheffi, 2016).

Global trade channel and entry mode choice

Companies also face the international challenge by tackling the international sales and marketing subject. After a firm has decided to sell in a foreign market, it must choose the appropriate way to organise its activities to supply such market (Kouvelis et al., 2001). A fundamental problem in new markets approach is the entry mode setting (Fernandes et al., 2014).

Understanding the real costs and operational performances in cross-border trade processes is critical for companies to design their global supply chain network (Hausman et al., 2010; Hausman et al., 2013). Global Trade Management describes the process required to support cross-border transactions between importers, exporters, trading partners and governments (Hausman et al., 2010). Moving goods across borders increases lead times and variability on financial and physical flows (Blanco and Ponce Cueto, 2015), while setting the logistics strategy in line with corporate objectives represent a crucial challenge, due to the close relationship between company internationalisation choices and logistics processes (Marchet et al., 2016).

Firms aiming at internationalising have to set the entry mode in order to make the best use of their scarce resources (Fernandes et al., 2014). Entry mode setting has been one of the most studied topic in international management (Shunko et al., 2016), and recently new factors, such as the country risk, location, legal rules and uncertainty have been researched (Fernandes et al., 2014).

Nevertheless, supply chains are central to understanding wealth creation and capture in an increasingly globalized world (Gereffi and Lee, 2012). The increasing disaggregation and dispersal of supply chains is profoundly affecting the geographical distribution of value added, input costs and profits of multinational firms (Seppala et al., 2014; Manova and Yu, 2016).

Uncertain demand and taxation pose new challenges for global distribution network design, related to the creation of responsibility centres (e.g. cost, profit or investment centres) (Fernandes et al., 2015). In a global approach, each downstream distribution centre can be a subsidiary or a branch of the corporation company, located in different countries and subject to specific local tax rules (Fernandes et al., 2012). A central role is played by transfer prices;

when transaction occurs between two entities located in different countries, the use of transfer prices has impact on the profit to be taxed (Vidal and Goetschalckx, 2001; Webber, 2011). Consequently, they can be defined in order to maximise the overall profit of a company as a whole (Balaji and Viswanadham, 2008; Huh and Park, 2013). "International tax arbitrage" refers to any tax strategy that exploits gaps between the tax systems of different nations (Webber, 2011; Shunko et al., 2016), and the impact of tax considerations on operational and supply chain decisions is gaining increasing importance among practitioners and scholars (Vidal and Goetschalckx, 2001; Balaji and Viswanadham, 2008).

In addition, other factors such as exchange rate volatility should be taken into account, since a depreciated home currency fosters an exporting policy, while an appreciated home currency fosters investments in production facilities in the foreign market (Kouvelis et al., 2001).

Discussion and conclusions

Despite global supply chain design and management has been representing one of the most active research topics in global logistics since the beginning of the century (Vidal and Goetschalckx, 2001), global supply chain area still represents a relatively "immature" research topic, gaining increasing interest from practitioners and academics (Ibrahim et al., 2015). The present paper addresses the need for critically review the extant literature, drawing some interesting research area in GSCND.

From an academic perspective, the paper offers a guide to examine previous studies on this topic and highlights the research streams that need to be addressed in further research. From a practical viewpoint, the outcome of this review can help companies involved in international distribution understand both the significant logistics issues involved and the main drivers affecting company choices.

Based on our study, it emerges that global distribution network design and international transport configuration have already been jointly studied (i.e. issues 2 and 3 in Figure 1), while including production issues in logistics configuration (to define the postponement boundary strategy) represents an innovative and understudied research area. Concretely, it refers to stretching the postponement boundary concept into a global network (i.e. merging issues 1 and 2).

Another relevant research gap consists in the close relationship between logistics processes (i.e. issues 2 and 3) and company internationalisation choices (i.e. issue 4). Indeed, on the one hand logistics is a key enabler for company internationalisation, while on the other hand internationalisation contributes to increase logistics network complexity (Marchet et al., 2016).

The literature review also suggests that several drivers may affect the decisions related to above-mentioned four issues (i.e. global operations and postponement boundary, global distribution network design, international transport configuration and global trade channel and entry mode choice). These drivers can be grouped into five categories: logistics costs, financial issues (in turn, related to both customs and duties, and transfer prices and fiscal optimisation), service level, resilience and sustainability.

Previous studies were mainly focused on the trade-off between logistics costs and service level, while the other drivers received less attention and may open new research fields. For instance, to adopt a new perspective that

simultaneously considers together legal, fiscal and logistics issues seems to be beneficial (Henkow and Norrman, 2011). Furthermore, it could be interesting to better investigate the role of financial supply chain management in GSCND, as when firms manage flows of goods and information within the supply chain, they often neglect managing financial flows (Wuttke et al., 2013; Liebl et al., 2016; Gelsomino et al., 2016). Lastly, scholars have focused on risk strategy description or evaluation, without taking into account global context-related elements. As risk can initiate from any stage in the supply chain, the role of risk management in a firm global supply chain should be better studied, in order to improve supply chain robustness and resilience (Ibrahim et al., 2015).

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Parcel Logistics

Exploring the temporal and spatial impact of seasonal parcel demand on urban freight

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Purpose

In this paper, we aim to understand temporal and spatial peaks in parcel carrier operations in central London. As seasonal periods become longer with many retailers extending Black Friday sales from one day to a week, or longer, parcel carrier demand and associated van use is increasing, impacting on the urban environment in terms of congestion, reduced air quality and increased carbon emissions.

Research Approach

The research is based on an in-depth analysis of raw manifest data provided by a major parcels carrier covering their operations in an area of central London over a 4-month period (1st October 2016 to 7th February 2017, inclusive). This substantial database (>840,000 consignment records) provided information on delivery and collection locations and times, service type and failed delivery attempts. Analytical and visualisation techniques were used to infer temporal and spatial relationships found in the data.

Findings and originality

Focusing on the land use in the vicinity of Oxford Street, the dataset comprised ~23,000 items delivered by up to 68 vans each day, providing insights into the complexity of parcel carrier operations at a level of detail and scope not attempted before. The research findings provide support for the wider consideration of how different carriers might benefit from collaboration where live carrier data could be shared with a third-party Freight Traffic Controller to produce more efficient delivery schedules to reduce last-mile freight traffic.

Research Impact

The research provides a detailed insight into parcel demand and carrier activity, contributing new analyses and methods for exploring carrier manifest data, both historic and live, to support efficient transport operations, particularly during seasonal peaks. The findings are feeding into an existing programme of work being undertaken as part of the Freight Traffic Control 2050 project

(www.ftc2050.com) looking into freight generation by different land use types and the potential role for micro consolidation hubs in collaborative last-mile logistics operations.

Practical Impact

The research has a strong practical focus and has support, through data and information provision, from major UK carriers. The insights will have practical value for carriers in better understanding customer demand in relation to their operations, and how data analytics can be used to their advantage.

Keywords: parcel distribution, urban freight, data analysis and visualisation

Introduction

Rapid growth in e-commerce has seen a 17.3% increase in online retail spending between July 2015 and July 2016 (ONS, 2016) and has contributed to increased numbers of delivery vans in urban areas. This is heightened during busy sales periods such as Black Friday (late November) and the run up to

Christmas (Cherrett et al, 2017) where an analysis of national parcel carriers (excluding Amazon and DHL) indicated that October to December was the busiest period with some 439 million parcels delivered to homes across the UK (Ofcom, 2015). Van traffic is exacerbated by the fact that the parcel distribution sector is highly competitive with many independent businesses operating in an 'everyone-delivers-everywhere' environment (Browne et al., 2014). As a result, van traffic has grown faster than car traffic in recent years and accounted for 14% of all UK motor vehicle traffic in 2014 (Department for Transport, 2016).

In view of such trends, the use of and demand for kerbside parking and unloading places is of increasing interest and importance both to local authorities and to parcel carriers. Local authorities have the responsibility for managing and controlling how kerbside space is used (e.g. deciding on parking and unloading restrictions), while carriers have a direct interest in where they can stop to make their deliveries as quickly as possible without incurring penalties for illegal parking (UPS incurred $17m in parking fines from their vehicles operating in New York, USA in 2016 (Jensen, 2017)). Recent parcel carrier surveys have shown that more than half of their round time can be spent parked by the roadside (Piotrowska et al, 2017) highlighting the need for suitable places from which to unload and make deliveries. In response to growing pressures on kerbside space, recent developments have included the concepts of 'virtual loading bays', where operators can pay for timeslots to unload on restricted kerb space (Pink, 2017), and 'shared drop zones', where dedicated kerbside staff make 'last 500m' deliveries on behalf of operators (Huschebeck, 2014); however, both involve added costs for carriers.

Parcel carrier data provides a rich source of information on delivery volumes to specific locations (e.g. streets, postcode areas, individual buildings) and about the vehicle rounds undertaken to service them. Such information is of potential use in assessing parcel carriers' contribution to traffic and their needs for kerbside space. Such data can also be used to determine how different types of land use (e.g. offices, domestic residencies, commercial premises, public sector organisations) contribute to the demand for parcel delivery, which may inform where new delivery areas might be best located. Research has suggested that certain types of land use receive substantial flows of parcel traffic: a study of a major office block in central London found that more than 40% of all goods vehicle deliveries were associated with parcel and mail flows (Browne et al., 2016).

In this paper we focus on detailed analyses of a parcel carrier's operations in central London to identify peak periods in both time and space, where negative externalities such traffic congestion, noise and vehicle emissions may be most critical. The work forms part of an EPSRC-funded project called Freight Traffic Control 2050 (http://www.ftc2050.com/).

Data description and methodology

Vehicle manifest data were obtained for all last-mile deliveries and collections undertaken by a major UK parcel carrier within central London, operating mainly in the W1, WC1, WC2 and EC1-4

postcode areas between 1st October 2016 and 7th February 2017. Approximately 90% of the work was business-to-consumer (B2C) related across a mixed land use profile including retail, commerce and domestic customers. A total of 396 unique shippers of goods (i.e. consignors) were observed in the data with major fashion and general retailers generating the most activity and an online seller of travel tickets generating the greatest number (~110,000) of records. The data included parcel barcodes, delivery addresses, manifest ID numbers, driver ID numbers and various temporal information detailing when the barcode was scanned, along with associated event types which drivers selected from a set of pre-defined options (e.g. 'collection', 'delivered', 'delivery failed'). The entire database comprised 843,696 records with each record usually corresponding to a delivery or collection attempt. An individual consignment could have more than one record associated with it due to a failed delivery attempt and a repeated attempt the following day. In the most extreme case, 29 delivery attempts were made for one parcel with the average being 1.3, and 2.4 delivery attempts per parcel where the first attempt failed.

For the detailed spatial and temporal analyses, a smaller study area based around Oxford Street was chosen (Figure 1). This area is of particular interest for London's West End Partnership – a group of stakeholders including Transport for London (TfL), the Mayor of London and other city authorities and business associations who have a shared vision for Oxford Street to become the 'best outdoor shopping place in the world' (West End Partnership, 2017). The area is approximately 1.3km along the topmost edge (Seymour Street, A5204) by 400m along the rightmost edge (Regent Street). Despite this area being quite small (~0.5km2), it is densely populated with a mixed land use of shops, offices and private addresses containing 1172 distinct postcodes. For spatial analyses, heat maps were generated using GIS software (QGIS) based on latitude and longitudes obtained for each postcode. These enabled the numbers of parcels destined for particular postcodes to be displayed, with a radius of 50m being drawn around each point to illustrate where overlaps in delivery locations occurred.

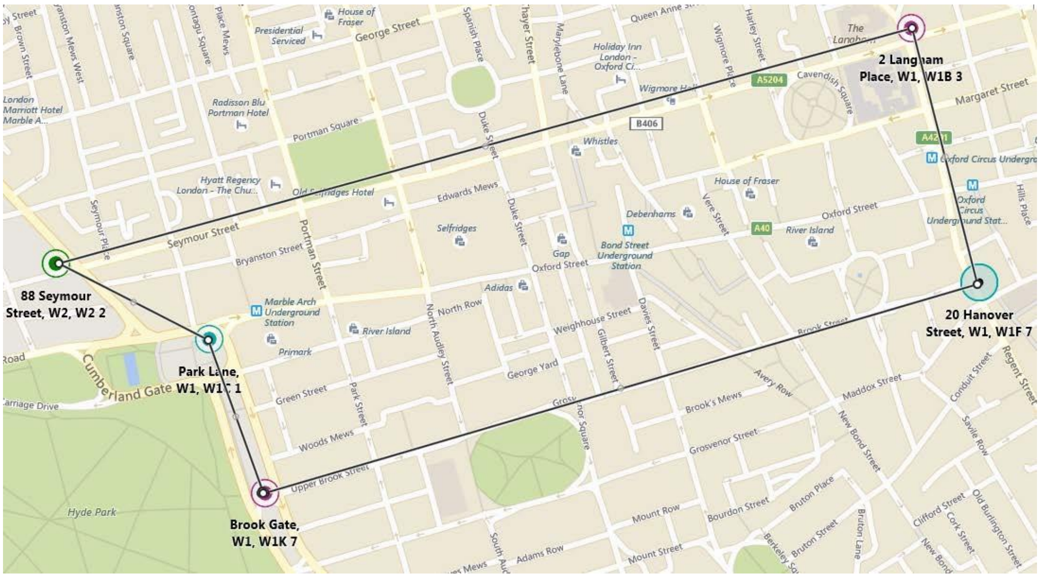


Figure 1 – Oxford Street study area (Map source: Bing)

The Oxford Street study area represented around 2% of the overall dataset and, as data were extracted by matching to a full postcode, records with missing, partial or malformed postcodes were not included in the analysis. Further records could have been obtained by trying to resolve individual addresses but this was not done for data protection reasons. The clean records comprised around 65% of the total dataset and therefore represented only a sample of the full activity in the area.

Results and discussion

Analyses of the parcel carrier data from the Oxford Street study area are presented and discussed in the context of their contribution to better understanding of urban last-mile freight activity.

Overview of operations

The carrier mainly operated Monday to Saturday with no work on Sundays, with the exception of the Sunday after Black Friday. Mondays were the busiest day of the week, with around 241 manifest entries per day in the Oxford Street area (Figure 2), which was due to the very high proportion (49%) of failed deliveries on Saturdays that required subsequent delivery on the Monday. The high failure rate reflects the number of offices that are closed on Saturdays and efficiency could be improved significantly if the carrier were able to avoid making such wasted trips. Failure rates during the week ranged from 7.4% (Thursdays) to 14% (Mondays) and, in comparison, IMRG (2014) estimated that 13%-14% of all online shopping deliveries in the UK arrive either late or when the customer is not at home but in the case of tracked services, B2C failure rates were observed to be much lower, at 2%3% (IMRG, 2017). Averaging over all days, there were 139 successful deliveries, 24 failed or carried forward deliveries and 7.4 collections per day within the Oxford Street data, with the actual activity for the carrier estimated to be around 1.5 times greater, given the sample size of recognisable delivery points (65% of the sample). Total parcel activity across the area may be around 20 times higher again, given that the carrier in question has an approximate 5% national market share (Royal Mail, 2013). These results could be extrapolated further to the goods sector as a whole by

considering that a survey on Regent Street in central London found that 21% of all motorised goods vehicles were parcel carriers and couriers (Transport for London, 2009).

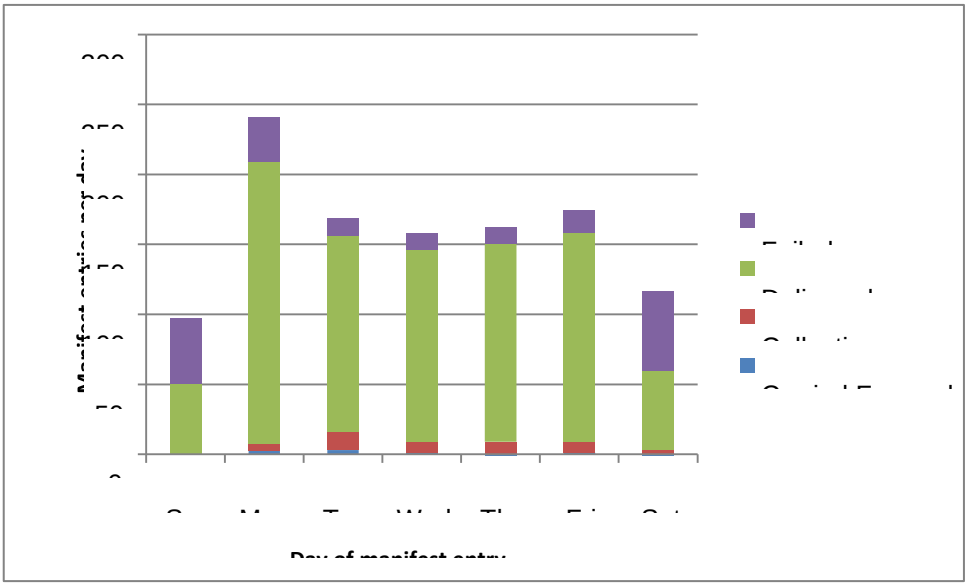


Figure 2 – Number of manifest entries by day of week (Oxford Street area)

Temporal analyses

The number of deliveries made each day in the Oxford Street area was highly variable (Figure 3) with a number of peaks where over 250 deliveries were recorded in the data: Monday 3rd October (n=358), Monday 10th October (n=312), Monday 24th October (n=274), Tuesday 29th November (n=329) and Monday 12th December (n=276). It is suspected that Monday 28th November would also have been a peak day; however, data were not available due to a system fault. The peaks in November and December were expected due to their proximity to the Black Friday sales and to Christmas. Mondays were already observed to be the busiest day of the week however specific reasons for the peaks in October are not known. When investigating the entire dataset (i.e. the wider central London area), a somewhat different picture emerged with the greatest activity observed on Monday 5th December, followed by Monday 12th December, but with no noticeable peaks in October. This illustrates the fact that different delivery patterns can be observed in different areas depending on the mix of land use and that it may be problematical to attempt to generalise freight vehicle impacts from one place to another.

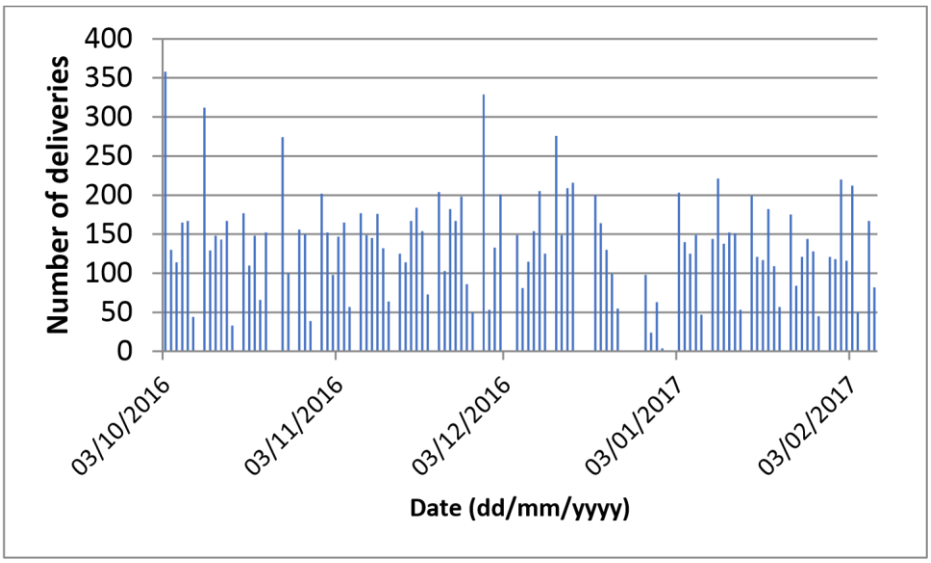


Figure 3 – Number of deliveries each day (Oxford Street area)

The majority (64%) of on-street activity took place between 11am and 4pm, peaking between 2-3pm (Figure 4); this mainly reflects the fact that the work necessarily takes place during the daytime when the consignees based in offices can receive their goods. Collections took place throughout the day unlike some carriers who prefer to leave collections until later in the round, after all deliveries have been made. Collecting throughout the day likely allows more efficient vehicle routing but may be slightly more difficult in terms of organising parcels in the back of the van. Proportionally more failed deliveries were recorded after 5pm likely due to customers having left their offices to go home.

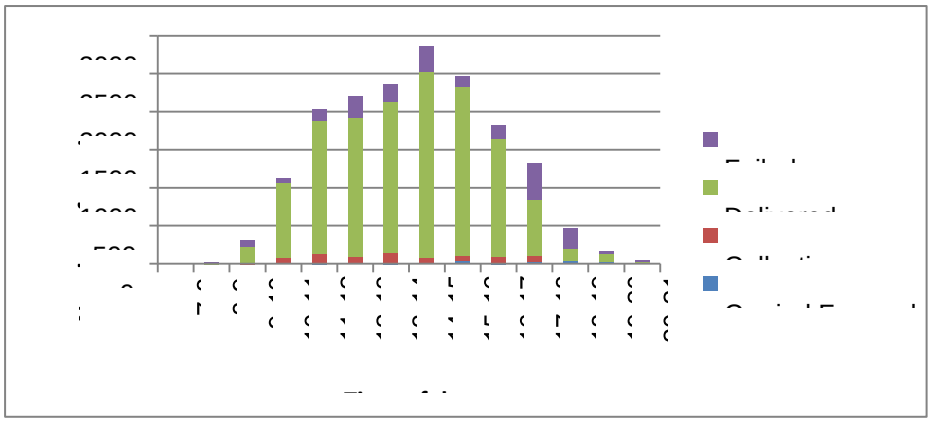


Figure 4 – Number of consignments by time of day (Oxford Street area)

Spatial analyses

Of the 1172 postcodes in the area, 708 were found in the data and the remaining 464 postcodes received no delivery or collection. Combined deliveries and collections, including failed attempts, were mapped to reveal levels of van activity across the area (Figure 5). Of particular interest are the locations receiving the most traffic as these will likely be the places where nearby unloading places will be most needed. Such mapping may be of use both to local authorities in their planning of kerbside space utilisation and to carriers when planning vehicle schedules and routes. Parcel carrier operations typically involve considerable time spent walking between customers while the vehicle is parked by the roadside (Allen et al, 2017) and better knowledge of how to cluster groups of consignees could help them identify more optimal locations to park, as a base for the walking operations.

Most of the activity hot spots (Figure 5) appeared to be in areas of mixed land use with multitenanted offices, shops, restaurants and hotels, including those on Oxford Street, Regent Street and opposite Portman Square (Figure 1). Individual customer addresses generating these deliveries were not known as they had been removed from the dataset for confidentiality reasons and the records could not be reliably used to determine the extent to which personal deliveries were made to workplaces, as personal and work-related deliveries could not be easily distinguished. Such information is of interest for workplaces and transport authorities in London who would like to restrict such activity on the basis of the added staffing resources required for receiving personal deliveries and the added parcel carrier contribution to road and kerbside congestion (Harris, 2017).



Figure 5 – Total number of deliveries, collections and failures (1 Oct 2016 to 7 Feb 2017)

To illustrate the extent to which the busiest locations differed from the norm, the ‘top 8’ (1.1%) postcodes, corresponding to three ‘hottest’ division bands used in Figure 5 (i.e. those with >285 deliveries, collections or failures), accounted for 13.7 times the mean activity, or 15.5% of the total activity (Table 1). In addition, the ‘top 20’

(2.8%) and 'top 45' (6.4%) postcodes accounted for 31.3% and 50% of total activity, respectively, indicating the skewed nature of the spatial distribution, with a relatively small number of places generating high levels of activity and many postcodes generating little. The high standard deviation values observed for the 'top 8' (Table 1) were largely due to the presence of one postcode that had a high number of collections (177) but relatively few deliveries (28), whereas the norm was for deliveries to outweigh collections by 18.6 to 1.

Table 1 – Comparison of 'top 8' and all postcode areas in terms of delivery and collection activity over the period (1st October 2016 to 7th February 2017)

	Number of occasions of activity All postcodes (Top 8 postcodes)			
Activity	Total	Average	Standard Deviation	Maximum
Deliveries	14009 (2099)	21 (262)	44 (111)	379
Collections	753 (239)	6 (30)	17 (60)	177
Failures	2257 (294)	6 (37)	8 (23)	84
All	17019 (2632)	24 (329)	50 (50)	407

Express deliveries

Also of interest were express deliveries, as they can have a significant impact on vehicle activity where they are performed before other (non-express) deliveries to ensure they are completed on time. Such prioritisation can result in the same places being visited on the same round at different times of the day, especially where strict time window delivery deadlines are involved. The only priority consignments in the dataset were guaranteed 'next day' deliveries which accounted for around 13% of the total activity in the Oxford Street area. A combined heat map of the express and non-express deliveries (Figure 6) showed, perhaps unsurprisingly, that there was considerable overlap between the busiest locations for each (where orange and purple combine to become brown). If delivery rounds could be organised in a consistent way from day to day, in terms of the times when key locations were visited, then virtual loading bay locations and time slots could be introduced and booked by carriers to aid last-mile logistics management (Pink, 2017). This could be combined with offering customers delivery time windows to match vehicle

routes but at present, this detailed knowledge of vehicle routes is not typically known, being left up to the driver to decide. It is not certain if consistent routes could be achieved due to the day-to-day variability in delivery and collection demand.



Figure 6 – Spatial variation in express (next day) consignments vs non-express consignments

Conclusions

The analyses have demonstrated the potential benefits of parcel carrier manifest data for investigating peaks in temporal and spatial demand and resulting vehicle activity. Challenges in using such information include dealing with missing and poorly formatted data fields and the sheer volume of data, with around 840,000 records obtained for a 4-month period. While this dataset represents only a small fraction of total urban freight activity it provides an indicative sample for the parcels sector to complement other data sources from which data projections may be made. As manifest data are routinely collected by carriers, analyses are far more cost effective than manual surveys conducted by the roadside or in-vehicle.

Local authorities need to rethink the way in which kerbside space is allocated and give greater consideration of urban freight user needs. Our results show that a small proportion of locations are generating a large amount of kerbside activity and these locations can be targeted for improved access by, for example, considering the introduction of virtual loading bays or shared drop zones. Authorities may also consider ways to encourage shifting deliveries to off-peak times to reduce or spread out demand for kerbside space and reduce the impacts of parcel generation across busy areas, although there may be limited scope for this as the daytime deliveries currently observed are largely dictated by customer needs (e.g. business opening hours). In addition, authorities and businesses may wish to ban personal deliveries to workplaces in order to reduce parcel carrier activity in busy urban centres, although this may simply shift ‘the problem’ elsewhere with unclear overall effects.

Parcel carriers face a highly challenging task in scheduling and performing deliveries and collections in a congested city such as London, where competition for kerb and road space is keen. At present, the vehicle routing and delivery/collection task is usually left entirely to the driver's discretion, as vehicle routing software, for example, is typically not useful as walking options are not usually considered (Allen et al, 2017). Further research within the FTC2050 project will include development of methods for clustering customers to optimise the combined driving, parking and walking task.

Failed deliveries are another area where improvements may be made. In many cases it is the sender of the goods (e.g. an online retailer) who demands a certain delivery requirement of the carrier (e.g. next day) but this does not necessarily match the customer requirement (for example, they may be closed on a Saturday). Carriers could potentially reduce failed deliveries through gaining a better understanding of when their key customers are actually able to receive deliveries; however, at present, they are simply following delivery instructions and such detailed customer knowledge typically lies only with experienced drivers and not within the carrier's fleet management systems.

This research has suggested how the data may also be used to build a freight activity profile of different types of generators of demand (e.g. offices, domestic residencies, commerce) although it could be a difficult and time-consuming task to categorise customers, especially in multi-purpose buildings, and carriers may not wish to provide such information for data protection or commercial reasons.

The research findings provide support for a wider consideration of how different carriers may collaborate with each other and a futuristic scenario in which live carrier data are shared with a third-party Freight Traffic Controller to produce more efficient delivery schedules for more sustainable urban logistics.

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Analysing the performance of last-mile parcel delivery operations in London
Marzena

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Introduction

A major proportion of parcel delivery activities take place in urban areas representing a significant part of urban freight transport. The parcels sector contributes to the challenges of traffic congestion, emissions, pollution, noise and accidents facing many urban locations, while operating within a competitive and increasingly demanding environment (Allen et al., 2016).

The growth of the last mile movement of parcels in urban areas is driven by the increasing demand of business-to-business (B2B) and business-to-consumer (B2C) ecommerce (the B2C's ecommerce share in total UK retail sales was around 14% in 2016, and is forecasted to reach just over 20% of all retail sales by 2021 (Mintel, 2016; Office for National Statistics, 2016)). At the same time the fragmentation of the parcel distribution sector means that it consists of a high number of independent operators of different sizes and geographical reach. Many of them suffer from poor vehicle utilisation and low profit margins as they operate in an environment where 'everyone- delivers-everywhere' (Browne et al., 2014).

The aim of the paper is to enable a better understanding of the operational practices and challenges faced by parcel carriers in London. The study highlights the importance of combining multiple research methods to gain a better understanding of operations undertaken by parcel carriers in urban areas. As far as the authors are aware, this is the first ever attempt to study the delivery strategies and the walking component of last-mile parcel operations in any detail.

Methodology

The project commenced with a structured literature review of the parcels sector to identify the key recent developments and operational challenges within the sector. A total of 70 peer-reviewed academic papers published between 2000 and 2016 were consulted for this purpose. Furthermore, this work has been complemented by the primary data collected to gain a detailed understanding of the daily parcel delivery operations carried out in central London. As part of this work a sample of 25 delivery rounds were surveyed over a three-day period to investigate vehicle and driver activity at three London depots. The primary data was collected using a range of sources including manual recording by surveyors and manifest data for each vehicle.

Structured literature review

The academic publications relevant to the parcels sector were identified through a library literature search of online databases including ScienceDirect, Emerald and Taylor & Francis Online. A set of search terms used for this purpose included: parcels, parcel carrier, parcel delivery, parcel operations and last-mile delivery.

The relevance of each article to the topic was established through its abstract content. In cases where this process was not conclusive, the full text of the publication was scrutinised to ensure its suitability. This initial process of literature search was expanded with further relevant publications found in the bibliographies of consulted sources. Once the process was complete, the identified articles were classified according to various criteria including: research approach and methods, geographical location, as well as publication date, and content. There has been a growing interest in the parcels sector as suggested by the rising number of articles published within the considered period of time. Furthermore, the variety of issues addressed by the literature and a wide range of academic disciplines dealing with them confirms the complexity of the sector and its challenges.

Two dimensions of the applied research approach were used to classify the selected literature: from empirical to theoretical, and from descriptive to prescriptive. Over half of the articles (54%) were categorised as empirical, and the same proportion of publications were identified as descriptive. It has also been possible to select a third group of publications which represents studies combining theoretical and empirical approaches, by often trialling models using empirical data. The literature was also classified by the applied research methods. Approximately half (49%) of publications are modelling/simulation focused, looking mostly at issues around network design, optimization of operations and vehicle routing and scheduling. A multi-method approach was the second most often used research method with 34% of articles falling into this group. Other categories of research methods applied across the remaining literature included case studies, interviews, questionnaire, scenarios and a literature review.

A distribution of the papers by geographical location suggested that their significant proportion (33%) relate to European countries, followed by the Far-East (19%) and North America (11%). A considerable volume of articles (27%) does not state their geographical background, while 9% of the publications deal with studies of multi-region context. The remaining 1% of articles present research related to South America. While the growth in number of publications is present across all geographical locations, it has been most steady among articles with the European background. The changes in the number of articles focused on other locations are more varied and characterised by the fluctuation of growth and decline in the considered period of time.

The analysis of the literature was also carried out based on its content. A wide range of issues have been addressed by the publications and they were clustered into ten themes which emerged from the review work of the topics they covered. As papers address multiple topics, they were assigned to one or more of the identified themes. The second most often addressed issue related to the last-mile B2C deliveries, with 20 per cent of all papers included in this theme. The following section provides the main findings of the literature review of this group of articles.

Literature review of the last-mile Business-to-Consumer (B2C) delivery

The nature of the last-mile delivery operation makes it the most costly and inefficient element of a supply chain. As noted by Jung et al. (2006) the cost of pickup and delivery operations accounts for over 40% of the total cost related to the delivery service. Overall, the identified literature mentions two types of last-mile B2C deliveries - home delivery and customer collection points (e.g. Weltevreden, 2008; McKinnon and Tallam, 2003; Morganti et al., 2014a; Morganti et al., 2014b) with the latter option seemingly prevalent in the reviewed publications. Some case studies that focus on the customer collection points were identified in the literature providing an analysis of the solution in various European countries, including the Netherlands, the UK, Germany, France and Poland (Weltevreden, 2008; Morganti et al., 2014a; Iwan et al., 2016). As noted by Morganti et al. (2014a), about 20 percent of parcel deliveries to households are carried out using alternative delivery options, with growth (in the UK, France and Germany) estimated at up to 150 percent between 2008 and 2012. Some of the benefits offered by the collection points, including higher load consolidation, the scope to use larger vehicles, fewer delivery points and a lower number of failed deliveries, were identified as the reason for their attractiveness, confirmed, for example in France, by their cross-country presence, including rural areas (Morganti et al. 2014a). However, although the popularity of the alternative delivery solutions is increasing (Morganti et al., 2014a), direct home deliveries are still dominant in the parcel sector operations (Zhou et al. 2016). A study of a situation with simultaneous offering of home delivery and customer collection points was carried out by Zhou et al. (2016) who tried to establish the role of distance in customers' choice of collection point service based on cost. Their findings suggested the opportunity for a considerable cost savings to be achieved due to fewer operating vehicles resulting in lower fixed and routing costs as well as those costs associated with missed deliveries. The possible outcomes of the modelled transport impacts of customer collection points studied by McLeod et al. (2006) recognised the important influence of several factors including distance travelled by the parcel carrier and a customer collecting their order, the time needed to complete the delivery operation by the carrier, as well as the rate of first-time delivery failures. The factors that could have an impact on the attractiveness of pre-arranged delivery time windows and customers' readiness to be charged for such an option was the subject of a study by Goebel et al. (2012). The findings suggested the potential for cost and time savings as a result of lower handling, storage and transport costs, and claimed that the resulting predictability of a delivery would reduce the need for the use of collection points by customers. A recent study by van Duin et al. (2016) confirmed these findings and noted that efficient delivery operations are influenced significantly by the pre-arranged delivery time windows.

Overview of the performance of parcel delivery operations

The results presented in this section are derived from a detailed survey of 25 vehicle rounds (out of 81 rounds in total) carried out by LGVs (light goods vehicles up to and including 3.5 tonnes gross vehicle weight) in which surveyors, based at three depots of two different parcel carriers, accompanied and recorded the driving and walking activity of multi-drop parcel delivery operations to business and residential addresses over a three-day period (25th-27th October 2016) in the WC1, WC2 and W1 areas in central London. These surveys aimed to capture information about the amounts of driving, parking, walking and the numbers of deliveries and collections made, through direct observation and in conversation with the driver. For the purpose of presenting the survey's results in this paper, the three London depots studied here are referred to as A, B and C, and Table 1 presents the characteristics of their delivery rounds.

		Depot A	Depot B	Depot C	Overall average
Number of rounds		8	8	9	8
Round duration (hours)	Min	7.7	5.6	5.1	7.3
	Max	10.3	7.2	9.1	
	Average	8.8	6.6	6.7	

Table 1: Characteristics of delivery rounds.

The survey took into account all time spent from the point of leaving the depot until returning to the same depot at the end of the round. The additional time spent at the depot (e.g. for loading the vehicle) was not considered here.

Distance and time statistics

For the 25 vehicle rounds that were studied, the average round time was 7.3 hours, with a range between 5 and 10 hours. The rounds originating at Depot A were considerably longer than the other rounds and this may be partly explained by significantly longer stem distances recorded for its operations, as illustrated by Table 2.

	Depot A	Depot B	Depot C	Overall average
Average stem distance (km)	22.9	3.8	8.3	11.9
Average driven delivery distance (km)	14.2	15.3	7.2	11.9
Total	37.1	19.1	15.5	23.8

Table 2: Driving distances

The stem distance relates to distances driven from the depot to and from the delivery area, that is, between the depot and the first delivery point plus from the last delivery point back to the depot. The average distance driven within the delivery area, excluding stem mileage, was 11.9km while the calculated average distance walked was 7.9km. This indicates that walking constitutes a substantial proportion of daily delivery rounds for parcel carriers.

The proportion of time that was spent driving ranged between 23% and 67%, with a mean of only 38%. For the remaining 62% of time spent, the vehicle was parked while delivery/collection activities were undertaken, or while a short break was taken by the driver. In absolute terms, the average time spent parked was 4.6 hours. Given that 95% of the recorded stopping locations were 'on-street' (i.e. at the kerbside and typically on double yellow lines), and 'off-street' unloading areas (i.e. in car parks and loading bays on private space) were only used in 5% of instances, this indicates the pressure that this activity places on kerbside space and time availability for loading/unloading activities and other purposes. These results demonstrate that in central London, parcel carrier vans spend considerable amounts of time parked on-street, which may be of interest to both couriers, when negotiating their insurance cover for vehicle use, and to Transport for London in shaping policy for freight provision in the city (e.g. on kerbside loading bays).

Vehicle stopping strategies, addresses visited and items delivered/collected

The carrier survey established that the main objectives for the interviewed drivers were, primarily, to meet all their delivery time windows and to undertake the work as efficiently (i.e. quickly) as possible, while trying to follow all parking regulations in order to avoid incurring any fines. The drivers indicated that they knew most parking attendants working in the area and the majority of them were prepared to show some discretion to drivers infringing the regulations for brief periods of time.

The daily round structures used for allocation of work to drivers were identified in advance and usually permanent, unless the volume of work was too high for a driver to complete. In such cases some part of the excessive workload was distributed among other drivers. However, the sequence in which the assigned tasks were performed was decided individually by the drivers. With a significant variation in their work experience and local knowledge, this presented the risk of operations being carried out inefficiently, however, the drivers did not utilise any routing and scheduling software to assist in round design. Communication with operations and transport managers revealed that there is a frequent discrepancy between registered business addresses of receivers and the actual point of delivery for the building. As a result of this problem, together with the walking involved in making deliveries, existing routing and scheduling software is unable to produce practical optimisations and indicate suitable vehicle stopping locations (as they overlook the walking component of delivery rounds).

When the driver had a number of different delivery time window targets to meet (e.g. before 9am, 10am and mid-day) the preferred strategy was to “get them out of the way” to the exclusion of any other deliveries even if this meant returning to the same areas later on during the day. The reason for this was to avoid any risk of missing the target delivery time which could happen if there was a delay due, for example, the customer not being available to accept a delivery. An important observation made during the vehicle rounds relates to the fact that deliveries and collections were undertaken by the same vehicle, but following two different strategies. Almost all collections for one of the parcel companies were planned for and performed at the end of the round, once all deliveries had been completed, but the collections made for the other parcel carrier were scattered among deliveries. While the latter approach is expected to be more efficient in terms of a vehicle routing, it presents a challenge to the driver in the form of the vehicle space management and the danger of collections being mixed up with deliveries.

The preferred parking strategy was stopping on-street as close as possible to an individual customer but sometimes parking restrictions or the road network topology (e.g. one-way streets) meant that the driver decided to park a bit further away (e.g. on a side street) and then perform a walking tour around a number of different customers located relatively close to one another. Sometimes this involved a return walk to the vehicle to pick up more parcels, as the driver could not carry them all at once. On average across all the studied rounds, there were 1.9 customers served per vehicle stop but individual round averages varied substantially: from 1.1 to 5.2 customers per stop. The former value indicates that some drivers preferred to move the vehicle between customers, and typically this would involve only a short distance (e.g. 50m) between stops, while the latter suggests more clustering of customers on walking tours. On a few occasions where a desirable parking spot was not available immediately, the driver drove around the block a few times looking for a space. The drivers indicated that they would welcome more parking options (e.g. loading areas) being made available to improve the situation.

As illustrated by Table 3, the average number of parcels delivered or collected on each round was 126, to an average of 72 customers, during 37 stops. This equates to an average of 1.8 items per customer and 3.4 items per stop.

	Depot A			Depot B			Depot C			Overall average
	Min	Max	Average	Min	Max	Average	Min	Max	Average	
Stops	22	59	40	25	48	34	14	72	38	37
Addresses served	53	102	70	32	86	57	48	120	86	72
Items (delivered/collected)	93	336	164	58	105	83	74	177	132	126

Table 3: Number of stops, addresses served and items delivered/collected

On average, 3.5 minutes were spent per item delivered (or collected), calculated as the total round time divided by the total number of items, however there was a variation between depot averages ranging from 3.0 to 4.8 minutes per item.

Initiatives to mitigate the last-mile delivery problems

Considering the impact of the last-mile delivery operations on urban areas, there is a need for new ways of performing these operations. A number of innovative solutions have been trialled and the results suggest that they can offer important benefits in terms of lower costs and higher operational efficiency leading to fewer LGVs and their lesser impact on the society and the environment. These alternative freight delivery models include shared drop zones, designated to freight delivery and collection operations and acting as micro-consolidation platforms serving urban areas. An example of such a solution is a French initiative called local logistics points and known as ‘Espaces Logistiques de

Proximité’ (ELP). The solution involves an urban transhipment facility from which deliveries are made to the customers located in the nearby area using environmentally friendly vehicles (Browne et al., 2012). Another initiative was set up in Paris as a ‘virtual exchange point’ operated by a parcel carrier, La Tournée, with no storage facility and parcels being delivered on foot following a sortation process taking place on the street. Other examples of innovative solutions within the parcels sector include ‘mobile city hubs’ using a van, a trailer, or a barge as storage platforms that can be transferred around the city and from which the final deliveries are performed on-foot, by tricycles or using other vehicles (eg. Vert Chez Vous on the River Seine and the ‘Mobile Depot’ piloted in Brussels by TNT) (Ducret, 2014).

Conclusions

The paper provides a systematic literature review of the parcels sector and helps to gain a better understanding of current operational practices and challenges faced by two parcel carriers in central London. The results suggest that for a significant proportion of the average round duration (62%) the vehicle was parked while deliveries or collections were being made. This confirms the pressure such activity places on kerbside space and its availability to other road users, particularly when 95% of the recorded stopping locations were 'on-street' (i.e. at the kerbside and typically on double yellow lines).

From a traffic and environmental viewpoint and from the point of view of the parcel carriers, more walking and less driving may be desirable. However, determining an optimal stopping strategy is a complex task taking into account decisions about how to group customers together to form linked driving and walking tours. The existing vehicle routing and scheduling software products tend to be unsuitable for parcel carrier companies as they typically do not consider customer clustering and walking options. Furthermore, although customer clustering practices may well increase the overall efficiency of parcel carriers operations, they are also expected to result in longer vehicle dwell times at each stop and create greater challenges for other road users seeking to obtain kerbside space. Another challenge that would have to be addressed relates to the desired maximum load weight and size that could be carried by the driver on a walking tour between customers.

Recognising the challenges facing parcel carriers in urban areas and given the unique characteristics of parcel delivery operations, the example initiatives of micro-consolidation platforms mentioned above may offer significant opportunities to meet the future challenges facing the sector, and become more widely adopted solutions for parcel carrier operations.

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Pharmaceutical Supply Chains

An evaluation of the applicability of complex adaptive system theory in the pharmaceutical supply chain

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Abstract

Purpose: The aim of this research is to evaluate if the Complex Adaptive Systems theory can be used to explain resilience strategies within the pharmaceutical supply chain

Research Approach: An in depth review of literature surrounding resilience in the pharmaceutical supply chain. In order to pursue this study agenda, data was collected from Scopus, the largest peer review journal as well as EBSCOhost. The PRISMA guideline was adopted in the systematic review process where 34 peer reviewed papers in the field of CAS, supply chain and supply chain resilience were identified with respect to methodologies employed, location of the study and approaches.

Findings and Originality: The systematic review of literature shows that there are inherent similarities between the concept of resilience and the CAS theory. The CAS theory explains that PSC's are dynamic, have emergent behaviours complex, adaptive, interconnected as well as possess schemas that regulate their operations. Hence if resilience strategies are to be employed to mitigate disruptive events they need to be harnessed in a manner to fit this particular supply chain. This work is innovative as it provides a new insight into the contemporary discourse on resilience strategy creation and deployment, examining the use of this theory in the PSC, and thus provides original contribution.

Research Impact: This study contributes to the existing literature base, by providing theoretical underpinnings in the area of resilience and the pharmaceutical supply chain. This furthers the CAS agenda, SCR agenda and also presents an innovative output which warrants more detailed analysis and feasibility testing.

Practical Impact: Complexity principles are multi-scaled and multi-domain and as such the suggestions put forward in this theoretical framework can be adopted in various supply chain networks as well as disruptive events. It provides new insights with regards to structures for managers seeking to design and improve resilience supply chains, a key element of which is the adoption of a holistic analysis by SC managers when developing resilience strategies. This is critical if disruptions are to be identified and mitigated before their impact is felt.

Introduction

Recent trends in managerial practices, volatility in demand and globalization have resulted in businesses having longer and more complex supply chains (Blackhurst et al., 2011, Wagner and Neshat., 2012). These resultant features, have made supply chains more vulnerable to the impacts of disruptive activities, which have severe consequences on the operational and financial performance of the firm (Wagner and Bode, 2009; Schmidt and Raman, 2012). Resilience within the supply chain which entails that a firm has the ability to prepare, respond and recover from a disruptive event has been posited as a remedy for vulnerability (Ponomarov, 2012). This underlying notion stems from the proposition that disruptive events cannot be curbed and as such resilience is essential to mitigate the impact of these disruptions (Petitt et al., 2010; Juttner and Maklan, 2011).

Several theories have been employed to elucidate resilience as a phenomenon within the supply chain literature: Resource Based View (RBV) (Howleg and Pil, 2008; Blackhurst et al., 2011; Bellamy et al., 2015); Dynamic Capability Theory (Ponomarov, 2012); Systems theory (Erol et al., 2010; Speigeler et al., 2012). Some of these theories however remain inconclusive as some essential elements required in explaining what resilience entails are absent. For instance, the RBV/Dynamic Capabilities theory only focus on the internal workings of the firm and therefore masks the complexities involved in supply chains as well as resilience strategies (Tukamuhabwa, et al, 2015).

In view of the foregoing, this study proposes the Complex Adaptive System (CAS) view of the complexity theory by Holland, (1995) as suitable in explaining supply chain resilience. The purpose of this paper, therefore, is to critically assess the contributions of the Complex Adaptive System (CAS) theory in explaining the concept of resilience within the pharmaceutical supply chain. The next section presents the methodology used in reviewing the literature, while section three presents the findings which includes definition, historical background as well as the dimensions of the theory. The paper concludes in section four where the relevance of CAS is assessed as well as its shortcomings with respect to resilience strategies in the supply chain.

Methods

The main aim of this systematic review of literature is to identify previous studies that have explored CAS as a theory in explaining supply chain resilience. As such, this study adopts the five step guidelines for literature review processes highlighted by Denyer and Tranfield (2009), as well as the PRISMA guidelines (2009) which will aid in identifying, analysing, synthesizing, interpreting and reporting evidence from existing literature. This is geared at producing a systematic review that is explicit and can be reproduced (Hohenstein et al., 2015). The first step of the research was formulating the questions which were aimed at developing a focus for the review to avoid ambiguity (Denyer and Tranfield, 2009). The overall aim of this study is to explore the applicability of Complex Adaptive System (CAS) as a theoretical lens in explaining pharmaceutical supply chains resilience. As such the review seeks to understand two vital questions:

RQ1: What are the dimensions of CAS?

RQ2: Can CAS be used as a theoretical lens in explaining pharmaceutical supply chain resilience?

In seeking to reduce the bias that may occur in this study as well as cover a range of information sources, Scopus, EBSCOhost and Google Scholar were the major databases employed. In consonance with existing systematic

management studies (Colicchia and Strozzi, 2012; Hohenstein et al., 2015), this review employed defined keywords in its search criteria. Here Complex Adaptive Systems/CAS combined with the phrase 'Supply Chain' and or' 'Resilience' in the article's abstract was used in the search process; this is based on the idea that, - the journal articles had to depict a clear link between CAS and supply chains or supply chain resilience. The analysis resulted in 45 preliminary articles. To certify that only high quality articles were adopted into the study, articles were limited to peer-reviewed journals as the peer review process is a quality indicator that assesses a study's conceptual and methodological rigor. As such, conference papers were excluded from the study. The review starts at 2001 because the first mention of CAS theory within a supply chain framework appeared then in Choi et al's paper in . After reading the abstracts, articles which seemed non-relevant to our study were excluded. The PRISMA checklist was used in arriving at the final papers employed in the review. Hence, 34 peer reviewed articles over a period of 16 years were identified as relevant to the study.

Findings

The study finds that the 34 papers employed in this study were published by 25 academic journals with Journal of Operation Management and International Journal of Production Research having the highest number of publications in 2013. The papers where then classified as either empirical articles or analytical research. Analytical papers are conceptual papers, mathematical papers or statistical papers. Empirical papers employ the uses of statistical techniques, case studies framework and or mixed methods. The study finds four empirical studies that had applied CAS theory in supply chains with their focus on the Automobile, Maritime and the Food industry. This calls for the need to examine resilience strategies, pharmaceutical supply chain and CAS theory.

Definition of CAS

CAS theory bears its roots in the complexity theory and has gained popularity in the social sciences such as; organizations studies. At the heart of Complexity theory are three basic concepts; self-organisation, emergence and interrelatedness that are developed on the works of previous system theories (Snyder, 2013). The Complex Adaptive Systems theory therefore proposes a higher level of interaction between components of a complex system with its distinguishing feature of adaptability.

A CAS is therefore defined as the ability of a system to reorganize its parts while adapting to the problems posed by interacting with its environment and evolving through a feedback mechanism (Choi et al., 2001; Holland, 1995). As such, a CAS must be able to distinguish itself from other systems as well as the ability to differentiate legitimate parts of its owners from evolving invaders without an obvious centrally controlled mechanism (Holland, 1995).

Dimensions of CAS

The study also finds 10 inherent characteristics of complex adaptive systems. Table 1 below presents the identified features, definitions and authors.

Table 1 Dimension of CAS and Corresponding Authors

Dimensions	Definitions	Authors
Adaptability	This implies that the agents of a system respond react and are sometimes proactive in its interactions with other agents or its environment.	Choi et al, 2001; Surana et al., 2005; Nilson and Darley, 2006; Pathak et al., Wycisk et al,2008; Ivanov, 2010; Hearnshaw and Wilson ,2011; Day, 2014;Aelker et al., 2013;Justice et al., 2016 Moncada et al.,2017.
Agents	This refers to the different components that make up a CAS. Agents may be individual or group of individuals within a system that operate at different levels.	Choi et al., 2001; Howleg and Pil, 2008; Wycisk et al., 2008; Ivanov et al.,2010; Kim et al., 2011; Carter et al., 2015; Nair et al., 2015; Tukamuhabwa et al., 2015.
Coevolution	Here a system learns new things that make it change and respond to the environment. These changes also affect the environment it operates in as such, affects other systems that exist within that environment.	Surana et al., 2005; Nilson and Darley, 2006; Pathalk et al., 2007; Wycisk et al, 2008; Mena et al., 2013 Day,2014; Tukamuhabwa et al., 2015.
Complexity	A CAS is made up of different agents that are interconnected and have feedback loop mechanism.	Choi et al,2001; Surana et al.., 2005; Nilson and Gammelgaad, 2012 ; Mu and Jia 2013; Carter et al., 2015; Justice et al., 2016
Dynamism	The ability of the system to continuously exchange information with its surroundings. It is dynamic as it changes and adapts to the situations that it encounters within its environment in order to achieve fitness. This may also cause a dynamic change in the whole system.	Surana et al.,2005; Nilson and Darley, 2006; Ivanov, 2010; Aelker et al., 2013; Bellamy et al., 2013; Hearnshaw and Wilson, 2013; Mu and Jia, 2013; Carter et al., 2015. Justice et al., 2016.

Dimensionality	This feature is defined as the level of freedom that each part has within a system. The presence of control restricts dimensionality.	Choi et al,2001; Nair et al., 2015; Tukamuhabwa, et al., 2015.
Non Linearity	Here, there is no consistent response between the cause of an event and the effect of that same event. It plays a role in the coevolution process. This implies that an extreme event may yield an inexplicable effect and does not depend on the nature and degree of connections of the agents within that system. It is in the process of responding to the effect of non-linearity that coevolution takes place.	Surana et al., 2005; MCarthy,et al., 2006; Nilson and Darley, 2006; Wycisk et al., 2008; Nilson and Gammelgaad, 2012; Bellamy et al.,2013; Nair et al., 2015; Tukamuhabwa et al., 2015; Sun et al., 2016; Rodewald et al., 2016.
Non Random Future	Common pattern of behaviours are exhibited /future cannot be predicted but some patterns can be identified.	Nilson and Darley, 2006; Aelker et al., 2013.
Self-Organization and Emergent Behaviour	Self-organization and emergence refer to the collective effects and behaviours of the decisions and actions of individual agents in a CAS that can cause changes. These changes may include creating of new structures and patterns and are viewed as a whole.	Choi et al,2001; Surana et al,2005; Nilson and Darley,2006; Pathak et al, 2007; Howleg and Pil, 2008; Hearnshaw and Wilson, 2011; Nilson and Gammelgaad, 2012; Bellamy et al., 2013; Mena et al., 2013; Carter et al., 2015; Sun et al., 2017
Schema	These are order-generating rules which determine how the agents and the system as a whole respond throughout an adaptation process. This implies that to provide for adaption, the system ought to make provision for changing rules as it interacts with each other and with its environment.	Pathak et al., 2007; Howleg and Pil, 2008; Nair et al., 2015.

The elements of CAS theory have been defined in Table 1 above these are: Adaptation, Agents, Complexity, Dynamism, Dimensionality, Non-Linearity, Non-random future, Self-Organization and Schema. The applicability of CAS to resilience strategies in the Pharmaceutical supply chain will be highlighted in the next section.

Contribution of CAS Theory to Supply Chain and Supply Chain Resilience

Characteristics of CAS	CAS and Pharmaceutical Supply Chains	CAS and Resilience Strategies
Adaptability	For CAS theory, adaptation implies the ability of a system to be flexible, reactive as well as proactive (Choi et al., 2001; Nilson and Darley, 206). In responding to changes in an environment, such as;- new regulations, change in consumer lifestyle, disruptive activities the pharmaceutical supply chain will have to adapt to meet up with consumers demand as well as remain competitive.	As a phenomenon in supply chain literature, resilience entails that supply chains have the ability to adapt to given changes such as threats and innovation (Ponomarov and Holcomb,2009; Ponomarov, 2012; Hearnshaw and Wilson; 2013).
Coevolution	Supply chains demonstrate coevolution features as government policies, disruptions and economic environment changes, the firms within the supply chain respond to these changes, which may in turn affect the environment they operate. For instance, if consumers demand for a product changes, the supply chain will have to respond to this demand by changing its strategies, the process of responding is what is referred to as coevolution (Nislon and Gammelgaad, 2012; Mena et al., 2013).	Resilience strategies within the supply chain emanates for the combined interfaces with different firms as they apply schema to increase the chances of survival (Day,2014).

Complexity	CAS highlights the complexities within a system that arise as a result of the agents trying to adapt to changes in the environment. Drawing on this, the CAS provides explanations as to multi-party behaviours in a pharmaceutical supply network (Mena et al., 2013).	Resilience strategies are developed to mitigate the vulnerabilities within a supply chain, of which complexity is one of it (Petitt et al., 2010Juttner and Maklan, 2011). As such; By providing in-depth analysis of the fact that pharmaceutical supply chains are complex , provides understanding of the nature of the supply chain and how to situate resilience strategies like agility (Surana, et al, 2005; Pathak et al., 2007).
Dynamism	A supply chain is dynamic as it changes itself to adapt to the changes within its environment. For instance it may change its suppliers if the demand from consumers becomes volatile.	CAS theory provides explanation that disruptions and threats within the supply chain occur as a result of the dynamic environment in which they operate. Resilience strategies are dynamic in nature and involve adaptation to both internal and external threats (Tukamuhabwa et al., 2015).
Dimensionality	Modern supply networks, exhibit certain levels of freedom as a result of globalization and outsourcing. This has given room to dimensionality within the supply chain.	Resilience strategies provide the basis for firms within the supply chain to respond to events. The CAS theory has provided insights to dimensionality within the supply chain. Individual firms within the supply chain have freedom to make certain decisions that may affect its performance and the performance of other agents within the system.

Non Linearity	The supply chain and its resilience strategies are non-linear, as small strategic changes or disruptive impact in the upstream sector of the supply chain may have massive effects on the rest of the supply chain (Surana et al., 2005; Mu and Jai, 2013). Nonlinearity in the supply chain can be seen in the case of the bullwhip effect where small disruptive impact on of the agents in the upstream sector can lead to oscillating impact for the whole supply chain.	Resilience strategies have to be non –linear to respond to environmental changes. The non-linear feature of a CAS provides explanations to issues like bullwhip effects. It therefore entails agility and flexibility (Aelker et al., 2013).
Self-Organization and Emergent Behaviour	Since there is no centralized control, each agent controls its activities. The interaction of these activities produces emergent behaviours. In the context of supply chain network, there is no single large firm that controls or organizes the entire supply chain. However, each firm in trying to achieve its goals, control and organizes its activities. The interaction and interconnectedness of these firms produces a collective behaviour – meeting the demand of the consumer.	Resilience strategies are a feature of a supply chain as it entails self-organized processes of different that facilitate adaptation. No single supply chain controls resilience strategies as resilience may differ from firm to firm. However the collective interactions of these firms produce are termed emergent behaviours. Choi et al,2001;Surana et al,2005; Howleg and Pil, 2008; Bellamy et al 2013; Mena et al., 2013; Carter et al., 2015; Sun et al., 2017
Schema	Suppliers, wholesalers, distributors are agents within the supply chain and they operate at different levels. They have different sets of rules guiding them and they all strive to take actions that are most beneficial to them (Choi et al., 2001; Pathak et al., 2007; Kim et al., 2010).	Resilience strategies may be Schemas which will enable firms within the supply chain modify their operations to achieve their goals.

Table 2 above provides tabular representation of the link between CAS features, the pharmaceutical supply chain and resilience strategies. Thus Adaptability, Coevolution, Complexity, Dynamism Dimensionality, emergent behaviours and Schema have been highlighted as traits that can be explored within resilience strategies.

Discussions

The systematic review of literature shows that there are inherent similarities between the concept of resilience strategies and the CAS theory. For instance the theory elucidates adaptability and dynamism as inherent features which provide explanations for the dynamic and adaptable nature of resilience strategies. The CAS theory also explains that PSC's are dynamic, have emergent behaviours complex, adaptive, interconnected as well as possess schemas that regulate their operations. Hence if resilience strategies are to be employed to mitigate disruptive events they need to be harnessed in a manner to fit this particular supply chain. Some implications for adopting the CAS theory include the fact that some of its features such as non-linearity may provide possible predictions of risk, disruptions or policies within a supply chain. Also by employing CAS theory, the unit of analysis should be the supply chain as a system and not individual firms (Tukamuhabwa et al., 2015). This work is innovative as it provides a new insight into the contemporary discourse on resilience strategy creation and deployment, examining the use of this theory in the PSC, and thus provides original contribution.

5. Conclusion

This study employed a systematic review of literature to examine the dimensions of CAS theory and its applicability to resilience strategies within pharmaceutical supply chain. The underlying idea here is that resilience strategies deal with high level of abstractions concerning business environments. As such, businesses can gain competitive advantage from their complex interactions with their environment. The study finds ten elements of the CAS theory where each of them can be employed in understanding various facets of how supply chains operate as well as its applicability to resilience strategies within the pharmaceutical supply chain. The study also finds that there is a dearth in empirical application of this theory and calls for further research into employing it as a theory in resilience strategy studies.

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Disruptions, recovery strategies and the pharmaceutical supply chain; empirical evidence from first tier customers in the united kingdom

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Purpose: The aim of this research therefore is to explore the causes of drug shortages within the pharmaceutical supply chain and assess the adopted mitigation strategies.

Research Approach: The study is carried out from an inductive perspective where we seek to understand the phenomenon by a detailed review of extant literature followed by a series of semi-structured interviews with first tier consumers within a case study framework. The respondents were chosen using purposive sampling as those best to comment on the phenomenon under scrutiny. Data was analysed using thematic analysis, where a dual focus was adopted; 1) the preliminary focus was on the identification of system themes (where the system was impacted and the responds e.g. complexity, disruptions and product alternatives) and 2) the secondary focus was the impact on the patient as system recipient and product user (where themes such as stress, anxiety, and adverse drug reactions emerged).

Findings and Originality: The analysis show that drug shortages within the pharmaceutical supply chain in the UK occur as a result of stringent regulatory frameworks, faults in the manufacturing processes, lack of Active Pharmaceutical Ingredients, monopolistic wholesaler markets; lack of information dissemination, offshore trading and price manipulations for profit. The impact on the consumers is reported to be extensive and can endure long after the disruptive event occurs. The findings indicate that existing recovery strategies are however cumbersome, add complexity to the supply chain and in extreme cases facilitate the infiltration of counterfeits. The study is innovative as it explores disruptive events and associated recovery strategies which have not been adequately addressed in supply chain management studies to date.

Research Impact: This research contributes to existing literature by extending discussions on supply chain disruptions within a dynamic supply chain whilst focusing on product service supply chain recovery strategies and mechanisms.

Practical Impact: This study provides Operations/Supply Chain Managers and Pharmaceutical companies and professionals with strategies that can be adopted can adopt in reducing and recovering in a more resilient manner to disruptive events. This thus presents the bedrock for resilient practice and systems design and development, thus reducing system vulnerability and ultimately leading to improved product availability and patient care.

Introduction

This study examines the causes of drug shortages as a disruptive event in the UK pharmaceutical supply chain. More specifically, the study seeks to explore why the pharmaceutical supply chain are susceptible to drug shortages. This is pertinent because, drug shortages are defined as a supply issue that affects how the pharmacy prepares or dispenses a drug product of influences patients care (Panels, 2015), and has become a global phenomenon which has risen significantly over the last decade (Pauwels et al., 2015). For instance, a survey on drug shortages by European Association of Hospital Pharmacists (2015) revealed that 99% of pharmacists in European hospitals experienced drug shortages in the year under review. Drug shortages is potentially detrimental to the patient as well as members of the supply chains as it can harm treatments, delay medical procedures, and result in medication errors (De Weerdt et al., 2017). This study therefore seeks to contribute to existing supply chain literature by examining the weaknesses that make the supply chain susceptible to drug shortages. This section provides the background to the study; the next section explores concepts related to understanding drug shortages within the supply chain literature, while section three will present the methodological approach. The study concludes in section five with a conclusion and recommendation for best practice.

Literature Review

Supply chain disruptions which are events that disrupt the normal flow of goods and services within a supply chain have been reported to have adverse effects on the financial and operational performance of the firm (Schimdt and Raman, 2012; Urciuoli et al., 2014; Thekdi and Sarvos, 2016). This notwithstanding, the research on this topic has received limited empirical attention (Bode et al. 2011; Simangunsong et al., 2012). It is also purported that existing literature tends to examine disruptive events as homogenous, in spite of the fact that they have varying causes and effects as well different mitigation strategies (DuHadway et al., 2017). Supply chain disruptions can therefore be classified based on the sources of disruptions which could be exogenous or endogenous (Hendricks et al., 2009; Urciouli et al., 2014; Gunasekarean et al. 2015); action of the disruption as intentional or unintentional (Marley et al., 2014); as well as impact of the disruption as dynamic or stable (Saghafian and Van Oyen, 2016).

Similarly, supply chain complexity (Wagner and Bode, 2016), supply chain structure (Craghead et al., 2007), the characteristics of the supply chain (Wagner and Bode, 2009), global sourcing as well as outsourcing (Christopher and Holweg 2011) have been suggested as elements that increase supply chains vulnerabilities to various disturbances (Craighead et al., 2007; Ellis et al., 2011; Chopra and Sodhi 2014) and economic factors such as wage inflation in lower cost countries (Wagner and Neshat 2012). For instance, the Japaneese earthquake and Tsunami in 2011, which disrupted the supply of glycine (an ingredient for solid-dosage products and the gelatine used in soft gel capsules -(Miller 2011))- in some pharmaceutical supply chains exposed these supply chains to various risk as a result of the complex multi-layered supply chain as well as outsourcing.

However, empirical evidence exploring vulnerabilities of the pharmaceutical supply chain is limited. For instance, -Breen (2008) explored the nature and prevalence of risk in the pharmaceutical supply chain and identified 35 risks the supply chain was exposed to. Also, Quadri et al., (2015) explored the causes of antibacterial shortages from 2001 and 2013 in the US, using the Utah database of drug information, they found that a total of 148 drugs were short in supply over a 13 year period. This study however fails to explore why these drug shortages occurred and how they were being tackled. Similarly, Pauwels et al.,(2015), studied the characteristics, effect, causes and management of

drug shortages of hospital pharmacies in Europe and find that drug shortages were caused parallel trading, tendering and manufacturing problems. This study however examined only hospital pharmacists and explored it from a clinical perspective. In view of this, there is need to examine in detail why the pharmaceutical supply chains are susceptible to drug shortage, from an operations management perspective. As such, this study hopes to answer the following questions: Why is the pharmaceutical supply chain exposed to dynamic disruptions like drug shortages? How do pharmaceutical supply chains mitigate the impact of these disruptions?

Research Strategy and Design

The case study approach which is a rigorous and well established research method was chosen as the research strategy (Yin, 2013). The case study was considered appropriate as it presents an avenue for the researcher to investigate a phenomenon in a real life setting as well as suitable for research areas with limited pre-existing theories (Gibbert, et al., 2008).

Data for this study was gathered in two separate stages, where multiple data sources and different data collection methods was employed. The first stage began with a review of literature using the systematic literature review approach, to understand the underlying constructs of supply chain disruption as well as to effectively classify the phenomenon under study. The next stage involved the selection of the case study. The convenience sampling technique was the criteria for selecting the case study. An invitation to participate in the research was circulated and interviewees who positively replied to the invitation were used. Multiple case studies were employed which provided depth as well as breadth to the study (Yin, 2013). The first tier consumers which are pharmacists, were specifically selected for this study , as the study draws upon the definition of drug shortages by Panel(2009)-A supply issue that affects how a pharmacy prepares or dispenses a drug or influences patients care-.' This suggests that the bane of drug shortages rests on pharmacist within the pharmaceutical supply chain.

Prior to the interview, the participants were sent an interview protocol and a leaflet which provided a brief of the research. In line with case study guidelines highlighted by Yin (2013), the first two interviews were conducted on the participants' premises where each interview lasted between 30-45 mins. However whilst analysing these interviews, the need to explore other categories of first tier consumers arose, as such the snowballing technique was employed to access hospital and online pharmacists. As such: the total numbers of participants were two community pharmacists, 1 online pharmacist and two hospital pharmacists. The participants however choose to remain anonymous with regards to the study. The interviews were audio-recorded after receiving consent from the interviewee and then transcribed manually following the 24 hours recommendation as highlighted by (Blackhurst et al., 2011). The transcripts were coded and analysed using a software package called Nvivo.

Analysis of Data

In order to deliver to the study aim, during the interview, participants were asked the following: what is your understanding of drug shortages and why do you think drug shortages occur. The findings are described in accordance with existing literature and matched with excerpts from the transcripts. Table 2 below presents a summary of the analysis of the study.

Table 2 Causes of Drug Shortages

Emerging themes	Definition In Literature	Excerpts from Interviews
Manufacturing Processes	The manufacturing process of a pharmaceutical which is tagged as cumbersome is another highlighted factor that exposes the supply chain to drug shortages. These manufacturing processes may range from the failure of the product to reach the desired quality as stipulated by the regulating bodies, or the lack of raw materials which most times is sourced outside the manufacturing regions.	Hospital Pharm. 1 'A product recall can cause a drug shortage and this can happen for instance if the firm discovers that a batch of drugs that had gone out, did not meet the quality requirements'. Hospital Pharm. 2 'The MHRA regulates the quality of drugs produced for consumption in the United Kingdom for the right grade and the right ingredients, if a firm fails the quality check in the production of raw materials, they will have to reorder it, sometime these raw materials come from different parts of the world which may take weeks to get. These create a backlog in the production processes and hence cause drug shortages'. Community Pharm. 1 'A break down in the manufacturing plant or something as trivial as a change in packaging can upset the whole system. Like with the Glucopen recall where they could not source for the active ingredients'.

Managerial Practices	The managerial practices of the firm also weaken the system which in turn makes it impossible for the system to resist drug shortages when they occur making it vulnerable to various risks (Blackhurst et al, 2011). This is evidenced from the data, For instance, an informant explained that some manufacturers had to adopt the managerial practice of rationing drugs supplied to wholesalers and pharmacists, to curb wholesalers and some pharmacists who sold medicines abroad because they were more profitable. While this strategy was effective for a while, it however leads to drug shortages in the long run (Bogaert et al., 2015).	Community Pharm.2 'We also have incidences of manufacturing firms rationing drugs we buy and supply the drugs based on a quota system. For instance last month we had to fight a manufacturer because our quota for a particular drug was zero and we had two patients on this drug which will cause a shortage. I think manufacturing firms decided to start selling drugs on quota system to curb the incidence of wholesalers or even some community pharmacists who were selling drugs abroad for profit'. Hospital Pharm.1 'Manipulation of the market for profit, like what happened with pain killers-Codeine- a few years back, firms withheld products to create artificial scarcity, because they had forecasted a level of sales which had not been attained, they created artificial scarcity, increased the prices by about a couple of pennies and then re-introduced it back into the market when the agitation was high. Sometimes, artificial scarcity maybe because of the NHS price lists which makes profit margin quite narrows.' Community Pharm.1 'Selling of drugs abroad for profit is one major cause of drug shortages. Some wholesalers and even community pharmacists who have licences to trade, will buy drugs at a cheaper rate from the manufacturers and sell overseas especially within the EU region for profit creating drug scarcity. Sometimes, these wholesalers will have to repurchase these drugs again from overseas as a result of the quota system introduced by the manufacturing firms'. Online Pharm. 1 'A whisper that a drug is going out of circulation may cause panic among pharmacists. Then we order about three months' worth of the drugs, to save for the rainy day. This will cause the drug to become scarce in the market and then the prices will go up. Sometimes we get to sell to other community pharmacists for a gain'.
Supply Chain Characteristics	Supply chain characteristic which depicts buyer supplier relationship includes; supplier dependence and	Community Pharm. 2 'Let's say there is only one supplier that supplies a drug, and the supplier fails a quality check of raw materials, they may not be able to meet up production capacity which will cause

	consumer dependence. Supplier dependence is the degree to which a firm sources its inputs from a single supplier to alternative suppliers (Wagner and Neshat,2012; Peck, 2005).	the drug to become scarce. This happened with the case of Lazoprizole several years back'. Community Pharm.1 'Usually manufacturing firms use historical records of patients and the consumption pattern of a particular drug to determine the quantity it will produce. Sometimes they do not forecast correctly, as the number of consumers may vary depending of change in lifestyle. Take for instance anti-depressant drugs'.
Supplier Selection	Supplier selection refers to the process of selecting a supplier based on price negotiation and the ability to share in supply and demand risk (Chopra and Meindl, 2007).	Hospital Pharm. 1 'Sometimes it may not necessarily be a drug shortage as it may be the hospital management board's decision not to stock it on its formulary. For instance, I had a patient who came in yesterday and is taking lycionpril and hydrochrothyzine combination, we did not have it at the hospital, it was a local level decision not to stock the product'.
Supply Chain Design /Structure	The structure of the supply chain deals with the design of the chain, which can either be centralized or decentralized (Yang et al.,2015)	Online Pharm. 1 'I think the way the supply chain in the pharmaceutical industry is designed makes it difficult to access drugs. I feel smaller firms are penny pinching as they really do not make any profits. What really is is that we have the manufacturers and three major wholesalers who own and control the biggest retail stores/community pharmacies. Although there are short liners (small wholesalers), they sell basically generic drugs. When a drug is in short supply at the retail level, the big retailers simply meet their wholesalers or the multiple company for while small retailers have to get the drugs at a more expensive rate.'
Lack of Information sharing	Information sharing is necessary for integrating a supply chain (SC). To achieve efficiency, members in a supply chain are expected to collaborate in managing material, information and financial flow(Bian et al., 2016;Riley et al.,2016)	Community Pharm. 1 'In most cases, the manufacturing firms do not give reasons why we can't have a drug. You may call them to find out but you really can't get any information from them. Sometimes this information is required so we can explain to the patient better on why their drugs are unavailable. Also the firm should forewarn us in advance so we can be proactive because whispers may just lead to more shortages.' Community Pharm. 2

		'Your relationship in the market place is vital as lack of relationship will limit your information, increase the amount of shortages as well as lead to huge losses.'

4.2 Response of Drug Shortages to the Pharmaceutical Supply Chain

The study also asked how the firms managed drug shortages. The responses show that drug shortages have adverse effect on the supply chain as well on the patients. For instance, the study shows that trust between members of the supply chain are eroded when drug shortages occur. Sometimes this severance in trust may be between the patient and the pharmacists, the pharmacists and the wholesaler or even the manufacturer.

Table 3 Impact of Drug Shortages on the Pharmaceutical Supply Chain

Impact within the PSC	Excerpts from Transcript
Eroded Trust This is consistent with extant studies arguing that, under high trust conditions, the proclivity of economic actors to be opportunistic decreases, whereas under low trust conditions economic actors are more likely to behave opportunistically.	Community Pharm.1 'Sometimes when we receive a whisper that a drug is going out of circulation may cause panic among pharmacists. Then we order about three months' worth of the drugs, to save for the rainy day. This will cause the drug to become scarce in the market and then the prices will go up. Sometimes we get to sell to other community pharmacists for a gain'. 'If we decide to offer alternatives to the patients, some of them react psychologically'. I had a patient who had tried every form of anti-depressant and she reacted to them in various ways. Then she came to the pharmacy one day to pick up her drugs-the only combination that worked for her and I had to inform her that her drugs were unavailable. She actually went into a fit; I spent the best part of that day trying to reassure her that her drugs will be with her soon. Calling the GP to re prescribe an alternative was also a hassle'
Exposure to Risk (Financial, Security, Counterfeiting)	Community Pharm. 1 'When a patient comes to collect his prescription and its unavailable, after we have tried our possible best to get more stock and we can't seem to be making a headway, we ask the patient to go out and look for the drug'

	Community Pharm. 2 'Although we have never seen a counterfeit in our pharmacy, I have had a patient who went overseas on holiday and could not travel with his regularly drug. When he got back he had purchased a drug and asked me to confirm its authenticity'
Supply Chain Complexity	Community Pharm. 2 'Delay in patient's treatment occurs when we the pharmacist will have to call the receptionist to inform the GP that the prescribed medicines are unavailable. The GP has to go through the patient's medical history to understand the medical situation, before re prescribing an alternative. This process may take a couple of hours or even days and we as community pharmacists have no power to prescribe alternatives'.

Another effect of drug shortages is that the patients are also exposed to safety risks and financial risk as the patient may seek for alternative drugs outside the supply chain. Also, by seeking alternatives outside the supply chain, patients may knowingly or unknowingly purchase counterfeits. Consistent use of the alternative drug may also affect forecast of the alternatives and lead to the shortage of the alternative drug as well. Drug shortages can also delay patient's treatments as the source for appropriate alternatives continues which can lead to adverse drug reaction and complications. Sometimes, patients may react to drug shortages psychologically which may lead to several complications. The pharmacists are also stressed from having to explain to the patients the need for an alternative as well as seeking for the alternative. The need to call the GP to re-prescribe further complicates the supply chain and lengthens patients' delivery processes.

The findings also reported that mitigation strategies employed by pharmacists were the use of alternatives and sometimes stock piling if notification of a shortage was provided in a timely fashion. The use of alternative however is cumbersome as there is the need to understand the patients profile in order to come up with suitable alternative. The respondents felt that at times the medicines 'matching' process can fail, leading to a failure in the system. This implies that when a whisper is acted upon and it is not necessarily true, firms may not trust the information and resent the operational rework that they have had to undertake. Similarly, if firms get to know the reason for the drug shortage, like unethical hoarding of a product or parallel trading, trust is destroyed.

Conclusion

The aim of this research was to examine why drug shortages occurred within the pharmaceutical supply chain as well as assess the adopted mitigation strategies. The study was carried out from an inductive perspective where semi-structured interviews with first tier consumers within a case study framework was carried and analysed using

thematic analysis. The findings show that the pharmaceutical supply chain in the UK is vulnerable to drug shortages as a result of managerial practices, manufacturing processes, supply chain characteristics, supplier selection and lack of information sharing. The study also finds that these vulnerabilities expose the supply chain to financial, operational and safety risks. Similarly, the supply chain becomes more complex as a result of the adopted mitigation strategies and in some cases creates drug shortages in alternative supply chains.

Further areas for research should seek to understand these mitigation strategies and identify resilient strategies that will minimize the supply chains systems response negatively.

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REVERSE LOGISTICS PRACTICES IN THE NIGERIAN PHARMACEUTICAL SECTOR

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Introduction

Reverse logistics (RL) has received increased attention in recent years due to sustainability and circular economy implications of value recapture and end-of-life product disposition. Many companies have begun investing in this aspect of their supply chain operations (Rogers & Tibben-Lembke, 1998) and have realized both economic and ecological dividends via lower production cost, solid waste management costs and environmental impact of landfill (Berkowitz et al., 2000). RL of pharmaceuticals products predominantly involve the destruction and proper disposition of unusable drugs (Kabir, 2013). Pharmaceutical reverse logistics (PRL) operations therefore differs from that of other industries due to the nature of pharmaceutical products from industrial, regulatory requirement, and societal impact perspectives. Furthermore, PRL is important from business sustainability perspective (Kabir, 2013). However, knowledge of PRL practices in the Nigeria pharmaceutical industry (NPI) is arguably non-existent. This knowledge gap coupled with the hazardous threats of having expired, damaged, defective (EDD) and counterfeit drugs in circulation form the basis of the exploratory study presented in this paper.

Literature Review

The systematic literature review (SLR) for this paper considered empirical studies on PRL practices with a specific focus on the NPI. The themes used for this review were Supply Chain Management, logistics, RL framework, the pharmaceutical industry, and NPI. The SLR utilised the three-stage approach delineated by Trandfield et al. (2003) and the four-stage database interrogation process developed by Delbufalo (2012) to delineate 428 journal articles. The SLR showed a gradual increase in theory usage in RL research, but a majority still lack good theoretical underpinning. Most RL articles are practitioner-oriented and in practitioner-related journals, rather than academic journals (Dowlatshahi, 2000). Thirty percent of the articles employed mixed-method approaches while 50% of the journal papers employed qualitative methods, which indicates increasing acceptance of qualitative research method in logistics research. Although the dominance of quantitative methods is not evident in SLR, quantitative research methods are still the most dominant method used in logistics research (Näslund, 2002; Sachan & Datta, 2005). The SLR showed that a general increase in RL research is not geographically widespread and is still relatively low in the pharmaceutical context. Nineteen important articles resulted from filtering, albeit only 12 specifically addressed issues in PRL.

Teunter et al. (2003) conducted an in-depth case study of RL in the pharmaceutical production of a German pharmaceutical company however they excluded RL processes in other key aspects of the pharmaceutical supply chain (PSC) such inventory management of finished products, physical distribution between channel partners. Kumar et al. (2009) conducted USA based research on RL process control measures for the PSC industry and used the Define, Measure, Analyse, Improve and Control (DMAIC) process for improvement of RL. Khan and Subzwari (2009) conducted research on RL in Pakistan's pharmaceutical sector and proposed a model to affirm the positive correlation of RL to regulatory and customer service, counterfeit control, distribution system, and modern IT.

Although the outcome of this study addresses PRL, the empirical findings are not based on the social, economic and infrastructural experience in the NPI.

Ngwuluka et al.'s (2011) assessment of pharmaceutical waste management in some NPI revealed poor performance in terms of waste management. The findings, however, lack empirical evidence of PRL practices as waste management differs from RL. USA based research, conducted by Hejrani and Ko (2013) focused on the RL network model for efficient medical waste management and proposed an innovative way to model an RL network for medical waste management. Kabir (2013) focused on RL research relating to issues faced by pharmaceutical organisations and contributed a general perspective of drivers for RL in the pharmaceutical industry. However, it failed to consider country-specific factors that differentiate or can potentially shape pharmaceutical industries in developing countries.

An empirical study conducted by Singh et al. (2013) focused on the RL process, characteristics of the medical waste recovery activities, features of RL, and IT implementation in the RL process, and proposed a strategic framework named the 5R Optimum Model (Reduce, Recycle, Reinforce, Report and Regulate) for PRL activity. The primary focus is the condition of pharmaceutical recovery in India but it provides a useful typology for consideration in NPI. Narayana et al.'s (2014) analysis of the prevalent issues and complex interaction of factors affecting RL process in Indian PSC using a systems thinking approach and modelling methods. Their study however is also limited to the Indian pharmaceutical industry and restricted by the paucity of empirical data at a national level and lack participation from certain stakeholders.

Xie and Breen (2014) looked at bridging the gaps in the PRL in community pharmacy in the UK National Health Service (NHS) by benchmarking against battery RL systems. The research found that the return rate for battery waste and level of stakeholder engagement in battery RL is much greater than those in the waste medicine RL. Oko and Nkamnebe's (2013) research on RL management and the drive for environmental sustainability in Nigeria generated valuable data on the operation of companies in the Nigerian food beverage industries. Their research found these companies are technologically biased in area of product quality for enhanced corporate efficiency and shareholders' welfare at the expense of RL programmes and health standards for the general public.

Somuyiwa and Adebayo (2014) evaluated the effect of RL objectives on economic performance of a selected group of food and beverage companies in Lagos, Nigeria. Despite the difference between the pharmaceutical and food and beverage industry the research findings are applicable to the NPI. The examination of RL practices in pharmaceutical manufacturing industry in Ghana by Kwateng et al. (2014) is the closest academic research to this study but limited to manufacturers' perspectives.

The advent of Nigerian pharmaceutical industry (NPI) began with some multinational companies having sales outlets in Nigeria purely to meet local pharmaceutical needs. The Pharmaceutical Manufacturing Group of the Manufacturers' Association of Nigeria (PMGMAN) estimated in 2009 that the size of the NPI to be in excess of US $2 billion annually; prescription and ethical pharmaceuticals contribute about US $500 million; over the counter (OTC) pharmaceuticals account for about US $900 million; biological products such as vaccines, insulin, interferon etc. account for about US $100 million, while related healthcare and lifestyle products account for about US $500 million (Wambebe & Ochekpe, 2011). According to the Pharmacists Council of Nigeria (PCN), The industry comprises about 128 registered pharmaceutical manufacturers (PM), 724 drug distributors, 1,534 pharmaceutical retailers (PR), and 300 pharmaceutical importers (PI) (Wambebe & Ochekpe, 2011).

Based on the SLR of this study and the foregoing discussion of 12 key articles, several RL issues have been addressed in literature but none specifically address RL practices in the NPI. There is a dearth of work that tackled RL frameworks in the pharmaceutical context. It is the aim of this paper to fill this gap by using the seven perspective framework to develop an empirically informed and theoretically informed knowledge of PRL practices in Nigeria, and develop recommendations that can facilitate best practices.

RL encompasses all logistics activities, but the difference lies in the direction of the activities. Essentially, RL deals with how products are efficiently retrieved from the point of consumption and transported back to the point of origin (Setaputra & Mukhopadhyay, 2010). RL provides strategic cost savings contrary to the traditional quick-fix cost-savings methods (Dowlatshahi, 2000).

De Brito and Dekker (2003) argued that the best approach to understand RL, its fundamentals content, their interaction is to structurally analyse the phenomenon from five essential perspectives: why (receiver), why (sender), how, what and who. Xie and Breen (2014) extended the framework by adding the where perspective. This framework provides a structure for understanding issues related RL and visibility of the vast assortment of matters involved (De Brito & Dekker, 2003), and further allows us to address shortcomings in articles reviewed in the literature, particularly in relation to the NPI. Therefore, based on the identified literature gaps, we formulated the following five research questions (RQs) to develop an empirically informed and theoretically grounded insight of RL practices in the NPI private sector, and both the framework and RQs are in Figure 1.

RQ 1: What are the characteristics of PRL practices in Nigeria?

RQ 2: What are the similarities and difference in PRL practices of PSC stakeholders?

RQ 3: How does this similarities and difference influences PRL operations?

RQ 4: What are the facilitators, drivers, and inhibiting factors of PRL practices in Nigeria?

RQ 5: Are there improvement opportunities envisaged? If yes, what are they?

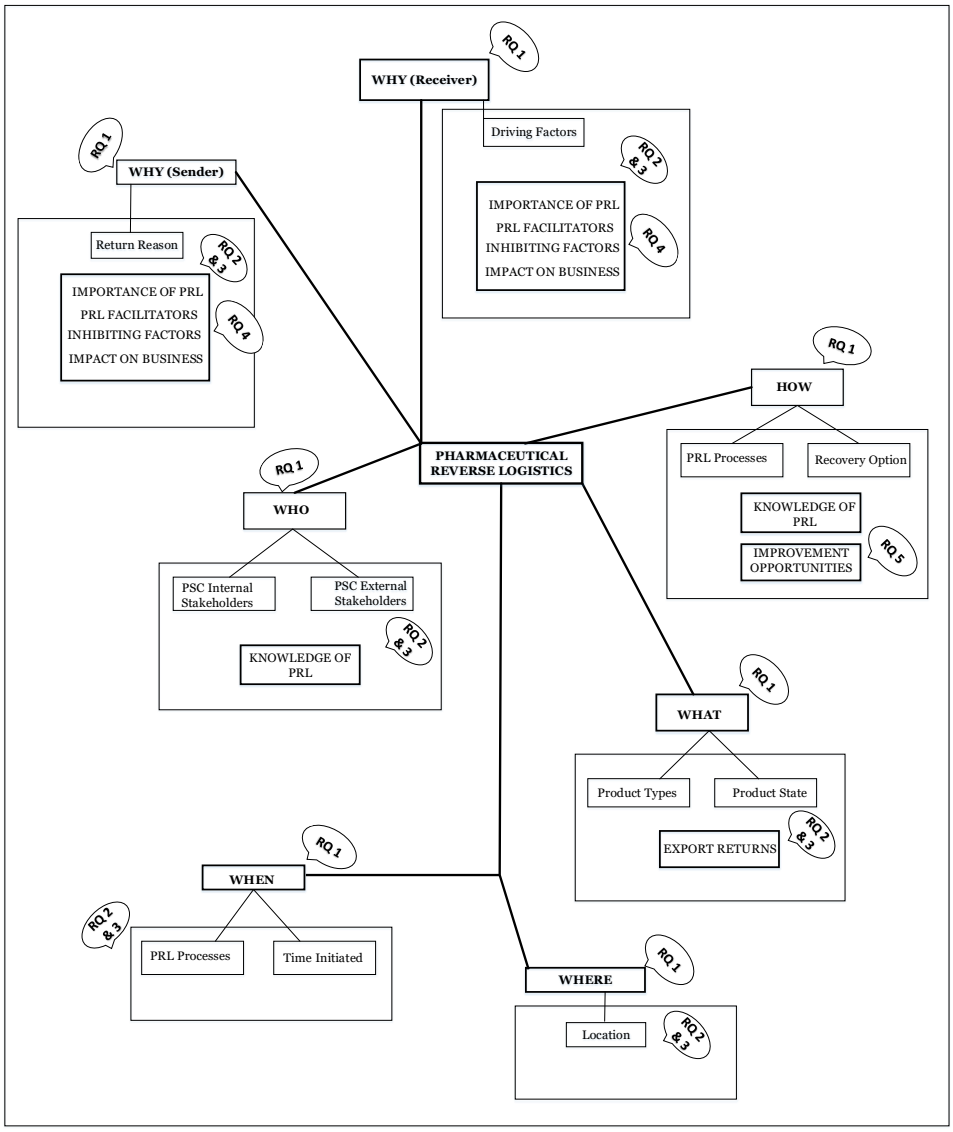


Figure 1: Conceptual framework for understanding PRL

Methodology

Multiple case research augment external validity and help guard against observer's bias (Voss et al., 2002). The empirical study therefore adopted a multiple case study method involving 21 semi-structured interviews (face-to-face and telephone) across 19 different PSC practitioner companies to address the five RQs guided by our adapted six perspectives framework. The data collection instrument was pilot tested before proceeding with the semi-structured interviews. We transcribed, reviewed and loaded into NVivo 10 software the empirical data to initiate the three-phase coding process. Phase one (open coding) generated a detailed write-up and presentation of the 19 cases as delineated by the conceptual framework. Phase two (axial coding) established preliminary connections among the cases by identifying similarities and differences which resulted in the conceptualisation of the empirical findings per PSC stakeholder type (category). Phase three (selective coding) identified similarities and differences among the six PSC stakeholder types (categories) and integrated the empirical findings into a cohesive whole.

Findings

Empirical evidence from the study showed that PSC activities have been in existence in Nigeria since the 1940s. EDD drugs are not like any other product that may be repairable and/or reusable so they are simply return to the supplier or disposed. Irrespective of the source of drugs in circulation, reverse movement of EDD drugs is restricted within the geographical boundary of Nigeria as exporting them from Nigeria is prohibited by law (Ngwuluka et al., 2011). Thus, PRL practices have been in existence in Nigeria since the 1940s, although the practice in Nigeria is at a lower level of sophistication and organisation when compared to best practices in developed countries. These disparities can be attributed to the low level of interest and commitment towards PRL; and the state of socio-economic development in Nigeria. The key empirical findings of this study are therefore presented below as delineated by the adopted conceptual framework.

The “what” perspective

Empirical findings revealed that product entering the PRL network are prescription and OTC drugs. The drugs are mostly in the following condition: untampered, short-dated, expired, damaged (packaging material), defect, left-overs, and counterfeit drugs. The condition of these drugs strongly effect the recovery process employed by PCs. This is consistent to De Brito and Dekker’s (2003) point that recovery options are influenced by how product deteriorated: Intrinsic, Homogeneity, and Economic deterioration.

The “why” perspective of the receiver

PCs (receivers) engage in PRL practice for multiple interrelated strategic reasons, such as economic reasons, corporate citizenship purposes, corporate social responsibility and sustainability objectives. PCs engage in PRL in order to free-up shelf space for saleable products, facilitate pro-active removal of EDD drugs from inventory to mitigate the risk of dispensing them, which ultimately increases customer satisfaction, trust and confidence in the pharmaceutical services; to mitigate wastage and democratise consumption; To capture valuable information from consumers, such as the level of acceptability of the drug and perceptions for product quality improvement.

PCs also engage in PRL in order to adhere to contractual obligations and professional ethics; maintain brand integrity and corporate reputation; prevent loss and facilitate proper recovery processes. PRL practices, however, increase the complexity of logistics activities and operational costs for managing returned drugs. PRL operation also delay and reduces profit in the short-term due to the cost of implementation. Empirical findings, however, show no compelling evidence of legislation influencing PRL operations in Nigeria. This can be attributed to inadequate regulatory policy, knowledge of regulatory guidelines and enforcement.

The “why” perspective of the sender

Drugs are generally returned or discarded by senders because they have expired, short-dated, wrongly ordered, and/or no longer needed. The type of reasons senders return drugs into the PRL network can be categorised according to their hierarchy in the PSC network. Distribution returns, such as product recall, B2B commercial return; stock adjustment returns; customer returns, such as B2C commercial return, warranty returns, end-of-use and end-of-life returns. There other type of returns, namely manufacturing returns, service returns, end-of-use returns, and functional returns. These type of returns are out of scope for this study as the first is initiated during the production

phase, the second does not exist as drugs cannot be repaired or refurbished, the third largely involves medical devices but sometime includes left-over drugs, the fourth involves products whose inherent function makes them go forwards and backwards in the chain, e.g. distribution carriers and packaging.

The “who” perspective

Key actors responsible for PRL operations comprises of internal and external PSC stakeholders. Internal players such as the management team, supply chain team, inventory controller, customer service team, warehouse team, quality team, finance team, sales representative, end-customers, quality team, warehouse team, logistics team, internal auditors, warehouse staff, store staff, store managers, store pharmacist, procurement staff, and sales staffs. External stakeholders basically include all PSC stakeholders such as PMs, distributors (pre-wholesalers), PIs, PWs, PRs, HBPs, end-consumers, retail outlets, satellite pharmacies, the Oshodi Medical Store, courier companies, transport service providers, the RA (NAFDAC, ACPN), and the waste disposal agency.

The “where” perspective

PRL players are located internally and externally. The PSC stakeholder’s facilities constitute the physical network structure where the actors are located. The PSC stakeholders investigated offer collection point for customer returns, and processing of returned drugs, and on-stock EDD drugs. Essentially, the physical network structure where PRL activities take place are the retail outlets, pharmacy main store, satellite pharmacies, transport/courier collection points, distribution centre, central Warehouse, waste disposal agencies’ facilities, RA’s collection facilities, and dump sites.

The “when” perspective

This perspective generates novel insight on PRL practices from the standpoint of time, and frequency of when key RL activities are initiated in the PRL network. Empirical findings showed that end-consumers typically return unwanted drugs back to suppliers within 24 hours of purchase for exchange or refund purposes. B2B customers return drugs back to suppliers based on return contractual agreement (RCA). There are scheduled and periodic exchange as well as forward and reverse movement of drugs between B2B channel partners depending the RL policy, RCA, and Service agreements in place. Intra-company forward and reverse movement of drugs takes place on a weekly, monthly, and quarterly basis depending on the PRL strategy employed. The combination of the situational, scheduled and periodic reverse movement of drugs within PCs and between channel partners generates insight on PRL practices from the “when” perspective of PRL.

The “how” perspective

Triangulated empirical findings confirmed six different PRL process flows; each process flow provides PSC stakeholders-specific insight on how PRL operations are carried out by the PCs investigated. Common to each of the six PRL process flows, seven key PRL activities (Returning, Collection, Gatekeeping and Inspection, Transportation and Transhipment, Warehousing, Sorting, Recovery) were identified and were consistent to extant RL literature. The six PRL process flows differs due to the type of organisation’s business model, RCA, and take-back policies employed.

Empirical evidence shows that the recovery option employed for handling returned and short-dated drugs is direct recovery (re-sell, re-use, re-distributed) and that for handling EDD drugs is process recovery (disposal). Contrary to extant RL literature, the only process recovery employed by the PCs investigated is disposal (flushed down the drain, buried, incineration, open-air burning, etc.). This can be attributed to chemical nature of drugs, inadequate technical know-how, and infrastructures to execute other process recovery options such as repair, refurbishing, remanufacturing, and recycling.

PRL Facilitators and Improvement Opportunities

Empirical findings revealed that PRL practices in Nigeria are facilitated mainly by the presence of RCA and sales-on-return agreement between channel partners, customer's proof of purchase, PC's liberal product take-back policy adopted and some drug disposal programme organised by the Association of Community Pharmacists of Nigeria (ACPN). Collective commitments of all PSC stakeholders in the industry is required in order to improve PRL operations in Nigeria. Collective commitment in terms of developing effective regulatory policies, strict regulatory enforcement, managerial commitment to excellent customer service especially in issues relating to drug returns, security of drugs in warehouses, transportation and recovery.

PCs should be encouraged to invest in training and re-training programs for staffs on various protocols to observe when managing the flow of drugs. Other improvement opportunities include the adoption of common process and standard by PCs for their PRL operations; investment in information systems to facilitate stock management process, procurement process, return processes, intra and inter-company communications, product traceability and control; investment in geographical expansion, and decentralisation of drug distribution centres to reduce over dependency; investment in public awareness campaign on the social, economic and environmental benefit of PRL practices. The implementation of these improvement measures will go a long way in improving the public health in Nigeria.

Conclusions

PRL is societally important as compromised drugs need to be retrieved from circulation and replaced to maintain drug availability for patients, and compliancy to regulatory requirements. This study provides numerous implications for practitioners in the PSC and PRL network. The study revealed country-specific factors that differentiate or can potentially shape pharmaceutical industries in Nigeria. The six typology of PRL process flows developed in this study can guide managers efficiently on their PRL operations. This study contributes an empirically informed and theoretically grounded understanding of PRL by adapting and operationalising the seven perspectives framework of RL in the Nigerian pharmaceutical context. This study extended the six perspective RL framework to seven perspectives and provided both valuable platforms and starting point for future PRL research.

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Port Management

INVESTING IN PERIPHERAL PORTS: PERCEPTION OF STAKEHOLDERS IN THE INDONESIAN PORT AND MARITIME INDUSTRY

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Abstract

Purpose: This paper presents initial results from one of the critical phases of an ongoing empirical study to explore important factors for a peripheral port to reduce its peripherality by becoming a hub. There is an increasing trend in more transhipment activities in container ports and also a rise of secondary ports for transhipment hubs (Wang and Ng 2011; Wilmsmeier and Monios 2013; Wilmsmeier et al. 2014). Hence, some peripheral ports are upgrading into secondary hub ports. In the literature, the definition of peripheral ports, peripheral port challenges, concentration, deconcentration factors and how it evolved over three decades have been discussed. However, it is still unclear why these peripheral ports are becoming rising secondary hubs. There is a need to define peripherality from the related stakeholders to understand their behaviour in the maritime transport business and their willingness to invest. There is also the need to manage concentration and deconcentration in ports so that more peripheral locations can access global markets, surrounded by uncertainty in international trade nowadays. Therefore, the main purpose of this study is to investigate perception of stakeholders in Indonesian port and maritime industry.

Research Approach: The Indonesian port and maritime industry is chosen as the focus of this empirical study because Indonesia is a developing country with one of the longest coast lines and a significant number of small container ports. It is the third country, after Japan and China, which has the most small ports, served by sub-1,000 TEU vessels (Monios 2017). Furthermore, Indonesian ports are still understudied. Qualitative interviews were conducted with a total of 46 respondents representing 7 types of stakeholders consisting of port operators, shipping lines, cargo owners, logistics companies, central government, local government and funding sources. Interviews were transcribed and analysed using Nvivo 11, qualitative data software. Overall, the ongoing empirical study uses a mixed method approach, hence, a quantitative phase will be conducted hereafter.

Findings and Originality: Findings from the interviews reveal that it is not only government which is concerned with ports in peripheral locations, but also some of the private companies who are willing to open new markets. They are interested in becoming the first movers with the confidence to confront competitors.

Research Impact: This study provides a better understanding on the behaviour of the different stakeholders, including transnational port operators and shipping lines. It also identifies their perception of peripherality and willingness to expand business to more peripheral locations.

Practical Impact: To guide ports in emerging economies in the development of their ports, especially from more peripheral locations, to increase its connectivity and improve economic growth.

Keywords: peripheral ports, peripherality, stakeholders perception, willingness to invest. Introduction

Introduction

There is an increasing trend in more transhipment activities in container ports industry. The function of hub or transhipment activities are known to consolidate cargo. Even though transhipment brings longer transit times and add more costs (Buethe and Kreutzberger 2001; Wilmsmeier and Hoffman 2008), these activities are increasing as demand for container port grows. Increased use of transhipment hubs started during the 1990s (UNESCAP 2007), with world total transhipment volume of containers doubling from 85 million TEU in 2005 (UNESCAP 2007) to 175 million TEU in 2014 and is forecasted to increase as to 320 million TEU by 2020 (Davidson 2014). In addition, there is also a rise of secondary ports for transhipment hubs (Wang and Ng 2011; Wilmsmeier and Monios 2013; Wilmsmeier et al. 2014). Secondary ports are medium sized ports, which are taking the role as 'second- tier regional hubs' as a result of deconcentration of traffic from large main hub ports to ports in more peripheral locations (Hayuth 1981; Monios 2017).

Deconcentration in port traffic can occur because of new port development, carrier selection, global operation strategies, governmental policies, congestion, or lack of space at existing main load centres (Ducruet et al. 2009). Reasons behind why traffic concentrates and deconcentrates are compiled by Ducruet et al. (2009) from literature between 1963 to 2008. He also argued that there is a shift from concentration to deconcentration studies, which is updated in Wiradanti et al (2017). In the literature, the definition of peripheral ports, peripheral port challenges, concentration and deconcentration factors causing ports to agglomerate have been discussed (Hayuth 1981; Notteboom 1997; Slack and Wang 2002; Ducruet et al. 2009; Fraser et al. 2016; Wiradanti et al. 2017). Furthermore, a 'greater rationalisation' is needed for small container ports to upgrade since feeder vessels are cascading in the current challenging global economic condition (Monios 2017). However, it is still unclear why these peripheral ports are becoming rising secondary hubs. There is a need to define peripherality across different stakeholders of maritime transport sector. Their actual perception on peripherality in ports will guide us to understand their behaviour and and their willingness to invest. There is also the need to manage concentration and deconcentration in ports so that more peripheral locations can access global markets, surrounded by uncertainty in international trade nowadays (Wiradanti et al. 2017).

Therefore, the main purpose of this study is to investigate perception of peripherality and investment in peripheral ports, from stakeholders in the Indonesian port and maritime industries. This paper presents initial results from one of the critical phases of an ongoing empirical study to explore important factors for a peripheral port to reduce its peripherality by becoming a hub. The paper is further divided into four sections. First, a literature review on peripheral port challenge, peripheral ports, emerging secondary ports, and concept of willingness to invest. Second, the methodology of the study. Third, the findings and discussion on stakeholders' perception on peripherality and willingness to invest in peripheral ports. Lastly, is the conclusions and agenda for future research.

Literature Review

Peripheral Ports, Emerging Secondary Ports and Peripheral Port Challenge

Peripheral ports are ports in an unfavourable location, either geographically or political/institutionally (Monios and Wilmsmeier 2012). Remoteness leads to low volumes for shipping companies, hence there is an imbalance in cargo flows and increased cost (Dunbar-Nobes 1984). They are small ports, 'desperate' for cargoes and trying to improve their position in the port hierarchy (Hayuth 1981). They are also very much dependent on a large main hub ports to be connected to trade routes (Ducruet 2008). Meanwhile, the term emerging secondary ports is explained by (Monios 2017) as follows.

'…. Able to insert themselves as second-tier regional hubs, between large hub ports and smaller local ports. This role becomes possible because, as container ships on the main routes get larger and container drops at each call increase, hub and spoke and interlining networks become more complex. This process of deconcentration in turn may be expected to lead to concentration at small ports because some will lose traffic to these new second-tier hubs' (Monios 2017, pp.3-4). The concept of 'Peripheral Port Challenge' (PPC) is first mentioned by Hayuth (1981), which describes the story of the container port industry in the United States since the 1970's, caused by the growing smaller ports that are early adopters of containerisation. Evidence of PPC are compiled in Table 1.

Institutional factors and Willingness to Invest

Slack and Wang (2002) argued that the reason behind PPC phenomena in Asia are institutional factors, which is 'the roles of the port authorities and terminal operators and their relationship with the shipping lines' (Slack and Wang 2002, p.164). They argue that institutional factor emerges because of the recent trend in global/international terminal port operations. First, global terminal operators are willing to expand their business in peripheral locations because they identified lower land and labour costs (Hong Kong's case) also better access to market (Shanghai's case) (Wang 1998; Slack and Wang 2002). Hong Kong's economy reached maturity earlier in the 1990s hence hub operators wanted to offset the high cost of land and labour to potential Chinese ports (Wang 1998, 2009). Since they already have business in the large hubs, they try to exploit new opportunities from the peripherals with no intentions to take away cargo from their large hub ports. Second, shipping lines are also putting effort to expand their business by having their own dedicated terminal, with their own standards in facilities and operations as seen in Singapore's case. Congestion, depth of water constraints, diseconomies of scale, distance from shipping lanes as argued in the US and European's case of PPC are considered not applicable to either Hong Kong or Singapore, and only partially relevant in Shanghai (Slack and Wang 2002).

America	**United States**: Large ports such as Port of New York/New Jersey, Seattle, San Francisco are challenged by smaller ports such as Vancouver, Portland, Tacoma which are early adopters of containerisation in the year 1970-1985 (Hayuth 1981).
	North America: Canada's Port of Prince Rupert and Mexico's Port of Manzanillo, are challenging the west coast port of the USA Los Angeles/Long Beach (Baker 2015).
	Latin America and Carribean (LAC): Secondary ports are emerging, such as Kingston challenging Houston and Port Everglades, also expected further transhipment growth (Ducruet and Notteboom 2012; Wilmsmeier et al. 2014; Rodrigue and Ashar 2015).
Europe	**Rhine-Scheldt delta**: PPC are not seen in ports in the Rhine-Scheldt delta. Net shifts or losses from large load centres (e.g. Antwerp-Rotterdam) are insignificant except Zeebrugge and that port concentration in the European container port system stagnated in the 1990s (Notteboom 1997, 2005).
	West Medditerranean: Gioia Tauro, Algeciras and Marsaxlokk are challenging Valencia, Genoa and Barcelona because post-panamax vessels need to decrease diversion distance from the main route. Such as (Notteboom 1997, 2005).
	UK ports: Felixtowe and Southampton has an increasing role as transhipment port, there are also deconcentration in traffic hence Teesport and Liverpool are becoming emerging as secondary transhipment port for northern UK (Wilmsmeier and Monios 2013).
	Eastern Medditerranean: More hub ports are emerging with a tight competition between Turkish ports, Greek ports Piraeus and Thessaloniki, Bulgaria's port of Varna, Romania's port of Costanza, because of its strategic location between Europe and Asia (Lowry 2011, 2012).
Asia	**Hong Kong**: Shenzhen ports has a cost advantage compared to Hong Kong such as significantly lower land costs and labour rates. The main players developing in Shenzhen are the same companies operating in Hong Kong (Wang 1998; Slack and Wang 2002).
	Singapore: Although having operational efficiency, Singapore is challenged by Tanjung Pelepas because they refused to give dedicated berths to the world's largest shipping line, Maersk SeaLand. Hence they build and operate their own terminals in Tanjung Pelepas, also followed by Taiwan's shipping line, Evergreen (Slack and Wang 2002).
	Shanghai: Port of Ningbo is challenging Shanghai with better maritime access, connections to interior markets and rail access (Wang 1998; Slack and Wang 2002).
	Chinese ports: The declining concentration of Ports in China in the last 30 years (Wang and Ng 2011; Wang et al. 2012; Wang and Cullinane 2014; Li et al. 2015). Chinese ports are also challenging other East Asian ports such as Singapore, South Korea and Japan (Lee and Rodrigue 2006; Lee and Kim 2009; Wang 2009; Tongzon and Yang 2016).

Source: Author

Table 1: Evidence of Peripheral Port Challenge

Besides the aforementioned institutional factors, it is still open to question why port operators are willing to invest in more peripheral locations. Studies on 'willingness' can be found in various fields such as willingness to pay in economics (Hanemann 1991; Jason F. Shogren 1994), willingness to change in public policy (Metselaar 1997; Tummers et al. 2012), willingness to invest in rural locations (Van de Walle 2002), willingness to pay in environmental studies (Nomura and Akai 2004; Hansla et al. 2008) and in health studies (Krupnick et al. 2002; Shiroiwa et al. 2010). More specifically in port studies, the willingness of shipping lines to make a port of call is explained in the case of Montreal and New York by Guy and Urli (2006). Hence, it is interesting to investigate how all port stakeholders are willing to invest in peripheral ports especially in Eastern Indonesia.

Methodology

The Indonesian port and maritime industries were chosen as the focus of the empirical study because Indonesia is a developing country with one of the longest coast lines and a significant number of small

container ports. It is the third country after Japan and China which has the most small ports, served by sub-1,000 TEU vessels, according to dataset in November 2014 by Monios (2017). Furthermore, Indonesian ports are still understudied. Qualitative interviews were conducted with a total of 46 respondents which represents 7 types of stakeholders. The nature of stakeholders in ports and maritime transport has different or even conflicting interests (De Langen 2007). De Langen (2007) identified port stakeholders into 8 main categories by their interest and influence. However, to fit with the port and maritime industry in Indonesia and their roles related to peripheral port development, therefore their categorisation is adjusted as shown in the following Table 2.

Stakeholders in De Langen (2007)	Adjustments for Stakeholders in this study
Port labour	Port Operators, either domestic and transnational companies.
Transport firms	It is splitted into Shipping Lines, which transports in the sea, and Logistics Companies, which transports inland, both domestic and transnational.
Local port related manufacturing industries	Merged into Cargo Owners who is the user of port service.
End users of ports	
Local environmental groups	Not prioritised in this study context.
Local residents,	Merged into Local Government.
Local and regional government	
National government	Central Government.
	Funding Source as additional stakeholder who has access to financing development projects.

Source: Author

Table 2: Determining main stakeholders in the study

Interviews were chosen as the initial data collection technique since behaviour and experience of the stakeholders can be captured better through interviews (Silverman 2010, p.124). Semi-structured interviews were used because they provide the chance to explore and 'probe' answers from participants (Saunders et al. 2007, p.315) and to follow up the participant's answer (Bryman and Bell 2003, p.343). During the interview process a list of question was used as a protocol. Respondents were all given the set of questions, which were introduction, main questions and a confirmatory question whether they are willing to invest in peripheral ports. The questions are listed in Table 3 as follows. Interview results were transcribed and analysed using Nvivo 11 qualitative data software. The interview respondents are chosen by purposive sampling, which is through the author's professional network and their profile is described in Table 4. Overall, the ongoing empirical study uses a mixed method approach hence a quantitative phase will be conducted hereafter.

Introduction • Which company or government institution do you work in and its main service/production? • What are your role and how long have you been working? **Part-1 Peripherality** 1. Are you familiar with the term peripheral / peripherality? 2. What does the term peripherality mean to you? 3. How important do you think peripheral locations are? 4. How far a location is considered peripheral? e.g. feeder services / pioneer services, product sales or production, or projects in the government 5. Is your business related with peripheral location? 6. Are there plans to expand your business in more peripheral locations? Why?	**Part-2 Peripheral Ports** 1. What are criteria of peripheral ports? 2. Are ports in peripheral locations important for your business/projects? Why? 3. What are potential / benefits of peripheral ports (as hubs) for your business/projects? 4. What are the criteria for a potential peripheral port to become hub? 5. How do you measure growth in the peripheral? **Part-3 Willingness to Invest** 1. Who are the main stakeholders in peripheral port development? 2. Are you willing to invest in peripheral ports? 3. What are the critical facilities that should be developed for ports in peripheral locations?

Source: Author

Table 3: Interview Protocol

Stakeholder	Company/Institution	Respondents	% of Transnational Companies
Port Operator	8	8	50 %
Shipping Lines	7	8	50 %
Cargo Owner	8	8	50 %
Logistics Companies	4	4	50 %
Central Government	6	9	n.a
Local Government	4	4	n.a
Funding Sources	4	5	80 %
Total	**41**	**46**	

Source: Author

Table 4: Background information of interview respondents

Findings and Discussion

Perception on Peripherality

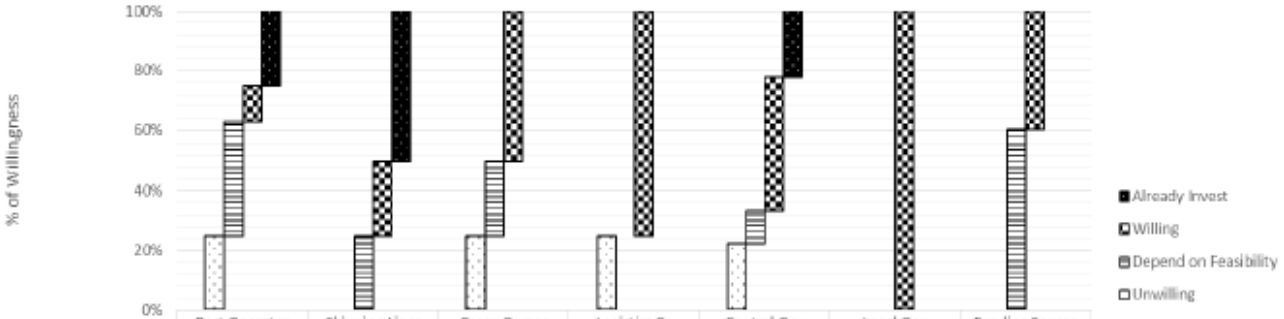
Respondents has a range of perception on peripherality including differences in the terms used. Besides peripheral location as remote, peripheral ports are perceived as lacking facilities and infrastructure, having insufficient cargo volume and industry, no or less connectivity and direct call, hub dependence, high cost, having imbalanced cargo and not in government focus. This is in line with the existing literature. Most of the international shipping lines perceived it as 'outport', or ports outside the main hub. The government are trying to develop more peripheral locations, however, it seems that they have less priority on building the port hierarchy. The government has chosen Kuala Tanjung (North Sumatera) and Bitung (North Sulawesi) to become Indonesia's main hub which in reality it is not working to attract shipping lines. However, still the eastern part is much dependent on Tanjung Priok (Jakarta) and Surabaya, which is on the eastern tip of East Java.

Most of the respondents believe that shifting the main hub for Eastern Indonesia from Surabaya to more Eastern ports like Makassar, Bitung and Sorong would be difficult since the trade volumes are small. They believe that these Eastern ports should increase cargo volume, by boosting large scale industry or natural produce cargo worth export in order to attract larger shipping lines. Transnational shipping lines also cooperate with domestic shipping to consolidate more cargo, hence, they can have efficient operations with their larger ships. More domestic shipping is now expanding their business to the Eastern region. Hence Eastern ports should follow the path of Hong Kong which emphasizes on centrality and gateway functions first, instead of Singapore's intermediacy and hub functions without significant domestic cargo (Lee and Ducruet 2009).

Importance of Peripheral Ports and Stakeholder Willingness to Invest

Respondents's willingness to invest was identified from their wordings, expression and actions. They are devided into four levels which are *unwilling, depend on feasibility, willing and already invest*. Willing here is defined as planning to, however, not yet implemented in operations or having MOU. They can either be willing to upgrade port facilities, shift from existing main hubs, add more shipping routes more ships for these locations or add new facilities such as warehouses and distribution agents. Meanwhile, they are considered *'already invest'* if there are real actions or operations that is implemented. Overall, stakeholder willingness can be seen in Figure 1. Respondents more willing to invest are shipping lines (especially domestic shipping), domestic port, and the central government. Respondents who heavily relies on feasibility are cargo owner, logistics companies and funding sources because they follow government plans and shipping lines' business expansion. Lastly, respondents not willing are transnational port operators and cargo owners.

The main reason for their willingness is because they perceive peripheral locations as having potential cargo which needs to open its access. Central government and state owned companies who perceive this are obliged to reduce economic inequality. Shipping lines also have emerging CSR programmes to provide services to these small-attractive locations and to benefit from first mover advantage. On the other hand, four main reason why particular respondents are not willing are as follows. First, they believe these locations are not important for their business and will not bring any benefit. Transnational port operators still seek for central-major cities in Indonesia such as Tanjung Priok and Surabaya. Second, they expect the government to provide basic facilities and infrastructure and they just want to operate there. Third, cargo owners have difficulty in shifting or opening new manufacturing facilities since it is difficult to manage their supply chains from peripheral locations. Lastly, difficult human resources.



	Port Operator	Shipping Lines	Cargo Owner	Logistics Co	Central Gov	Local Gov	Funding Source
Already Invest	2	4	0	0	2	0	0
Willing	1	2	4	3	4	4	2
Depend on Feasibility	3	2	2	0	1	0	3
Unwilling	2	0	2	1	2	0	0

Stakeholder Type

Source: Author

Figure 1: Stakeholder Willingness to Invest in Peripheral Ports

Different reasons for willingness might appear because each stakeholder have different goals and different financial conditions. It is realised that a company's background, whether they are domestic or transnational, influenced their stance on willingness to invest. Transnational port operators perceived as risky because building ports anywhere requires the same capital and in fixed location, so they are more interested with locations that are already has a hub reputation. However, it is not that different in shipping companies because both domestic and transnational shipping has the ability to change its route if not profitable. There is always a debate on 'chicken and egg', which should start first whether government or private sector. However, from this study it is seen that domestic and some transnational port and shipping companies are starting to expand in peripheral locations. Local government do not have much power to start an initiative. Furthermore, this case of Indonesia differs from Hong Kong's case where global terminal operators are willing because they seek cheaper land and labour costs (Wang 1998; Slack and Wang 2002).

Conclusion

Findings from interviews reveal that it is not only government which is concerned with ports in peripheral locations, but also private companies who are willing to open up new markets. They are interested in becoming the first movers with the confidence to confront competitors. Future research that needs to be explored is how to accommodate each stakeholders' motive, what incentives should be given for each stakeholder, and to be able to manage concentration and deconcentration. In addition since this is a qualitative study, reliability and validity are an important aspect to ensure trustworthiness, rigor and quality (Golafshani 2003). It can be achieved by eliminating bias and increasing truthfulness of a proposition with triangulation, which is combining different ways of looking at the issue (Denzin 1978 in Golafshani 2003; Silverman 2010, p.276-278). Therefore, triangulation will be conducted in the next phase using survey questionnaires to more stakeholders.

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Rail Freight

How helpful are the Network Rail proposed changes to charges and contractual incentives in PR18 to securing a modal freight from road to rail?

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Abstract:

Objective: The objective of this paper is to conduct a constructive criticism and offer recommendations on the proposed 2018 Periodic Review (PR18) of Network Rail.

Methodology: A qualitative research methodology was applied in order to achieve the objective.

Findings: The present model of governance and regulation by the Office of Rail and Road (ORR) in road and rail transport is complex and far removed from the commercial realities of a competitive freight transport environment. Road freight operators are not required to apply for access to the network, for example for time slots in peak or non-peak hours, to undertake commercial operations once an annual fee (in the form of a road tax) has been paid. Rail, by comparison, is governed by a charging regime for every active movement of mile made on the system.

Conclusion: To level the playing field, it is proposed that charges for road space/road miles operated (which could be set according to vehicle weight and operational hours) should be introduced as advances in technology now makes this feasible.

Introduction

The objective of this paper is to conduct a constructive criticism and offer recommendations on the proposed 2018 Periodic Review (PR18) of Network Rail (NR), covering the Office of Rail and Road (ORR)'s latest consultation on rail freight charges and contractual obligations that were published in December 2016. The focus of this paper is on rail freight transport where the Department for Transport (DfT) recently assessed the 'Future Potential for Modal Shift in the UK Rail Freight Market' in line with the EU Transport White Paper 2011(European Commission, 2011). Rail freight in Britain operates in a highly regulated environment. It is operated by private sector companies (FOCs) on railway infrastructure now effectively back in public ownership after a period as a semi-autonomous entity. To operate freight train services on the network, aspirant entrants are required to demonstrate adequate financial resources together with technical, operational and managerial expertise. These may appear significant barriers to new entry when comparing the competing and dominating road freight sector which is characterised by much lower entry and exit thresholds.

Rail freight also operates in a highly competitive domestic freight arena. It had previously been a dominant player in the movement of a variety of freight but for several decades has lost market share, however defined, to more competent, responsive, agile and available road based competition. Increasingly rail adopted a market stance built around the movement of bulky low value commodities over longer transport hauls. However, over the decades, the market has seen a significant change in cargo type towards low density high value goods (LDHV) being transported in containers or pallets. Furthermore there has been a relocation of manufacturing industries to the Far East. Another important change is the online shopping habits of customers which has resulted in an increased demand for prompt or next day delivery . Rail failed to capture any significant presence in these specific market segments. To compound the situation there was a gradual contraction of the railway network during the 1960-1980's resulting in reduced connectivity to urban areas and the growing numbers of out of town shopping malls. There was, as a result, little alternative than to use road transport. Rail was in fact confronted with a position where it was holding a declining share of a growing market for high value time sensitive traffic.

The de-regulation of road transport, linked to the development of a major motorway network from the late 1950s, reinforced this situation together with the changing patterns of industrial and commercial activity no longer linked to the proximity of rail facilities. Furthermore, rapid developments in vehicle technologies, ICT, logistics systems and networks took place with minimal or no rail participation in the LDHV traffic which was and remains governed by wholly different imperatives and expectations. Rail did not recognise the magnitude of these changes or develop any sort of continuous product and service development initiatives. The freight rail industry felt satisfied with the status quo and with offering services to big traditional customers who appeared content with a low cost service with longer transhipment times. It retreated into its comfort zone described as "what rail does best".

Unfortunately this supply side position of service offering exposed rail to even greater levels of vulnerability and external pressure as the recent precipitous collapse of the coal sector has demonstrated. Over a very short time period rail has lost over a third of its traffic volume, revenues and profits. By any measure this is a catastrophic collapse and should have been anticipated to allow alternative business and business models to be developed. As a consequence rail has technical, commercial and operational models that are wholly unsuited to developing a significant presence in the domestic inter-urban freight and logistics sector.

For rail to recover and develop new attractive and competitive capabilities a major re-positioning of its product and service offers is required. This needs to be underpinned by a pricing and access regime that is sympathetic on a sustained basis to the strategic position the sector is in and will not be restricted by an access charging regime which fails to recognise the current weaknesses of the rail freight sector.

Unlike rail freight, road freight services are driven by massively different ownership, operational, organizational and governance structures. It does not support large non-executive government superstructures which can and do directly have an impact on its future commercial positioning. The budgetary and governance processes (Control Periods) used by the ORR and Network Rail appear, by comparison, to be mechanistic and far removed from the commercial realities and dynamics of the domestic freight market. They are complex mechanisms which preclude the ability of the rail freight sector to respond with agility to cargo business offers and prospects. These aspects, although they may appear to be normal prerequisites, act as a deterrent to selling railway capabilities. This is particularly crucial when the ORR's regulatory ability has been extended from its initial Office of Rail Regulations to the Office of Road and Rail (Regulation) (see figure 1) with the slogan 'Protecting the interests of rail and road users'.

Complex regulatory economics and econometrics appear to be at odds with the commercial aspirations of the rail sector and wider measures to secure a shift in modal spilt to rail. The separation and contradiction in approach and objectives raises fundamental concerns as to the long term validity and rationale of the existing mechanisms and structures. It also exposes the major differences in the way charging for access to the national road system is currently operated and the advantages this endows to road freight service providers. This, together with the major differences in terms of the ability of new aspirant operators to offer road transport services, when compared to requirements for those in the rail sector, suggests the need for these mechanisms to be reviewed if ambitions on changing modal split are to be achieved.

The present regulatory structural position flows from the twin strands of railway reforms and privatization which occurred on a near simultaneous basis in Britain. Railways in Britain had been in national ownership since 1948 and as a consequence suffered from the inevitable political interference in terms of binary funding and modernization programmes, the definition of roles (commercial or socially necessary) and the development of a superstructure of organizations which could and did influence the capabilities of the rail sector. Mounting deficits and changed patterns of demand for freight transport, to which the railways seemed unable to respond to internally, compounded the problem. The railways were no longer a monopoly provider of transport services as road transport increased with major road infrastructure investments sponsored by successive governments. As a result of similar situations occurring outside the UK the demand grew for changes to be made in the financial management of the railways.

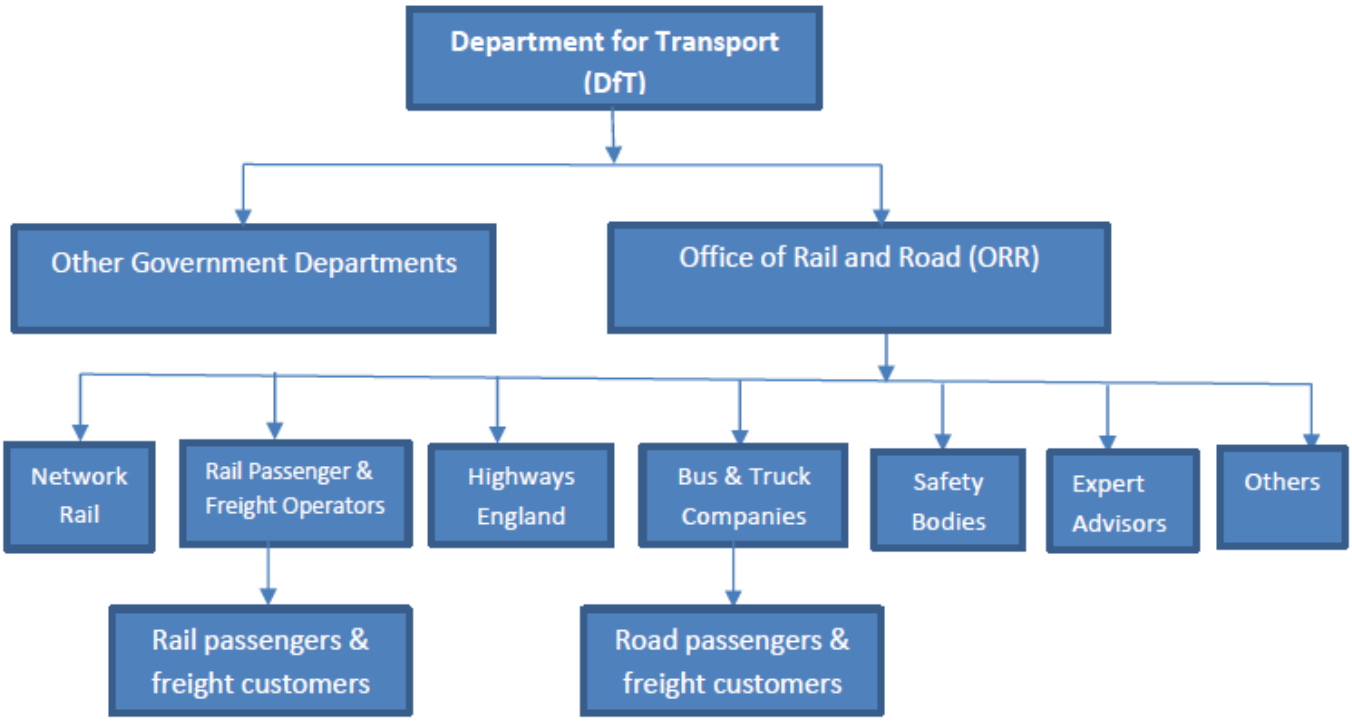


Figure 1 Current regulatory structure and relationship of rail (and road) industry in the UK

Within the rail sector there was an opacity as to where funds were being allocated and how well resources were being spent. This led to a call for a separation, initially for accounting purposes, between the infrastructure component (track, structures, signalling, power supply) and train operations. The separation option was proposed by the European Commission (EC) and was followed, to differing degrees and rates of implementation, in European national domains. This was overlaid by varying models of privatization with freight remaining a private business operation.

In Britain the infrastructure manager, initially Railtrack and subsequently NR became the monopoly owner and operator of the UK railway network, including track, signalling, bridges, tunnels and stations. The ORR is a regulatory body which holds NR to account for delivering what is promised – at the amount (charge) it agreed to do (responsibilities) it for – and makes NR meet its obligations to provide a safe, high-performing, and efficient railway. ORR does this by enforcing compliance with its licences and by conducting five-yearly (so called Control Period - CP) reviews that set its funding budget and what it must achieve within the relevant CP. Once agreed, the PR18 will be implemented over CP6 (2019-2024).

According to the current CP5 (2014- 2019) freight only line (FOL) charges and freight specific charges (FSC) are paid by freight service operators carrying certain commodities based on a "what the market can bear" test and these FOL charges and FSC are levied separately. How this market position is established and monitored is unclear in relation to competition from the road and waterways freight market within which rail now operates as a minor player. Both charges are capped in CP5 using the lower end of the range of avoidable costs as estimated by NR. The charges were phased in gradually over the duration of CP5. The PR18 proposes a change in the charging structure for freight operators by having a single 'mark-up charge' rather than two separate ones (Office of Rail and Road (ORR), 2015, 2016a, 2016b).

The basis of infrastructure charging is complex and involves agencies which are themselves not directly involved in a competitive domestic freight arena but where their (ORR and NR) actions and decisions have a major impact on the relative cost competitiveness of rail freight services. The road freight sector does not support this model suggesting an inverse relationship in relation to modal market share and the level of regulatory activity.

The research methodology applied in order to offer constructive criticism and recommendations is presented in the next section. This is followed on with the Findings and Conclusions.

Research Methodology

A qualitative methodology was applied in order to achieve the research targets of this paper. Official documents regarding freight fees and charges published by Department for Transportation, the Office of Rail and Road as well as the Network Rail were reviewed (e.g. Transportation 2016; Office of Rail and Road (ORR) 2016; Network Rail 2016; Network Rail 2015). Relevant research papers published in top ranking journals (e.g. *Transportation Research Part A: Policy and Practice, Research in Transportation Economics, International Journal of Transport Management, European Transport Research Review*) were also studied.

Paper	Published in	Methodology	Research Topic and Key Findings
Impacts of increased rail infrastructure charges in Sweden (Ljungberg, 2013)	Research in Transportation Economics	Mathematical models	Topic: Impacts of increased rail infrastructure charges. Finding: An increase in rail charges may reduce social welfare even though the reduction in rail transport mileage is small.
A logistical perspective on the potential for modal shift of freight from road to rail in Great Britain (Woodburn, 2004)	International Journal of Transport Management	A combined research method: questionnaire and interview survey	Topic: Mode shift from road to rail. Finding: Rail has potential to attract more traffic from road.
Comparison of external costs of rail and truck freight transportation (Forkenbrock, 2001)	Transportation Research Part A: Policy and Practice	Using empirical data to complete a mathematical comparison	Topic: Comparison of external costs of rail and truck freight transportation Finding: Rail external costs are less than that of freight trucking.
How to make modal shift from road to rail possible in the European transport market, as aspired to in the EU Transport White Paper 2011 (Islam, Ricci, & Nelldal, 2016)	European Transport Research Review	Literature survey , group discussion methodology and a system approach	Topic: Mode shift from road to rail. Finding: To offer a competitive price and reliable service will be vital to fulfil modal shift target.

Findings

Rail freight operators pay the infrastructure manager/operator, through an access charge, for the time, resource (signalling) distance and weight related components of the movement of trains across the network. The determination of the components of this access charge is opaque and complex. For freight services that operate on a routine point to point basis, on previously agreed schedules, the model is probably acceptable but this ignores the fact that a huge amount of potential rail competitive freight moves on a short term or spot response basis within Britain under a variety of operational and commercial imperatives. This is a market model that railways have not been able to address due to, among others, the inability to secure alternative train paths quickly at a competitive price. This lack of agility in relation to securing an appropriate and competitively attractive train path is a serious limitation to rail service capabilities. Rail services are in effect charged for the use of the network at the time of use on a mix of inputs. In marked contrast the road freight sector pays an annual charge per vehicle for access to the entire national road network irrespective of time and distance elements or any directly attributable items relating to road infrastructure attrition, emissions, excessive involvement in accidents and congestion generation.

The main objective of the NR proposed consultation (PR18) is to increase earnings from the freight operators through higher charges but the competitive situation cannot be ignored and the impact of increased charges could be highly detrimental to rail's future competitive positioning. It should be noted that rail has recently lost a significant part of its previous base traffic load in response to external environmental issues on coal power station emissions. It cannot expect to replace losses of this magnitude using the same operating methods and technology used in the bulk commodity sector or be charged for access to the network on the previous basis. Increasing access charges after the loss of over one third of rail's traffic volume appears to be a perverse aspiration driven more by arcane accounting requirements. Attractive pricing to induce traffic onto rail would appear to be more sensible unless any new services were identified as being specifically more expensive to accommodate or were occupying more space and inflicting higher levels of attrition on tracks and structures.

The model currently in use for the determination and levying of access charges appears to be increasingly arcane but one which appears to be currently embedded and largely unchallenged within the rail sector. Given the competitive market within which the FOCs operate, but the regulators and government departments do not, the ability to seriously and directly intrude into commercial positions is perverse and potentially detrimental to long term aspirations to significantly secure modal shift. The need for simplification, transparency, credibility and responsiveness to market requirements is clear. The ponderous positioning of the regulatory body (ORR) and government departments is mechanistic and appears to exist in a closed world that does not recognise the aggressively competitive cost driven basis of freight transport within Britain and the service imperatives that are now routinely required.

Pricing up access charges to FOCs in an attempt to secure financial rectitude could potentially cripple any attempt to secure a new traffic base. Given the ORR now has responsibilities for both rail and road the option to adapt the access charging system to level the playing field between the two modes (three if inter-modal or inland waterways or coastal is taken seriously) could be developed. The willingness or ability of the ORR to secure governmental support for this, particularly as it would imply an increase in road access charges, could however prevent this being implemented. The option for individual national governments within the EU (including the UK) to implement a charging regime that included the external costs of road transport was not progressed thereby leaving the road freight sector with a conspicuous economic advantage. For rail the opportunity rests with a focus to seriously address its cost base including access charges however compiled and to lower this to levels which equate with road freight. Equally it will need to address the low level of asset productivity, agility and responsiveness to service cargo offers and to develop new means of serving markets, domestic inter-urban logistics, where representation is virtually non-existent.

For the rail sector this suggests the need for a simpler basis of the calculation of access charges and for these to recognise the weak market share position rail is now in following the collapse of the bulk coal market. The big market where rail could potentially compete, the logistics sector, demands a very different approach based around product and service delivery linked routinely to a competitive pricing offer. Possibly some form of incentivised pricing mechanism linked to graduated/banded levels of traffic activity could be considered. As the rail sector moves to increasing levels of digitization monitoring vehicle and train activity could become a simpler and cheaper option and allow faster response times on service offers.

Other considerations that need to be recognised in any re-working of access charges include:

1. evolving positions on the organizational re-integration of train operations and infrastructure management
2. the dominant position of passenger services in relation to train path allocation
3. the release of unwanted train paths as coal traffic declined
4. the development of mechanisms to allow the rapid identification of available train paths and mechanisms to include swapping and “trading” between FOCs
5. the potential impact of new infrastructure development and the resulting availability of more track capacity for freight and passenger services

The separation of infrastructure and train operations was a fundamental component of the railway reform measures which flowed from Europe and which were largely adopted within Britain. The re-integration of franchised train operations and infrastructure has been trialled within specific passenger franchise areas. The potential benefits are not wholly clear given one re-integration was subsequently dissolved. Freight traffic is not limited to a prescribed franchise area in Britain. If it is to make any sensible impression on the major target market opportunity, inter-urban freight and logistics, it will need the ability to cross physical and organizational boundaries. At the same time it will need to be able to readily secure cross boundary access charges in the knowledge that these are based on compatible inputs that do not prejudice the determination of competitive pricing and schedule positions.

On the mixed traffic railway, that characterises operations in Britain, passenger services dominate. This position is made complex by the operation of trains with differing acceleration and braking characteristics and service call patterns, peak hour service operational requirements and pressure to move to longer service patterns in any 24-hour period. In addition the occupation of routes for engineering works including renewals, replacement and routine maintenance needs to be recognised as a constraint on rail's ability to deliver service on a 24/7 basis. The occupation of usual routes may preclude operations due to loading gauge and other limits. Many major commercial and industrial operations are active on a 24/7 basis and the rail freight sector cannot afford to ignore this requirement. The inability to service major ports at weekends effectively gifts traffic to road freight operators. Equally the closure of some inland terminals overnight also limits rail's ability to offer services and connections. The failure to recognise what the end users require is a major failing together with a failure to recognise the universality and flexibility of alternative road transport options.

Freight services are assigned paths in modular timetables and operators can, under prevailing rules, apply for additional train paths for scheduled or short term service requirements. The technical and commercial model of rail freight activity in Britain is built around trains of 20-30+ wagons with orchestrated calls to move to longer and heavier formations. This poses problems in terms of the acceleration and braking capability of such services, the routes over which they are permitted and issues arising in relation to a loss of train sequencing. Long slow heavy trains in disrupted train patterns are problematic in relation to available passing or holding points. Heavier trains are by definition more likely to inflict greater wear and attrition on tracks and structures and these factors will need to be adequately reflected in the compilation of access charges. The question arises as to whether this type of long heavy formation is relevant in relation to addressing the largest potential market for rail.

The recent precipitate decline of bulk coal traffic for power generation effectively knocked a major commercial and operational chunk out of rail freight's portfolio of activity and profits. Arguably rail had become excessively dependent on this traffic and failed to anticipate the impact, real or imagined, of external environmental pressures on exhaust emissions. As a consequence FOCs have released unwanted train paths. In reality these are of limited value for alternatives given their geographic location. The whole issue of the use, retention and release mechanism of train paths will become more acute if rail does make any significant penetration of domestic logistics markets governed much more by agility and responsiveness rather than fixed schedules and routes. This will need to develop a capability to rapidly assemble a service package including train paths/schedule alternatives with associated prices and the ability to defer, delay, transfer and swap options with other train operators. If major new rail infrastructure is eventually developed within the UK the position in relation to the availability of route capacity, train paths and schedules will need to be determined. The risk is that any "released" capacity on classic lines could readily be occupied by passenger services with freight again constrained with commercial consequences.

Conclusions

The present model of governance and regulation in road and rail transport is excessively complex and far away from the real commercial realities of a competitive freight transport environment. Rail freight has been operating in a very constrained market compared to its dominant competitor road and it is very unlikely that under such conditions the rail freight sector will be increase its share or regain its lost ground unless a wholesale overhaul for repositioning of products and services in both road and rail is undertaken. The current mechanistic regulatory regime and the relationship with Network Rail adds excessive complexity and cost and seriously constrains the rail freight sector's ability to adapt and respond to evolving market conditions of modern supply chains. The road freight sector that dominates the domestic freight transport market within Britain (and many other EU countries) is not on an equal footing under regulatory superstructure. Rail by comparison appears to be locked into an austere economic regulatory mode of operation irrespective of the dynamics of the freight market.

There is a major imbalance in terms of charging for modal access of the road and rail networks. Road transport makes a one off annual payment for this and can use either as much or as little road space in pursuit of commercial activity as the license holder wishes. Road freight operators do not have to apply for access to the network, for example for time slots in peak or non-peak hours, to undertake commercial operations once this annual fee has been paid. Metering road space/road miles operated, vehicle weights and the use of busy roads and peak travel times etc. should be introduced which is now technically feasible as a basis for charging. This sort of technology and system could be applied to vehicles including prime movers and trailers and demonstrate the bias created by the current method.

In contrast, rail by comparison is governed by a charging regime for every active movement of mile made on the system. The basis of rail access charging is overly complex and constrains access to markets that demand greater levels of agility and responsiveness. The remoteness of the regulatory arm and that of government from the realities of the competitive freight market is a concern. The position of the infrastructure manager now being back in the government fold is also a concern in terms of overall funding levels, the identification of priorities, the return of binary funding and botched investment programmes. There is a fundamental clash of positions between the operation of a publicly owned railway infrastructure and the operation of commercially successful rail freight services on it. Abstract aspirations to regulate without any real understanding of the freight market and a failure to address the access charge distortions in relation to road freight suggest reform of the prevailing structure is required urgently. More of the same could be a death sentence for rail freight.

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The resilience of rail freight traffic flows in the Cardiff and Bristol city regions

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Introduction

Logistics can play a significant role in the economy of a country or region, both directly and through the support it provides for other industries. For example, it has been estimated that the sector is worth £55 billion to the UK economy, comprises 5% of GDP and employs over 1.7m people (CTP 2017). Recent economic trends have heightened awareness of the concept of economic resilience, both at a national and regional level. Indeed, there is an increasing focus upon regional economic resilience by policy makers. However, policy makers often fail to adequately include freight transport within their decision making, such that it was considered to be "Cinderella of UK transport policy" (Gazzard, 2014). By considering the resilience of the logistics industry through the economic geography based lens, it is hoped that new insights into policy decision making related to the industry can be made.

Therefore, the aim of this paper is to define and evaluate economic resilience for the logistics industry, through the application of the concept to two neighbouring regions within the UK. Namely the Cardiff Capital Region (CCR) and Bristol City Region, formally known as the West of England authority. The regional pairing is home to two freightliner terminals in Bristol and Cardiff as well as several ports at Avonmouth, Cardiff, Newport and Portbury.

City resilience

According to the Rockefeller foundations 100 resilience cities initiative: "Urban Resilience is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience" (Rockefeller, 2017). Various disturbances to regions have been considered in recognition of their potential vulnerability, or lack of resilience, to such events. Economic events such as the "credit crunch", subsequent recessions and natural disasters have fuelled scholarly interest in the idea of resilience in an effort to better understand regions and their vulnerability to economic shocks (Bristow and Healy, 2014).

The effects of weather events have been recognised to cause significant disruption to the operation of rail services and how they can damage railway infrastructure. As a result detailed studies of the vulnerability of rail assets to weather events and, more longer term, climate change, have been evaluated in order to enable network operators to maintain a resilient railway with regions, such as Wales (Network Rail 2014).

In response to such events, Arup, in collaboration with the Rockefeller Foundation, developed the City Resilience Index (CRI) (Da Silva and Morera 2014). The CRI was created through a global process of stakeholder consultation involving a variety of cities around the world. The purpose of the CRI is to serve as a planning and decision-making tool to help guide urban development, including the planning and provision of transport infrastructure.

The index is an articulation of urban resilience based on the premise there are 12 universal factors or drivers that contribute to city resilience, with varying degrees of importance. Several of these factors are related to transportation infrastructure including rail. The factors are organized into the following four core dimensions, and their goals, of the urban resilience framework (Da Silva and Morera 2014). The two of particular interest are:

- Infrastructure and environment – quality and robustness of the systems that protect, provide and connect citizens, with the following three goals:
    - Reliable and mobility and communications
    - Effective provision of critical services
    - Reduced exposure and fragility
- Leadership and strategy – inclusiveness of governance, involving government, business and civil society, and evidence based decision making. Where two of the goals have relevance to rail infrastructure:
    - Effective leadership and management
    - Integrated development planning

Research method

Data has been largely collected from a wide range of secondary sources including policy documents, governmental statistics, academic journal papers and the trade and popular press. In addition, data sets have been created from publicly available data to give further insights.

Data for this research was specifically collected from http://www.realtimetrains.co.uk. This service provides real time information on train schedules. As well as timings, it also includes detail on motive power and trailing loads; shows all trains that are timetabled, with real time data for those that actually run; with raw data taken from Network Rail.

Only freight trains that have run are included, such as empty movements, but excludes engineering trains and light loco movements. Some trains considered within the dataset pick up and drop off on the way, an example of this is Margam to Tees Yard, which changed load at Llanwern. Additionally some products feed through a 'hub and spoke' type network, an example being Ford Bridgend, which go to/from Newport, and use 'trunking' to reach London. Weights are based on trailing loads, with wagon and cargo combined (not locomotive), also the maximum rather than the actual amount on a wagon is considered.

Information regarding the nature of products was based on knowledge of rail services and other Internet based resources. The period considered by this study was 13/7/2015 to 19/7/2015.

Rail freight overview

The diagram shown in Figure 1 gives an overview of the rail network in the Cardiff and Bristol regions. The commuter networks concerned with feeding passengers into the centres of Bristol and Cardiff from outlying towns and cities are well developed and have seen passenger numbers rise. Connections between Cardiff and Bristol could be considered to be at risk because traffic is routed through the Severn Tunnel, with the diversionary route, via Gloucester, being far longer. Going forwards, the Severn Tunnel is likely to come under increased levels of stress as it becomes more and more busy and the requirements of freight and passenger services need to be accommodated. Connections to other regions and cities such as Manchester, Birmingham, London and Southampton are very good with the South Wales and Great Western mainlines being electrified. However, the prime driver of electrification is the desire to increase passenger services between Wales and the West Country, and London.

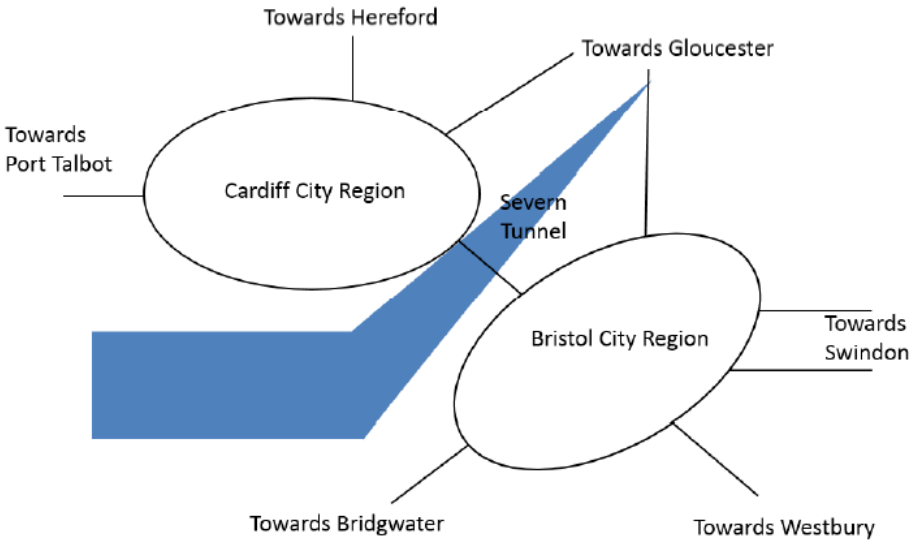


Figure 1: Overview of rail links in Cardiff and Bristol areas

Cardiff

In the Cardiff City Region, illustrated in Figure 2, coal, steel and aggregates are the main commodities still shipped by rail. These go throughout the UK and in the case of steel are both inbound and outbound e.g. scrap going into Cardiff and finished products going out of Llanwern. The Cardiff region also has connections to Southampton, but importantly these have to go through the Bristol City Region, typically via the Severn Tunnel.

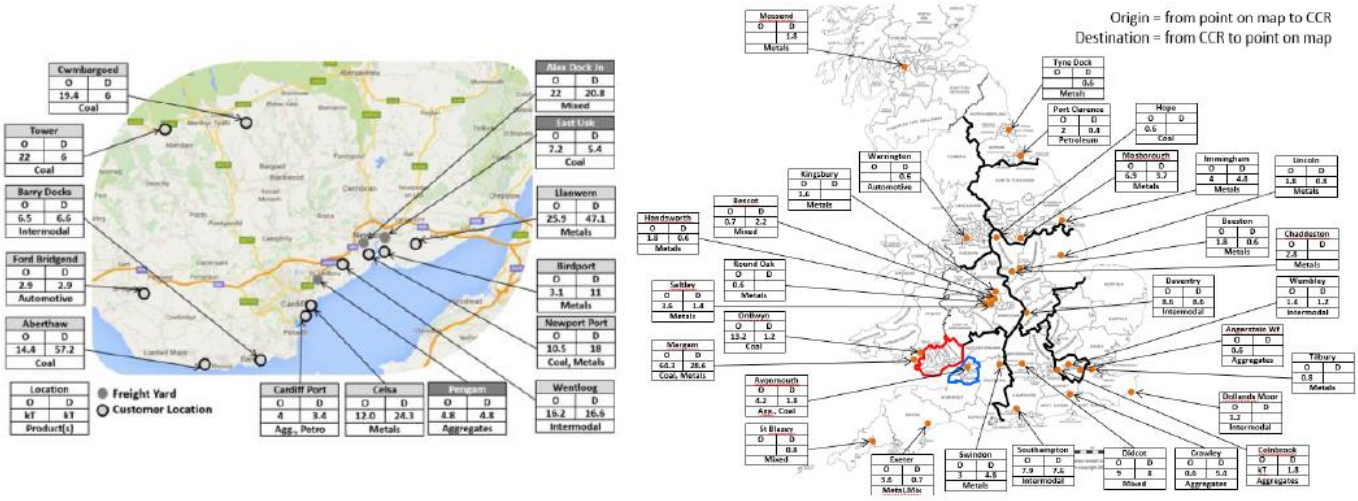


Figure 2: Overview of Cardiff City Region rail freight (regional and national)

Bristol

The freight flow to and from the Bristol region is illustrated in Figure 3. Some of the main freight routes are of coal from Portbury to power stations in the Midlands as well as the transportation of cars, plus container traffic for the Bristol area. Because of congestion on the mainline and the needs of high speed passenger services, freight traffic for the West Midlands is routed through the Cardiff City Region via the Severn tunnel and then the Hereford line to the Midlands.

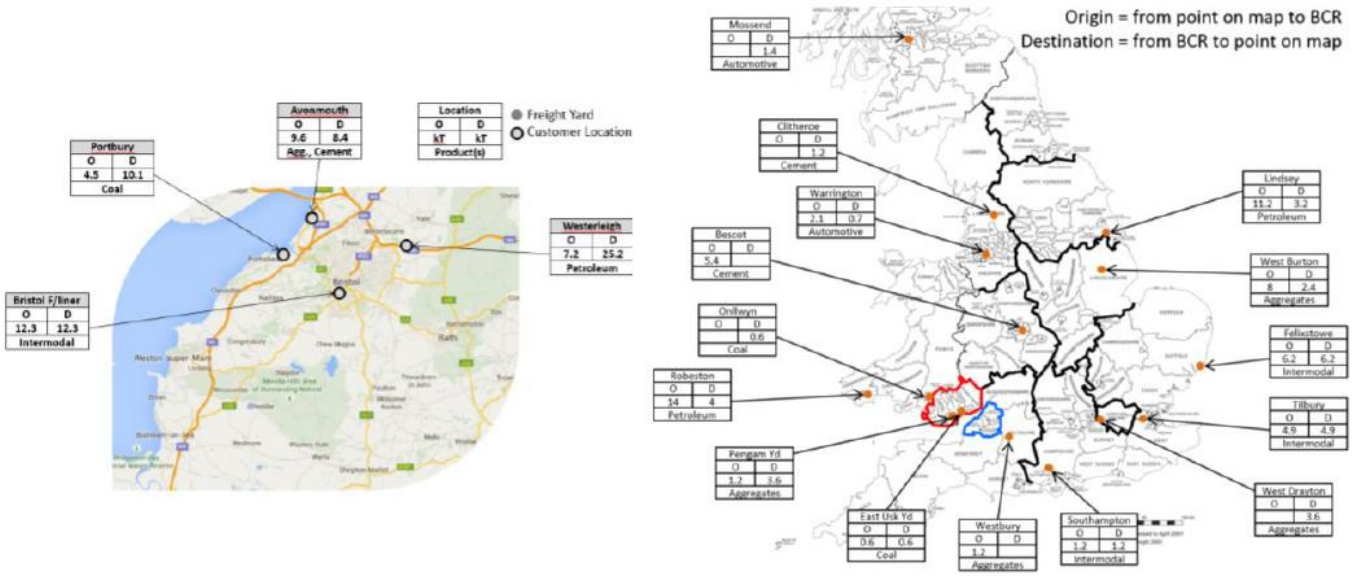


Figure 3: Overview of Bristol City Region rail freight (regional and national)

Rail freight data

Currently it is challenging to obtain a single detailed picture of what is happening with regards to rail freight within a specific part of the UK as most data is aggregated at the UK level. However, public accessible data sets are available that can help bridge this knowledge gap. Real time information on train schedules was collected from http://www.realtimetrains.co.uk for a period of one week. The dataset extracted contains the details of 417 trains, with a total trailing load of circa 569,000t. A summary of the data gathered is given in Table 1. As can be seen from Table 1, there is about twice as much freight originating from and destined for the Cardiff region than there is for the Bristol region.

	Cardiff	*Bristol*	*Combined*
Origin			
Number of trains	86	35	116
Trailing Load (000t)	88.3	33.7	115.9
Destination			
Number of trains	87	34	115
Trailing Load (000t)	146.7	56.1	196.8
Origin and Destination			
Number of trains	69	0	75
Trailing Load (000t)	83.4	0	89.4
Transit			
Number of trains	127	74	112
Trailing Load (000t)	188.5	98.6	167.0

Table 1: Overview of rail freight movements in Bristol and Cardiff regions

The data summarised in Table 1 has been disaggregated into the various freight types and is shown in Tables 2 to 4, where train numbers, tonnes transported and average trailing weight are detailed.

	Cardiff				*Bristol*				*Combined*			
	O	*D*	*O&D*	*Transit*	*O*	*D*	*O&D*	*Transit*	*O*	*D*	*O&D*	*Transit*
Aggregates	6	6		12	8	8		19	10	10	4	12
Automotive	1		8	6	3	3			4	3	8	
Cement					3	3			3	3		
Coal	12	12	46	5	2	1			12	11	48	4
Intermodal	14	14	6		10	10		14	24	24	6	
Metals	45	47	9	73				20	45	47	9	73
Mixed	7	7		9				12	7	7		9
Nuclear								2				2
Petroleum	1	1		18	9	9		5	11	10		8
Timber				4				2				4
Grand Total	86	87	69	127	35	34		74	116	115	75	112

Table 2: Number of trains

	Cardiff				*Bristol*				*Combined*			
	O	*D*	*O&D*	*Transit*	*O*	*D*	*O&D*	*Transit*	*O*	*D*	*O&D*	*Transit*
Aggregates	8.4	6.2		16.0	9.6	10.4		25.3	13.2	11.8	4.8	16.0
Automotive	0.6		5.7	4.3	2.1	2.1			2.7	2.1	5.7	
Cement					1.2	5.4			1.2	5.4		
Coal	10.0	16.8	59.6	7.0	1.2	0.6			10.0	16.2	60.8	6.4
Intermodal	17.5	17.8	10.7		12.4	12.4		18.0	29.9	30.1	10.7	
Metals	40.3	92.2	7.4	115.9				26.3	40.3	92.2	7.4	115.9
Mixed	11.0	11.7		11.7				19.8	11.0	11.7		11.7
Nuclear								1.4				1.4
Petroleum	0.4	2.0		30.0	7.2	25.2		6.0	7.6	27.2		12.0
Timber				3.6				1.8				3.6
Grand Total	88.3	146.7	83.4	188.5	33.7	56.1	0	98.6	115.9	196.8	89.4	167.1

Table 3: Thousands of tonnes

	Cardiff				*Bristol*				*Combined*			
	O	*D*	*O&D*	*Transit*	*O*	*D*	*O&D*	*Transit*	*O*	*D*	*O&D*	*Transit*
Aggregates	1.4	1.0		1.3	1.2	1.3		1.3	1.3	1.2	1.2	1.3
Automotive	0.6		0.7	0.7	0.7	0.7			0.7	0.7	0.7	
Cement					0.4	1.8			0.4	1.8		
Coal	0.8	1.4	1.3	1.4	0.6	0.6			0.8	1.5	1.3	1.6
Intermodal	1.3	1.3	1.8		1.2	1.2		1.3	1.2	1.3	1.8	
Metals	0.9	2.0	0.8	1.6				1.3	0.9	2.0	0.8	1.6
Mixed	1.6	1.7		1.3				1.7	1.6	1.7		1.3
Nuclear								0.7				0.7
Petroleum	0.2	2.0		1.7	0.8	2.8		1.2	0.7	2.7		1.5
Timber				0.9				0.9				0.9
Grand Total	1.0	1.7	1.2	1.5	1.0	1.6		1.3	1.0	1.7	1.2	1.5

Table 4: Average trailing weight

The data on freight volumes suggests that the resilience of the Cardiff region is worthy of particular attention as the risk from disruptions might be greater and that there could be a knock-on effect for services to / from the Bristol region.

Additional rail data

In order to validate the results additional rail data was gathered. Based on Office of Rail and Road (ORR) Freight Rail Usage for 2014/15 (Office of Rail and Road, 2015) in the last 12 months, 110.1 million tonnes were lifted in the UK. An extrapolation of our data suggests that 23% of freight movements through CCR. Other sources (Welsh Affairs Committee 2012) suggest about 10-15%. Given some of the potential issues with our data (inclusion of empty movements, and exclusion of engineering trains and light locos), this lower figure would seem to be about correct.

Using data from Monitoring the National Transport Plan 2012 (Statistics for Wales, 2013) based on the above, equivalent values would be:

- Within Wales: 190.7kt/wk = 9539kt/yr
- From Wales: 58.2kt/wk = 2910kt/yr
- To Wales: 69.1kt/wk = 3455kt/yr

Our within Wales figures probably have double counting when focusing on CCR, due to trains being planned as loaded both ways. However, when trains actually run, they may be loaded in one direction and empty in the other, yet this is not reflected in the data. As previously mentioned, our data includes empty trains and interworks movements between Port Talbot steelworks and Llanwern steelworks. It is not evident if the data gathered from these additional data sources includes these, although empty trains may be excluded (for example the automotive NTP data shows no within Wales movements)

Total volumes:

- Overall = 10459kt
- Metals = 5449kt (52%)
- Coal = 2887kt (28%)
- Intermodal = 625kt (6%)

Therefore CCR, in % terms, would be about the same for steel, slightly lower for coal and slightly higher for intermodal.

The Wales Route Study 2015 (Network Rail 2015) sets out both the strategic vision and predictions for the passenger and freight railways in Wales between 2019 and 2043. The study considered both demand entirely within Wales, and also between Wales and the rest of the UK. Information extracted from this study is shown in Table 5. In addition to the data in Table 5, Network Rail identified that in 2043, based on an 18-hour day, there will also be a requirement for 1 path per day to Cwmbargoed and Tower.

	Our Data	*Network Rail 2019*	*Network Rail 2043*
Port Talbot	1tph	2tph	3tph
Hereford	0.2tph	0.5tph	1tph
Gloucester	0.5tph	0.5tph	1tph
Severn Tunnel	0.4tph	1 to 1.5tph	3tph

Table 5: Wales Route Study – trains to/from CCR

Rail freight resilience

With a specific focus on the Cardiff region potential or planned changes to rail use within the Cardiff region are identified and discussed in Table 6. These changes include freight use patterns, changes in the industrial make-up of the region (and further afield) and plans for rail passenger services.

Potential changes	*Impact of rail freight*	*Resilience implications*
Medium term future of coal mining	Reduction in the number of freight trains, particularly within the CCR	Frees up capacity, particularly on Valley Lines where significantly more passenger services are desired
Medium term future of Aberthaw Power Station	Reduction in the number of freight trains, particularly within the CCR	Frees up capacity, particularly on Valley Lines where significantly more passenger services are desired
Long term future of Port Talbot	Significant reduction in rail freight requirements	Releases significant capacity for passenger/freight use. Significant impact on logistics operations, leading to job losses.
Long term future of Llanwern	Less significant risk to rail freight volumes as many trains come from Port Talbot.	Releases some capacity and also removes some conflicting moves. Opportunities for rail connected terminal for other freight
Growth of intermodal	Generate new traffic flows, although extra terminals might be needed	Requires extra train paths, although may be constrained by availability of terminals in the long term
Growth of service economy	Creates a greater pressure for the movement of people, leading to tension between passenger and freight services	Freight potentially marginalised to off peak/night time workings, which don't align with customer requirements.
Development of Cardiff Metro services – Valley Lines (North)	Some impact on coal flows and availability of paths	Limited, except for coal terminals, although impact dependent upon final solution
Development of Cardiff Metro – Valley Lines (South)	Competition for paths, impacting on Aberthaw, Barry Docks and Ford Bridgend	Needs a solution that can accommodate rail freight. Ford traffic less affected as runs at night.
Development of Cardiff Metro – other routes	Competition for paths, particularly on South Wales Main Line. Number and nature of movements unsuited to evening/night time focused operations	Tension between passenger and freight aspirations. Extra capacity likely to be needed to maintain existing freight operations.
Electrification – infrastructure	Slightly enhanced gauge for trains, opportunities for electric haulage	Gives more options for traction, although most trains would still need diesel until line to Birmingham electrified.
Electrification – services	More frequent and faster services to London leading to pressure on GWML	Conflicts for longer distance flows to SE and ports. Some diversion opportunities, but apart from Southampton, these would add time

Table 6: Rail freight resilience

Table 5 shows that some of the changes, in particular those associated with the de-industrialisation of the South Wales area, will release capacity for passenger or freight use. Whilst others, such as elements of the Cardiff Metro scheme, could present challenges, in particular connectivity that requires the use of the South Wales Main Line.

Conclusions

The paper has identified a range of different factors that could affect the resilience of the rail freight industry in the Bristol and Cardiff Regions, and hence the urban resilience of these regions. Some of these reflect macro level factors often outside the control of the sector, such as industrial change, while others are more specific to individual modes e.g. the availability of rail terminals. Potential conflicts between passenger and freight based modes, such as the desire to increase passenger numbers, were also identified.

These changes and their potential impacts need to be considered in a holistic manner by policy makers at local, regional and national level. In particular when making development and planning decisions that place demands on the existing rail infrastructure without making new investments.

Acknowledgements

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Rail freight at a turning point - what direction will it go?

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Purpose: The objectives of this research are to assess the scope for modal shift from road to rail; identify barriers and recommend measures and interventions required to realise this potential.

Research approach: To achieve the aforesaid objectives, the approach combines research methodologies of qualitative and quantitative consultation with industry stakeholders.

Findings: There is a structural change in the freight market with the decline of low value, high volume cargo traditionally attracted and suited to the rail sector namely coal, iron ore and steel giving a perfect symbiosis of bulk cargo and steel on a steel infrastructure In contrast there is growth in high value consumer goods and manufactured cargo. The movement of these types of cargo require reliable, faster and cost effective services. This study identified some barriers for rail sector to attract these cargoes. The study recommends a set of measures and interventions for rail freight growth and thereby modal shift from road.

Recommendation: The relevant stakeholders will have to make their own priority, deliverability, cost and timescale to implement the interventions. Once implemented, the interventions will have a significant impact on the rail freight growth and cause modal shift from road to rail and thus will result in carbon saving.

Keywords: rail freight, forecast, growth or decline, barriers, interventions, reduction of carbon impact

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Introduction:

Currently transport emissions make up nearly a quarter of total UK domestic greenhouse gas (GHG) emissions, with road freight a significant contributor, e.g. HGVs were responsible for 17% of total UK transport GHG emissions in 2014 (Department for Transportation (DfT), 2016). Transport (30%) was the second largest CO2 emitting sector (behind Power generation sector 39%) followed by Industry (11%) in 2015. Since 1990, the CO2 emission share from the transport sector has grown by 5% whereas the share of industry sector has dropped by 6%, due to many factors including structural changes in the economy, application technology, and efficiency improvements. The average annual growth rate of transport emissions since 1990 was 1.0% while industry decreased on average by 1.2% annually (see Figure 1) (International Energy Agency (IEA), 2017). An analysis on the GHG and CO2 emissions from EU-28 countries shows similar trends. This data indicates that the transport sector has to play a significant role in reducing emissions.

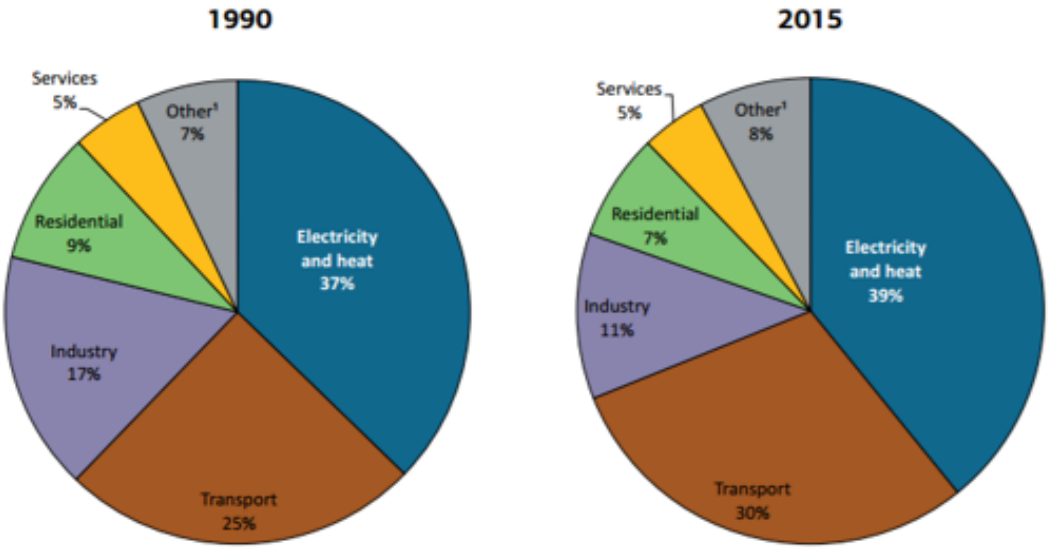


Figure 1 OECD CO2 emissions by sector (International Energy Agency (IEA), 2017).

The Paris Agreement at the Twenty-first Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNCCC) (in December 2015) marked a clear turning point towards a low carbon future. Generating electricity from coal emits approximately twice the carbon dioxide (CO2) for each unit of electricity compared with gas. The UNCCC Committee has estimated that by dispatching gas ahead of coal, the average carbon intensity of the power sector in 2014 would have reduced from around 450g/kWh to 250g/kWh. Coal is also responsible for significant emissions of other pollutants, including Nitrogen Oxides (NOx), Sulphur Dioxide (SO2), Mercury and particulate matter (PM), all of which have a negative impact on human health and the environment (Department for Business Energy & Industrial Strategy, 2016).

The UK Government has set a legally binding Fifth Carbon Budget that aims at which a 57% reduction in emissions by 2032 and 80% by 2050 compared to 1990 levels (Department for Transportation (DfT), 2016). The Industrial Emissions Directive (IED)[1] came into effect on 1 January 2016 in relation to existing large combustion plants, and sets new emission limits for key air pollutants. Three compliance options were available to plants:

1. To meet the emissions limit requirements from 1 January 2016. Compliance is estimated to require an investment in the order to £50m-£75m per 500MW unit[2];
2. To participate in the Transitional National Plan (TNP) that allows certain older plants to meet the emission limit requirements described above until July 2020. Plants in the TNP are subject to an annual emissions allocation within a declining overall UK maximum emissions ceiling. By July 2020 they must either meet the emission limit requirements or they can continue

[1] See http://ec.europa.eu/environment/industry/stationary/ied/legislation.htm for details
[2] Coal and Gas Assumptions. DECC (Parsons Brinckerhoff), March 2014
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/315717/coal_and_gas_assu
An analysis on the GHG emissions from EU-28 countries shows similar trends. Shifting freight from road to rail is therefore at the heart of the UK and EU government policy (European Commission, 2011, 2016; Islam, Ricci, & Nelldal, 2016). The UK Government has set a legally binding Fifth Carbon Budget that aims to achieving which a 57% reduction in emissions by 2032 and 80% by 2050 compared to 1990 levels. mptions.PDF

operation with a higher emissions limit but limited to 1,500 hours a year (i.e. 17% annual load factor).

3. To utilise the Limited Lifetime Derogation (LLD) which limits plants to 17,500 hours of operation between 1 January 2016 and 31 December 2023, after which they must close.

A majority of the remaining UK's coal power stations are participating in the TNP and therefore have time until 30 June 2020 to install the equipment needed to meet the emissions limit requirements. Traditionally rail freight transport is favoured in transporting low value high volume cargo such as coal since it is seen as a sustainable transport mode option.

In 2012, coal was generating more than 40% of the UK's electricity, but new analysis by Imperial College London reveals coal supplied just 2% of power in the first half of 2017. (https://www.theguardian.com/business/2017/jul/19/how-coal-lost-power-britain).

Although the decline of coal use in power plants is a bad news from rail freight transport point of view, the good news is that plummeting coal use led to a sharp fall in the UK's annual carbon dioxide emissions.

Shifting freight from road to rail is at the heart of the UK and EU government policy (European Commission, 2011, 2016; Islam, Ricci, & Nelldal, 2016). To achieve modal shift and the environmental benefit that rail freight brings, the rail freight sector should be helped to react positively to the major structural changes in freight markets: Apart from the already stated decline in traditional bulk rail freight commodities, coal, iron-ore and metals, there are changing patterns of consumption driven by the rise of internet shopping; and next-day deliveries (see figure 2). The service requirement (e.g. emphasis on faster and reliable service) for these types cargo is different from the service requirement of traditional rail cargo. The rail freight industry needs to innovate its operational offer and respond to potential service requirements.

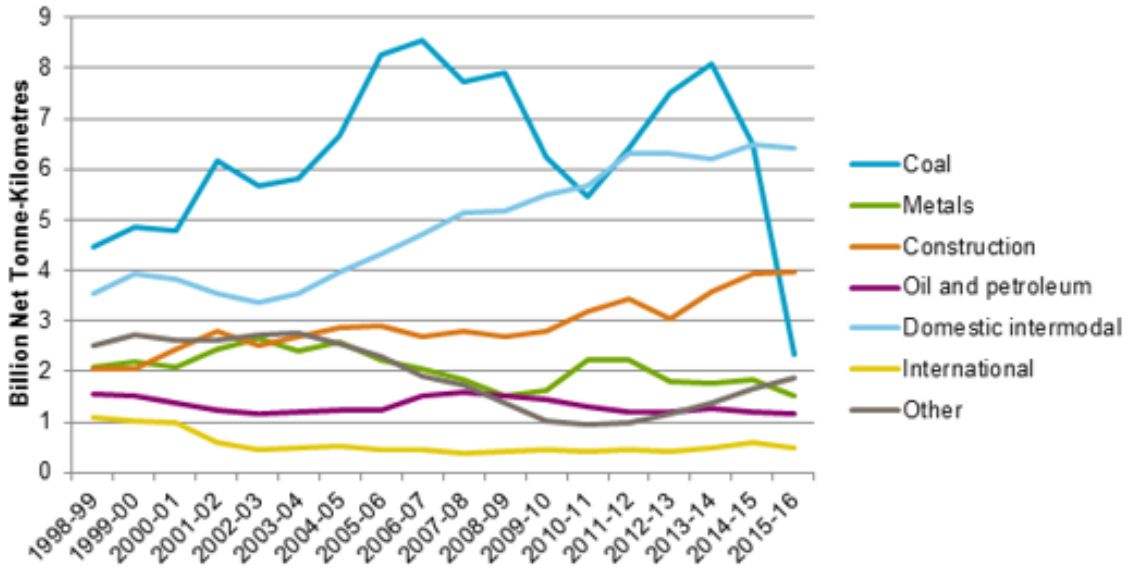


Figure 2. UK Domestic rail freight moved by commodity 1998-2016 (Department for Transport (DfT), 2016)

Purpose:

The objectives of this research are to understand the future growth potential in the UK rail freight market; assess the scope for modal shift from road to rail; investigate the policy measures required to realise this potential and assess the reduction in carbon emissions these measures may bring.

Research approach:

To achieve the aforesaid objectives, the research applied qualitative and quantitative research methods and consultation with industry. The consultation group included Freight Operating Companies (FOCs); Network Rail, ORR; shippers/consignees; and relevant people in the Government. The qualitative method included a review of rail network capacity around infrastructure pinch points, route capacity, terminal location and resource availability etc. Applying quantitative methods, High level forecast for key commodity groups or sectors was made. This forecast reflected current barriers in the analysis.

Findings:

To achieve modal shift, the rail freight sector will have to address a number of barriers as discussed below.

Terminal related barriers: Whilst there are terminals available, many terminals are unable to offer effective and efficient appropriate modal transfer due to smaller size, ill-equipped facilities, poor (access and departure) design, limited operating hours etc. Taking into account the current freight trend, the required terminals for network access may not be conveniently located for the sender or receiver of the goods consignment. Moving freight by rail includes additional transfers from/to road at either end of the route, complete with attendant lift costs, time requirements and the extra management involved in co-ordinating potentially three separate movement legs. This adds significant cost to using rail as a mode opposed to a single, direct door-to-door road haulage service with a single contractor.

Flexibility and reliability: With the continuing use of "Just in Time" logistics throughout much of Britain's manufacturing and distribution sectors, it is important that shippers are able to send goods as and when they are required, with a high degree of reliability. This may require frequent transport haul but smaller consignment sizes that negatively affects rail freight's ability to compete with road effectively. Also many consignments are added or cancelled to match the shippers' or consignee's 'last minute' stock adjustments and updates. Meeting such adjustment is a big challenge for rail freight operators under the current industry operating model which doesn't have a level playing field with road. Rail has demonstrated a requirement for large, regular shipments which provide 'critical mass' to underwrite the sending of the entire train. This minimum size requirement tends to limit the number of firms which can use the railway to large distributors. Even these firms find the inability to flex the load size a problem and this means that road haulage is often the fall-back for adjustable capacity. This is particularly the case with regard to domestic movements. But with road haulage, it is easy to accept flexible load sizes, with additional vehicles being relatively easy to hire or cancel as and when required. However load matching technology, has been emerging for some time. In the passenger space it has been quite disruptive such as Uber, but in the freight sector the disruptive technology has yet to reach a tipping point.

Regarding rail path allocation, due to the congested nature of much of the railway network, and the priority given to passenger train services, rail freight services are often given sub-optimal routes or paths through the network. Also at times a rail freight train has to suffer hours of waiting time resulting in much longer transit time causing unreliability and inefficient rolling stock utilisation (Department for Transport (DfT), 2016).

Consultation with the intermodal industry found that the low numbers of available flat wagons resulted in unaffordable pricing for setting up new flows. This is especially the case given gauge restrictions requiring specialist rakes of wagons and also the increasing number of European size 45ft boxes which do not efficiently fit on a standard 60ft container wagon. The number of wagons available is further limited by the long periods of time rolling stock can be tied up due to lengthy scheduling.

Consultation with the industry suggests that many of the UK Freight Operating Companies (FOCs) have little incentive and / or high barriers to entry to actively seek out new flows due to excessive development cost and financial risk, given the low margins in the sector; things get even more complicated with the high capital cost and long asset life of equipment.

Matching capital intensive long life assets with a high fixed cost base against a volatile / variable demand base (outside of coal / bulk) is at the heart of matter.

The rail freight industry requires a wide range of skills and needs a diverse intake of people to ensure efficient movement around the system. There is a need to upskill the current workforce in the use of new technology and systems to ensure that innovative and flexible solutions can be implemented quickly and efficiently.

Overcoming these barriers will be crucial in achieving modal shift and market growth aspirations. Table 1 summarises the barriers and if removed, the potential to achieve modal shift with in higher growth in different rail freight sectors.

Table 1: Identified barriers and their interaction with identified potential freight traffic growth sectors

	Construction	Intermodal International	Intermodal (Domestic)	Channel European Freight	Automotive
Network Capacity Limitations	✓	✓	✓	✓	✓
Terminal Access and Limitations	✓	✓	✓	✓	✓
Wagon Availability				✓	✓
Transit Time			✓		
Transshipment Costs		✓	✓		
Facilities & Equipment	✓	✓	✓	✓	✓
Train Path Suitability		✓	✓	✓	✓
The 7 Day Railway Service		✓	✓	✓	✓
Diversionary Routes	✓	✓	✓	✓	✓
Variance in Volume		✓	✓	✓	✓
Ease of Access		✓	✓	✓	✓
Demand Side Inertia	✓	✓	✓	✓	✓
Start Up Risk		✓	✓	✓	✓
Skills and Training	✓	✓	✓	✓	✓

Groupage is a key part of road freight's success in providing flexible haulage for firms and manufacturers of all sizes by combining consignments into a unit load. It is difficult to extend this service to sharing individual containers (or wagon loads level) in the rail sector. But the service concept can be extended to a full train conveying part loads for different FOCs, operators or customers between fixed locations, applying modern supply chain solutions. This could support the development of the domestic rail intermodal sector where individual consignment volumes can be relatively low. Alongside this, a freight sharing platform or "IT cloud" can be developed to allow shippers, consignees and FOCs, the visibility to match available or free transport capacity on a scheduled train service to consignments. This system is already being successfully used by the road sector and thus there is a strong potential for its applications in rail. The tracking of individual loads on the train is currently harder than on road due to the widespread application of telematics on lorries. Application of appropriate IT services, e.g. GPS on locomotives/wagons, can help FOCs to counter this by considering equipping drivers with iPads, and making train operations data open source and available on the internet.

Table 2: Potential solutions and/ or interventions to the identified barriers

	Network Limitations	Terminal Limitations	Wagon Availability	Transshipment Costs	Facilities & Equipment	Train Pathing	The 7 Day Railway	Diversionary Routes	Load Variance	Ease of Access	Demand Side Inertia	Supply Side Inertia	Complex Skill Needs
New-build Terminals		✓			✓					✓	✓	✓	
Refurbished Terminals		✓			✓					✓	✓	✓	
Capacity & Gauge Enhancements	✓		✓			✓	✓	✓					
ITS Solutions for Rail freight			✓		✓	✓				✓			
Supply Chain Solutions			✓	✓	✓					✓			
Web-Based Portal									✓	✓	✓		
Financial Assistance										✓	✓		
Sharing Loads)						✓				✓	✓		
Rail Freight Forum							✓			✓	✓	✓	
Freight Path Improvement			✓			✓							
Cost Stability Development										✓			
Wider Policy Framework											✓		
Channel Freight Review	✓					✓	✓	✓			✓	✓	
Rail Freight Innovation Fund			✓		✓						✓	✓	
Large Project Procurement	✓										✓		
Market Entry Review										✓		✓	
Cross Government Policy Intervention										✓	✓		
Freight Corridor Resilience	✓							✓					
Express Freight Solutions									✓		✓	✓	
Strategic Freight Network	✓	✓				✓							
Consolidation Centre				✓					✓		✓		
More European Rail freight	✓						✓				✓	✓	
Skills Access and Promotion													✓

In order to provide a clear and ongoing location for dialogue and understanding of the requirements of freight users, a forum for discussion could be created with representative bodies from the market sectors identified as being suitable for future growth. This will enable a clear understanding of their requirements to be developed, as well as providing a body to facilitate other interventions, share best practice while preserving commercial confidentiality, and to work with FOCs to ensure successful modal shift. For example, this body could inform the requirements of the web-based portal. In this respect the rail freight industry could more closely emulate the technical information sharing that takes place within the aerospace industry. The Rail Freight Group already facilitate this where possible but there is much more that could be done.

Recommendation:

There is a structural change in the freight market that demands change in rail freight service operation. There is evidence that FOCs are consistently improving productivity and reliability but customer expectations of service levels are also becoming more demanding. The FOCs will have to offer reliable, cost-efficient and effective service to its customers to encourage and maintain modal switch to rail. The current study has identified a numbers of barriers (see Table 1) to rail freight growth and modal shift from road to rail. To overcome the barriers, the study is recommending a number of appropriate measures and interventions (see Table 2). The relevant stakeholders will have to take a view and make their estimated priority on, deliverability, cost and timescale to implement these interventions. Once implemented, the interventions could have a significant impact on rail freight growth and modal shift from road and thus the resultant potential carbon saving. Rail is more energy efficient than road freight by some margin but it needs to continue to improve to maintain this advantage. Despite this environmental advantage it remains a moot point as to whether further mode agnostic regulation is required to level the playing field between road / rail cost wise particularly with regards to influencing the decision by the private sector to allocate sufficient resources to protect long life freight assets against volatile changes in demand for such assets.

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Retail Supply Chains

Reshaping the Book Supply Chain: Challenges and Opportunities

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INTRODUCTION

The bookselling industry is currently in the midst of a massive transformation due to the onslaught of online sales and disruptive technologies, the prolonged economic recession and the fierce competition between small independent businesses and large corporate chains. Although books are well defined homogenous products with low marginal cost (Tang, Montgomery and Smith, 2010), the sector is characterised by a high level of complexity. The book supply chain consists of a multitude of publishers who develop complex trading relationships with a variety of large retail accounts and a plethora of small independent retailers (Chen, Chan and Cheng, 2011). The consumer base is widely heterogeneous with an increasing buying power. To attract new customers, bookshops offer increased product differentiation and penetrate new marketing channels. The ascendance of internet commerce in 1990s has fostered the growth of the online book market (Lichtenberg, 1997) which has since flourished tremendously due to greater consumer confidence in online purchasing, easier accessibility to a wide book range, improved transaction processes, convenience catering to the taste of online customers and more attractive pricing (Mangan *et al*, 2011). The rapid evolution of the e-book industry was accompanied by a shift of customers from physical books to e-prints. This trend affected traditional independent booksellers who were struggling to survive in a hyper-competitive business environment (Li and Wang, 2011). To strengthen their position, and maintain their competitiveness, many of them accelerated transformation and upgrading to reinforce themselves. They started investing in digital publishing technologies, adopting virtual warehousing models, outsourcing distribution and centralising logistics activities for online and entity sales to achieve economies of scale. In conjunction with the closure of large bookselling chains (e.g. Borders), low e-reader sales and the buy-local movement, small independent bookshops see a rise in sales and are resurging in the market as small fast moving forces (Zipp, 2013). As a result of those changes, the level of operational complexity and the strain on distribution systems has increased considerably during this period.

OBJECTIVES

This paper aims to describe how bookselling businesses transform their supply chains to retain their competitive position into a fluid and ever changing market. The objectives of this paper are:

- To present a comprehensive overview of the book supply chain to widen understanding of contemporary trade structures and distribution practices.
- To review a number of social, financial, technological and logistics innovations that are currently adopted by many bookselling businesses in order to remain competitive.
- To provide insights into the challenges and the opportunities that contemporary bookselling businesses face focusing on Waterstone's case study.
- To identify how bookshops can reshape their supply chains to strengthen their market position.

RESEARCH DESIGN

The study reviewed a number of journal papers, company websites, reports, and other sources such as blogs and social networks to identify the latest trends in the bookselling sector. It was noted that there is a gap in the literature with regard to the challenges and the opportunities faced by the sector since 2005. Thus, it was deemed necessary to collect primary data through two face to face interviews with the manager of Waterstone's branch in Southampton to shed light in the changes implemented and the challenges and opportunities faced during the recent transformation of Waterstone's supply chain with the introduction of the Book Hub and the centralisation of their distribution activities.

THE BOOK SUPPLY CHAIN

The current profile of the book industry casts a wide net which begins at the publishing line and continues through to the long tail of sales distribution (Figure 1). It encompasses a range of functions including marketing, sales, warehousing, data management, order processing, logistics, collections and customer service. The principal trading actors and their roles across the book supply chain include:

- ***Authors*:** They are the creators of original literary, academic and creative works, such as novels, short stories, poems, scientific documents and plays. Authors have the exclusive right to do or authorise any production or distribution of their work.
- ***Purchasing Agents:*** They are also known as the 'gatekeepers of publishing' as their main role is to discover new unsolicited manuscripts that stand out or receive referred submissions and sell them to publishers. They often hone manuscripts to make them more appealing to publishers and the international readership, offer career mentoring and negotiate contracts with publishers.
- ***Publishers*:** They are persons or bodies who acquire from authors the right to produce, edit and disseminate the printed and electronic versions of their work. The following categories exist:
    - *Trade Book Publishers:* They acquire, edit, produce, publish and sell the books that are predominantly found in conventional bookshops.
    - *Bargain Book Publishers:* They create low-cost books for the 'bargain sections' of shops.
    - *Academic Book Publishers:* They create physical or electronic textbooks and ancillary items as workbooks and guides for schools and universities having in mind specific course syllabus.
    - *Professional Publishers:* They create books geared for scientists and professionals. Due to the need to provide reliable and up-to-date information, books are usually in electronic format.
    - *Publishing Houses*: They undertake the entire publishing process including books acquisition, copy editing, graphic design, production and printing, and often distribution and sales.
    - *Self-Publishers*: They are authors who maintain the full control of the entire publishing process including the design, distribution and marketing of their book. Their aim is to push their book onto the market, retain more rights over it and sell it at a substantially lower cost.
    - *Hybrid Publishers*: They are authors that are both self and traditionally published. Most of them embark on their self-authoring career and, while walking down this path, they get noticed by publishers looking to partner with the strongest players in the field.

- ***Sales Representatives*:** They are teams that are responsible to sell books to customer accounts.
  - *In-house Sales Teams*: Publishers develop in-house control of sales when they have an important geographical concentration of sales and a significant market share.
  - *Contracted Sales Teams*: They are independent sales representatives that are commissioned when publishers lack expertise, affiliations with distributors, knowledge of local market conditions and financial power to warrant a house sales department.
  - *Hybrid Sales Teams*: A mix of in-house and commissioned sales representatives are used when publishers cannot effectively serve themselves across their entire catchment area.
- ***Distributors*:** They are entities that buy books from sales representatives and make them available to end users through various channels. They offer basic fulfilment services (e.g. warehousing, order receipt and returns management), operational support (e.g. warehousing, packaging and shipping of overstock) and marketing services (e.g. advertising and sales cataloguing). They can be:
  - *In-house Distributors*: Many large and specialised publishers with a defined market niche (e.g. schools) have developed in-house distribution systems to enable direct contact with clients, access sales information and market own titles. This way they deliver books more effectively and predictably and receive a stable flow of payments. However handling and fixed costs rise.
  - *Contracted Distributors*: Most small/medium-sized publishers outsource distribution to third-party agents to bring down costs. Usually, third parties have exclusive territorial rights to the publishing lines they represent to increase their profits and facilitate returns.
  - *Shared Distributors:* Many distributors and publishers with own distribution systems share their services with smaller publishers. The former aim to achieve greater economies of scale and the latter to extend their reach and trade with larger customer accounts.
- ***Wholesalers*:** They are middlemen who buy large book quantities from publishers or distributors and re-sell them to end retail customers facing difficulties in replenishing stock themselves:
  - *Trade Wholesalers*: They play a key role in quickly re-filling re-orders from smaller and independent retailers not meeting a minimum order size or require urgently a just-in-time replenishment. Also, they are often responsible for shipping online orders to customers.
  - *Mass Wholesalers*: They serve major grocery, convenience and drug stores through the provision of a wide range of specialised services to retailers (e.g. buying, merchandising and inventory management) that publishers would have been unable to offer otherwise.
  - *Library Wholesalers*: They offer a range of customised services allowing for the consolidation of orders and shipments from a plethora of publishers servicing academic and public libraries.
- ***Points-of-Sale*:** They include all conventional and virtual locations selling books to end-customers:

  A. *Conventional Bookshops (Brick-and-mortal):* These include bookshops that have a physical presence and offer face-to-face customer services. Storefront visibility and appealing interior design are two of their most important weapons against online shops. Three main types exist:
  - *Chain Bookstores*: They belong to a network of conventional stores that are owned by a single entity, feature similar layout and sizing, offer same product options and share common business practices. They usually place large orders directly to distributors and publishers.
  - *Independent Bookstores*: They consist of single privately-owned and uniquely-designed shops which specialise in a particular genre and hold a relatively low number of titles. Despite their seeming simplicity, they develop complex channel relationships with a multitude of suppliers.
  - *Unbranded Bookshops*: These are unmarked outposts of book chains that do not use company branding but enter local markets as independent sellers. This way, they enhance high streets, reinvigorate the physical books market and integrate with local communities. Though, the direct competition of bookstores that are under the financial security of multi-million parent companies with small standalone shops can lead the latter out of business.

B. *Online (Click) Bookstores*: They are '*bookstores that have integrated tools based on information and communication technologies to improve their functioning and create value for the enterprise, its clients and its partners*' (Li and Wang, 2011). Two main models exist:
   - *Pure-Click Bookstores*: They are bookselling firms that have transacted in e-commerce without the intervention of conventional retailers. Transactions can be carried out 24 hours a day through secured online payment systems. Online orders are shipped from publishers to regional distribution centres (DCs) via central hubs. From DCs, books are shipped to clients.
   - *Click-and-Mortal Bookstores*: These businesses integrate offline and online operations by operating both a physical and an online shop. Books are shipped from publishers DCs to a national hub before being sent to shops. Online orders are despatched from the central hub.

C. *Mass Market*: This category refers to large retailers whose retail mix includes books. It covers from mega-sized warehouses filled with thousands of titles to supermarket aisles:
   - *Big Box Stores*: They are large free-standing retail establishments usually operating as part of a chain. They sell books on an exclusive basis or as part of a wider general merchandise range.
   - *Grocery Stores*: They are bulk sellers of food and other commodities. Publishers opt to sell in grocery stores best-selling and fast-moving titles to grow their market share and expand their reach by tempting regular grocery shoppers to stop in book aisles and browse books.
   - *Specialty Stores*: These shops trade various products that may come with associated books. Examples include the sale of children books in toy stores, and chic-lit books in boutiques. The main advantage is that retailers promote books without facing competition from rival titles.

D. *Libraries*: These serve the informational, educational and recreational needs of a community by enabling its members to access book collections, archives and computers (Sin and Kin, 2008).
   - *Public Libraries*: They are libraries open to the public and usually supported by public funds. Typically they offer book lending services, computer access, and reading and meeting spaces.
   - *Academic Libraries*: These are owned and operated by schools and universities that facilitate access of students and staff to a variety of educational resources. They may be sole providers of specific course material and offer a plethora of publications in substitutable formats.

E. *Other:* A wealth of alternative points of sale exist. The most common are:
   - *Bookstalls*: These are curb side stalls that stand alone or form part of cluster settings in select catchment areas such as flea markets, shopping streets and festival sites.
   - *Pushcarts*: These are mobile carts used by roadside book vendors and loaded with a pile of cast-off new or second-hand books usually sold at scrap value.
   - *Book Trucks*: These are push carts rolling out of a truck and down a ramp. They are used by publishers to make their imprints more accessible outside bookshops (Davis *et al*, 2015). Café tables and chairs are usually available for customers who want to sit and browse books.

- ***Purchasing Options*:** The most common methods of buying a book include (Xu *et al*, 2009;):
   - *In-store Purchases*: Consumers physically going to bookstores and buying physical books.
   - *Online Purchases:* Consumers buying books on the web and receiving them at home.
   - *Click and Collect*: Consumers making online purchases and collecting books from stores.
   - *Pickup Points*: Consumers buying books online and collecting them in convenient locations.
   - *Self Pick-up*: Consumers buying books online and collecting them at warehouses.
   - *E-books*: Consumers buying e-books on the web and downloading their electronic versions.
- ***Returns*:** These are returns of excess inventory due to inaccurate forecasting and order mistakes, contractual agreements, loose return policies, product damages and end of sales offers (Giménez, Lourenço and Soto, 2005). The internal return process includes books receipt, refunding, quality assessment, legal certification of destruction, classification, recovery and disposition through:
   - *Re-Sell:* Books in excellent condition can be re-incorporated in the main inventory.
   - *Store to Sell in the Future*: Seasonal publications that are in excellent condition, such as textbooks, can be stored for sale in a subsequent term. Storage costs must be considered.
   - *Sell Online*: The internet forms a good route for the fulfillment of unsold books (e.g. Ebay).
   - *Sell to Mass Marketers*: Unsold and recoverable books can be liquidated in mass marketers.
   - *Sell in Secondary Market*: Books in recoverable condition can be sold to second-hand shops.
   - *Donate*: Unsold books in excellent or recoverable condition can be given to charities.
   - *Destroy and Discard*: Non recoverable and non-economically recoverable books are returned to publishers or are being stripped of their covers and are discarded or recycled.

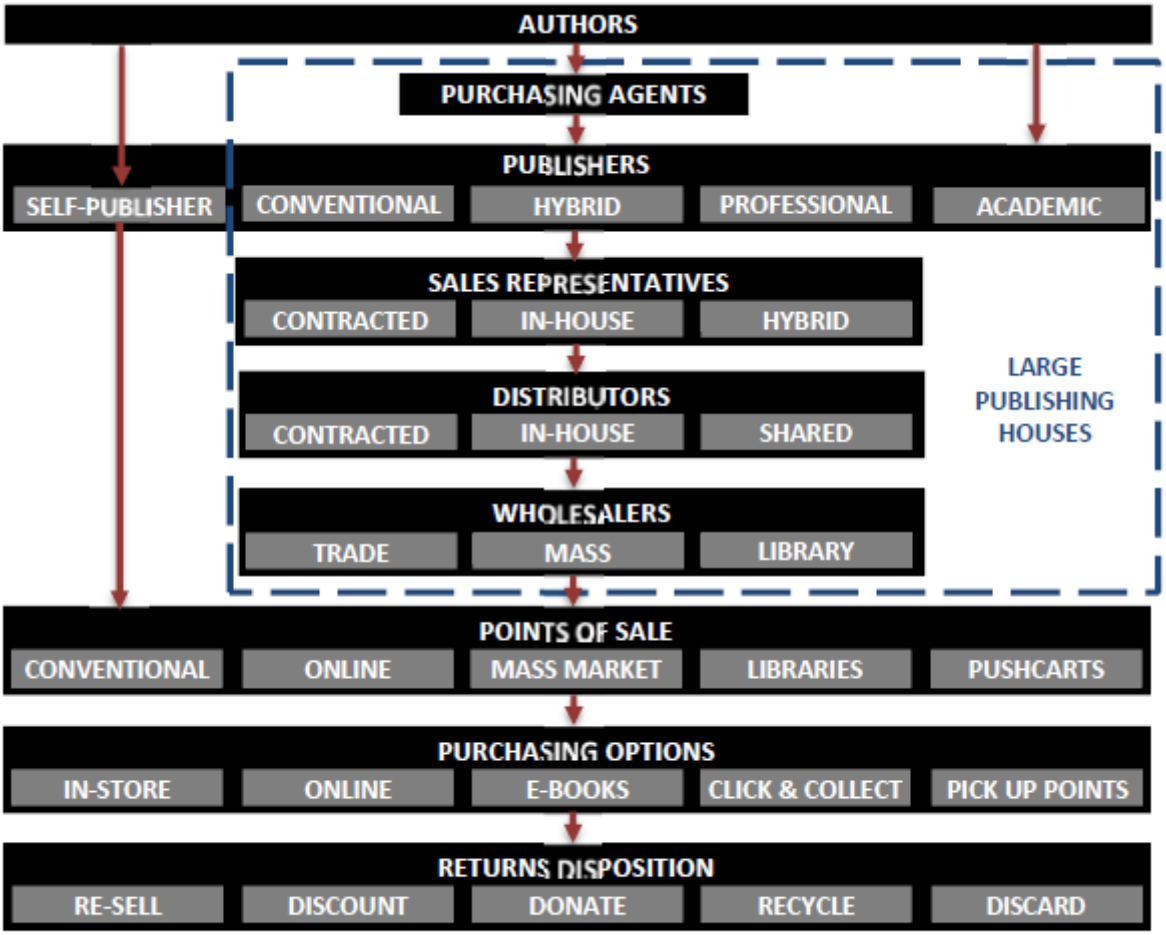


Figure 1: The book supply chain.

EMERGING INNOVATIONS IN THE BOOK SUPPLY CHAIN

Nowadays, more and more booksellers adopt various innovative practices to strengthen their position and maintain their competitiveness. Examples include:

- ***Social Innovations***: Community support is one of the secret ingredients behind the survival of local bookshops currently facing fierce competition from online and big chain rivals. For example:
  - *Cultural Events:* Local bookshops have become public gathering spots that support local cultural and artistic activities and strengthen community cohesiveness.
  - *Buy-Local Movement*: This trend has grown steadily over years and has benefited local shops that add to a community's sense of identity by offering expertise and the luxury of browsing.
  - *Bookstore Tourism*: It is a form of cultural tourism that promotes independent bookstores as a group travel destination. It was initiated as a grassroots activist endeavour that aimed at supporting locally owned and operated bookshops that were struggling to survive.
  - *Subscription Services*: This model includes monthly subscription to cultivated themed boxes that suit readers tastes, enrich reading experience and eliminate reading indecisiveness.
- ***Economic Innovations***: Seeing the profit margins being encroached by bookselling giants independent bookstores have taken creative steps to fight off the growing competition:
  - *Multi-Purpose Activities*: A rising number of bookshops engage in more than one line of business to reach new customer groups, secure further income streams and alleviate some of the economic pressure. Usual secondary activities are publishing and digital re-publishing.
  - *Long Tail Marketing*: Often bookstores diversify completely their commercial activities from the publishing wing and integrate in-house cafes, bakeries and other shops (Zipp, 2013).
  - *Crowd-Funding*: It is one of the newest tactics embraced by independent booksellers and self-published authors who use online fund-raising platforms to collect donations from a wide-support base to finance a book launch, reduce book prices or expand business activities.
- ***Technological Innovations***: Rapid technological developments and e-commerce innovations have unleashed powerful forces that are affecting enormously the book sector (Li and Wang, 2011):
  - *Self-Publishing Platforms*: These provide templates, editing, conversion to e-book, proof-reading, assignment of ISBN number, print-on-demand, distribution and marketing services.
  - *E-books*: Digital publications can be read in technology enhanced devices such as e-readers, computers, tablets and smartphones. They offer user-friendly access, provide a plethora of titles and cost less than paper books. Piracy, data privacy and a luddite resistance-to-change exhibited by old-timer readers, publishers, distributors and printers has affected their sales.
  - *Virtual Warehousing*: The use of a single in-house or third-party storage facility for the fulfilment of online orders increases data accuracy, facilitates real-time visibility, centralises administrative work, reduces overhead costs and helps book firms access new sales channels.
  - *Internet of Things*: Machine-to-machine technologies allow automatic data exchange, sales monitoring and vehicle and packaging tracking to increase speed and reduce costs and waste.
  - *Print-on-Demand*: It allows books to be printed in small batches or be digitally delivered only when an order is placed. That helps neutralise the risk of publishing a new book.
  - *Smart Tracking*: Examples include voice-picking, augmented reality and RFID devices (Hinkka, Holmström and Främling, 2012) to boost picking accuracy, productivity and network visibility.
  - *Social Media*: The use of social media as marketing platforms allows small bookstores to reach customers without the benefit of giant advertising budgets (Zipp, 2013).

- ***Distribution Innovations***: Many businesses try to ease the distribution bottleneck by adopting:
  - *Omni-channel Models*: Many book firms adopt a cross channel business model by fusing their websites, mobile applications and in-store services to offer customers a unified experience.
  - *Consolidation Centres*: These are introduced in book distribution networks to group small disparate shipments, simplify the goods-in process, alleviate traffic congestion, cut pollution, reduce empty-running and free-up sales floor (Triantafyllou, Cherrett and Browne, 2014).
  - *Driverless Vehicles:* Large booksellers as Amazon start deploying autonomous vehicles and drones to deliver book orders to customers and move goods in and around warehouses.

CASE STUDY: WATERSTONE'S

Waterstone's is a British book specialist established in 1982. In 1998 it became a subsidiary of the HMV Group, a global entertainment retail chain owning a number of small book and music retailers across various international locations. Since 2007, Waterstone's has worked in partnership with Unipart Technology Logistics (UTL) to process store and online deliveries. As of 2011, Waterstone's belongs to the Russian held A&NN Capital Fund Management. It currently operates 275 stores and employs around 3,500 staff in the UK and Europe and trades about 30,000 book lines. Since 2012, it has introduced its own Café W brand and has partnered with a number of companies to sell their products such as Amazon to sell the Amazon Kindle (Waterstones, 2017).

Direct-to-Store Deliveries System

As of the time of the 2008 interview with the manager of Southampton's outlet, Waterstone's employed 4,500 booksellers across a total of 325 branch outlets in the U.K. The goods-in process at the time was managed independently in stores, with staff and managers having the autonomy to place direct orders to over 2,500 publishers. According to Southampton's manager, the main supplier base for his shop was formed by 7 publishers who were delivering stock daily (Penguin Books, Harper Collins, Bookpoint, The Book Service, Littlehampton Book Services, Macmillan Publishers and Oxford University Press). Another 15 UK based publishers were delivering books, stationery and promotional material on a weekly basis. Hundreds more publishers were shipping orders on a per request basis. The majority of the main suppliers had employed 3PL providers, predominantly Parceline (65% of deliveries), DHL (25%) and FedEx (<10%) while many more small size orders were shipped through the Post Office. Although Waterstone's had worked with individual publishers, distributors and retailers to design a custom-built re-usable tote box, the vast majority of incoming goods were packed and transported in cardboard boxes. During a typical week, about 270 cardboard boxes (15.2m^3) were shipped in 31 delivery trips made by the 7 main publishers. During October and November, a 10% increase in the number of deliveries (n=34) and a 230% increase in the number of cardboard boxes (n=884) were recorded resulting in a 4.7% increase in the last-mile distance travelled and a 16.6% increase in the CO_2e produced. The use of cardboard boxes was creating increased levels of waste and heightened demand for handling and time. Overall, this system was resulting in high levels of small inbound loads carried by vans, highly frequent orders from too many origins, low forecast accuracy, increased operational handling and processing at stores, long customer fulfilment times, reduced sales and poor customer satisfaction (UTL, 2017).

Transition to the Book-Hub

In September 2008 Waterstone's started replacing the existing 'direct-to-store deliveries' system with a new automated consolidation centre to simplify the goods-in process and enable more efficient and cost effective communication between stores and publishers. The Book Hub was a new 14,700m² distribution centre in Burton-Upon-Trent in Central England with a capacity to handle up to 1.5 million shipments a week and over 70 million books a year. Since its opening, most of the existing 2,500 publishers changed their delivery schedules and gradually joined the scheme. At the time of the 2011 interview with the new manager of Southampton's outlet, a number of shops had already joined the scheme on a pilot basis. Under the new regime, publishers were shipping their books to the Book Hub where consignments were processed, consolidated and delivered to stores using Waterstone's fleet. In the Book Hub, books were priced, packed, stickered and sorted in a cross-belt system with 100 chutes, each with 24 receiving locations for totes to match to up to 24 book theme categories. Bar-coded plastic totes were used to reduce the need to being scanned one by one upon their receipt at stores. Larger shops were receiving daily deliveries of up to 60 totes each and smaller outlets 1-2 deliveries per week. An in-house fleet of 60 rigid delivery vehicles was used and supplemented with sub-contractors on smaller routes. Book returns were back-loaded in delivery trucks and processed in the Book Hub. Slower moving titles were re-distributed within 24 hours using the available capacity of the delivery fleet, while unwanted items were recycled using an on-site pulping system. The site was also used by UTL that was responsible for the fulfilment of online orders for more than 150,000 lines.

The transition towards the centralised distribution system enabled stock concentration at the Book Hub cutting down the total number of store deliveries from the seven main publishers from 31 to 5 during a typical week and from 34 to 6 during a busy week (Figure 2a). As a result, a 80% reduction in the distance travelled by the seven publishers was noted during a typical week (from 6,357 km to 1,280 km) and a 77% during a busy week (from 6,656 km to 1,536 km) (Figure 2b). Further optimisation of scheduling and dispatching activities was achieved through defined delivery routes, in which specific stops were planned and executed in terms of quantities and time. More specifically, Waterstone's outlet in Southampton formed part of a delivery route that included another five stops in regional branches. Each shipment to Southampton included 30-35 plastic totes received on a defined time-window (14:00-15:00). Totes were carried from the service yard to the shop floor by the driver, rendering unnecessary the recruitment of a staff member to receive deliveries. On top of that, returns were back-loaded reducing the need to process daily dedicated collections as happened in the past. From an environmental perspective, the introduction of new, reusable pallets and boxes, filled with 'shelf-ready' stock which could be pushed straight onto the shop floor, led to drastic reduction of the packaging waste (cardboard and polythene) produced. Significant savings were also made in terms of the total emissions (kg CO_2e) produced from the seven main publishers both in the long and the last mile (Figure 2c). Despite the apparent benefits, Waterstone's new scheme experienced significant challenges due to delays in the implementation of changes which resulted in reduced stock availability and weakened stores proposition. The 2009-10 performance was reportedly affected with profits slumping by more than 70% to £2.8million. As a result Waterstone's kept relying on third-party wholesalers delivering goods when available stock was low. Despite the apparent difficulties during the first stages of the transition to the Book Hub, the store manager highlighted the satisfactory progress of the scheme and its function as a platform from which the company had already started to re-build profitability, while achieving significant transport and environmental benefits.

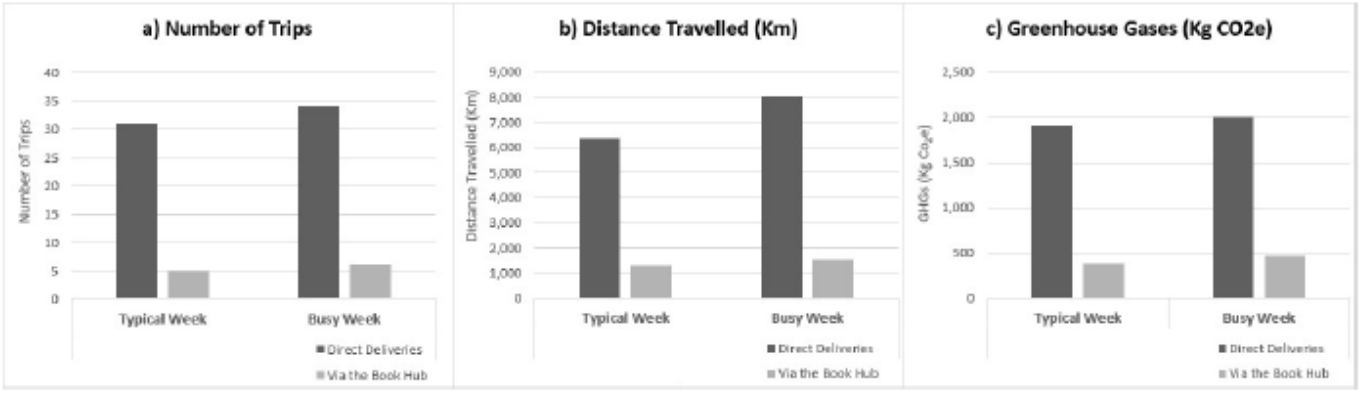


Figure 2: Weekly a) number of deliveries, b) distance travelled, c) greenhouse gases of the 7 main publishers servicing Waterstone's branch in Southampton before and after the transition to Book Hub.

2014-2017 Supply Chain Transformation

In light of the ongoing global recession, shifting consumer habits and intense market competition, Waterstone's joined forces with Unipart in 2013 to review its supply chain with the aim to reduce costs, improve customer service and survive the economic downturn. The transformation included changes in its relationships with suppliers, the integration of advanced IT and automation systems, operational processes and retail facilities. In addition, they refined store ordering systems, reduced in-store stock levels, increased the product range, adopted more visually appealing ways to present books and reduced delivery lead times to stimulate customers interest and enhance in-store experience. In the first year of its operation, the newly built customer-centric supply chain helped Waterstone's improve its forecasting activity to 98%, reduce its operational costs by 11%, cut returns and the associated costs by >28%, shorten lead time from 7-9 days to 16 hours and minimise in-store inventory levels by £5m (UTL, 2017). Further developments included the closure of underperforming stores, the opening of an internet outlet, a London superstore and three unbranded shops in small UK towns. The business supported the de-centralisation of buying by tailoring each branch to the needs of its customers.

CONCLUSIONS

This paper investigated the current transformation of the book supply chain in response to the ongoing economic recession, the advent of disrupting technologies and the changes in consumers habits. In examining contemporary trade structures and distribution practices, it was found that many traditional bookstores penetrate into new product market channels and integrate online sales in their operations. This though imposes increasing pressures on distribution and collection systems and makes logistics more complex to manage and expensive to operate as businesses have to deal directly with a multitude of suppliers and a widespread variety of products. Many small independent bookshops have responded by investing in tracking systems, becoming public gathering spots, specialising in particular genres, holding a relatively low number of titles, and by taking advantage of the buy-local movement and crowdfunding. Larger chains, such as Waterstone's, have responded by diversifying their retail activities, centralising their distribution activities to shorten their logistics and giving each branch the autonomy to make its own decision on the book lines they offer and better serve localised customer needs. Thus, to strengthen their position and remain competitive, bookshops must penetrate into new product market channels, integrate online shops, invest in disrupting technologies, offer specialised services, outsource distribution and centralise logistics activities to achieve economies of scale.

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Expectations of millennial consumers regarding online shopping and fulfilment

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Introduction

Traditional supply chains and distribution systems are challenged by the evolving behaviours of consumers and the continuous rise of online shopping, which has redefined the delivery process in a digital world. New generational segments of consumers are driving global consumption and among them are Millennials, i.e. those born between 1982 and 2004 according to most definitions (Hall & Towers, 2017), who are rapidly becoming the largest market segment for online shopping. According to recent industry studies, Millennials buy more than one-third of online, non-food shopping and 50% of them are expected to do so by 2019 (Pickburn, 2017). In the context of online shopping, retailers have to focus not only on moving goods across the distribution network, but also on providing the ultimate customer experience when consumers receive their ordered products or need to return them. This is driving various and exceptional logistics challenges for retailers to enable flexible order fulfilment and delivery, and improve at the same time visibility and real-time communication with customers. In this sense, retailers' competitive advantage is intrinsically linked to the design of appropriate, effective and efficient distribution systems (Murfield et al., 2017). This paper reports on a study-in-progress investigating Millennials' consumer behaviour towards online retail and their requirements for online product fulfilment in a pan-European context. Specifically, we investigate the impact Millennials' behaviours and preferences have on current online retail logistics and distribution systems (both forward and reverse flows) to identify what future distribution system redesign is required to fulfil their needs.

Literature Review

From 'Bricks & Mortar' to online shopping, multi-channel and omnichannel

Traditional retailing activities are based on the concept of 'bricks & mortar' (B&M) distribution channels, i.e. single-channel distribution systems where products are sold in physical stores accessed by customers for making their purchases. Alternative ways for selling products were introduced with the rise of online shopping and retailers are differentiating themselves depending on the adopted approach to retail logistics. In particular, online shopping sees the presence of the so-called 'pure players', i.e. retailers that do not have an up-front store presence and sell products only via the internet; and multi-channel retailers, or bricks and clicks/ multi-channel retailers who offer online shopping platforms along with traditional B&M retail channels (Xing et al., 2010). More recently, in order to satisfy the growing needs of diversified shopping preferences and seamless customer experience, retailers are moving towards the concept of 'omnichannel' distribution (Ishfaq et al., 2016a). While multi-channel distribution operates with isolated structures with independent online shipments and store deliveries through multiple but distinct distribution channels, omnichannel distribution integrates marketing and operational activities across channels with merged frontend and backend systems (Murfield et al., 2017; Hübner et al., 2016). With the rise of the omnichannel distribution new customer segments and distribution challenges for retailers emerged (Bell et al., 2014; Ishfaq et al., 2016b). In fact, customer expectations are changing rapidly, and this has an effect also on what logistics service quality (LSQ) means in an omnichannel context. As a consequence, it is imperative to understand omnichannel customer requirements to develop an efficient and effective logistics system supporting this new and growing distribution channel. In the existing body of knowledge, research on multi- and omnichannel

retailing focuses on channel-specific requirements, configuration of the logistics systems and their development for online retailing or customer behaviour (Hübner et al., 2016).

Logistics service quality challenges and impacts on distribution systems

Initial considerations for LSQ have been built on the construct of physical distribution service quality (PDSQ), defined according to the dimensions of availability of products, timeliness of delivery, quality of delivery, order status information and order condition (Mentzer et al. 1989, 2001). The literature has debated the traditional elements of PDSQ (primarily discussed in traditional business-to-business - B2B - contexts) in the light of online shopping and examined to what extent the dimensions of PDSQ can be translated and adopted for assessing the logistics service quality in a business-to-consumer - B2C - online shopping environment to design an e-PDSQ model, as discussed and tested by Xing et al. (2010) which found four critical constructs: availability, time, order condition and returns. Alongside, the concept of e-PDSQ needs to be complemented by considerations on the service quality of online shopping in general. Electronic service quality or e-SQ is defined by Zeithaml et al. (2002) as the extent to which a Web site facilitates efficient and effective shopping, purchasing, and delivery of products and services. E-SQ is affected by elements such as web site design, information availability and search, security issue, order transaction, and order delivery. E-SQ could be a differentiating element for online retailers to win the competition if associated with efficient and effective order fulfilment and is considered to be the essence of e-PDSQ and one of the critical elements affecting customers' perception of service quality and satisfaction Xing et al. (2010). Nevertheless, previous research seems wanting of extensive contribution on order fulfilment and logistics customer service factors especially in the context of omnichannel distribution with integrated supply chain and distribution operations across channels (Murfield et al., 2017).

The rise of the new generations: Gen Y, Gen Z and Millennials

Several classifications of generations have been proposed in the literature with generational cohort classifications based on shared experiences relating to life stage, rather than social class or geographic groupings (Sessa et al., 2007). The Millennials generation (born 1982-2004) is composed of individuals belonging to the so-called Generation Y (born after 1981) and to Generation Z (born after 1991) (Hall and Towers, 2017). A fundamental trait of Millennials is their early and frequent exposure to technology, which has implications for their cognitive, emotional, and social development as individuals, consumers and professionals (Immordino-Yang et al., 2012). Multiculturally and sexually tolerant, they are tech-savvy and always connected and they rely on technology for a number of purposes including entertainment and interaction with other people. Millennials have grown up in a favourable period of economic prosperity (until recently) and in a context of innovation and rapid change. They have witnessed a turbulent development of communication technologies and social networking technology in a global and massively connected world (Park & Gursoy, 2012). Alongside, Millennial consumers are commonly used to an increased availability of customized products and personalized services (Berry et al., 2010). Millennials want to have control on their decision making process, based on the information received from multiple sources. They are driven by spirit of collaboration, desire for innovation and novelty but also by inquisitiveness and impatience. In other words, like the song from the rock band Queen they 'want it all' and 'want it now' (Bolton et al., 2013). Millennial consumers, empowered and well-informed, want to be present everywhere with any media: they are 'omniconsumers' shopping across channels to maximise their utility and increase their satisfaction and contentment (Yee & Heutger, 2015). Therefore, managers and researchers need to understand expectations of Millennial consumers for the online shopping experience, and the implications for retail logistics and e-PDSQ.

Methodology

As noted above, there is a lack of empirical support regarding the expectations of Millennial consumers and their online shopping and fulfillment behavior and preferences. Thus, our research objective was to undertake an exploratory pilot study with a large sample to answer the questions and focus on Millennial consumers to obtain general insights, as compared to case studies or qualitative interviews with individuals. Surveys can provide an extensive number of respondents to generate both a description of the current situation and transferable theory (Babbie, 1990). Exploratory surveys are specifically appropriate to discover new facets of a phenomenon under study and provide preliminary evidence of relationships among concepts (Forza, 2002). Additionally, surveys can to have high external validity (Mentzer & Kahn, 1995). Thus, we selected a pilot survey administered to individuals at different moments in time to obtain different responses and allowed a statistical exploration of data to provide consumers' opinions on variables relevant to this study (Hübner et al., 2016). We generated measures for scale items from our literature review (Dabija & Grant, 2016) including both academic and practitioners contributions (Wagner & Bode, 2006). A first draft of the questionnaire was produced and refined through comments from the pan-European pool of researchers involved in this project. The survey was structured with closed-ended questions and multiple answers and is composed by 19 questions. The questionnaire purposively included control questions with the aim to confirm the reliability of the gathered responses (Fiore, 2016) and also allowed avoiding patterns that could occur through design (Hübner et al., 2016). Five-item Likert scales were used focusing on anchors ranging from 'seldom use' to 'use very often' or 'strongly agree' to 'strongly disagree' (Oppenheim, 1992). Since this study was a pilot at a pan-European level we focused first on two countries, Italy and Romania and respondents were selected according to a random sampling approach with the pool of respondents constituted of students attending undergraduate or postgraduate degrees in a variety of disciplines at two major institutions. The survey questionnaire was administered in December 2016 in Italy and in February 2017 in Romania. A little over 1,100 responses were obtained in total and the demographic composition had 54% female and 46% male; 43% high School, 39% post-secondary, and 17% other; and 39% from cities over 100,000 inhabitants, 49% from smaller cities and towns, and 12% from rural areas.

Findings and Discussion

Results in this section refer to respondents who chose points 4 or 5 of the adopted Likert scale, in other words are focused on those responses with an anchor of "strongly agree" or "use very often". According to the findings Millennials look for information and carry out their online shopping relying on a variety of sources and multiple responses were allowed. It appears that search engines such as Google, Yahoo, or MSN are the preferred tool used for online shopping (75%), even more than e-stores/ web stores of retailers (54%) and, surprisingly, more than buying platforms such as eBay or Amazon (45%) or manufacturers' e-stores (44%). Price comparison platforms such as Kelkoo are not very popular in terms of use among respondents (35%). From these results, it is crucial for companies to appear in the top ranking websites according to the search engines in order to be visible in the world of online shopping at the eyes of Millennials.

Figure 1 shows the motivations of respondents to purchase online versus in-store. The main motivation for online shopping is represented by the possibility to shop anytime, day or night (78%), together with the opportunity to have products delivered at home (77%), and to avoid dealing with salespeople (77%). However, it also seems that Millennials are not willing to tolerate traditional inconveniences of in-store shopping (e.g. crowds, queues), and thus

companies should make online shopping accessible and 'convenient for this category of customers as they may not wish to come to stores at all.

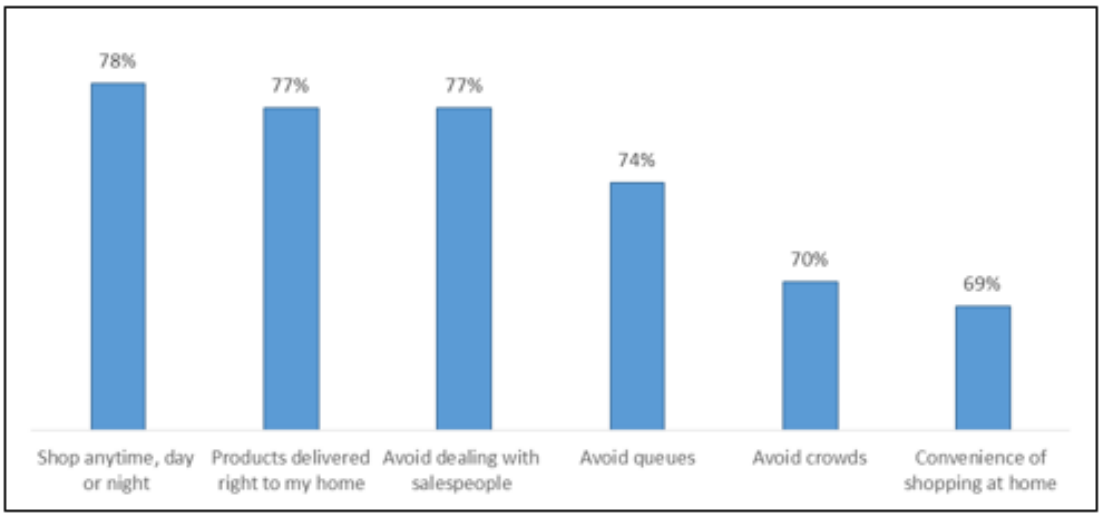


Figure 1: Motivations for online shopping

When it comes to the requirements for online fulfilment, respondents confirm their clear preference for convenience (71%), intended as ease to move within and find the desired product on the website followed by the possibility to return products (64%) when easy and convenient return policies and conditions are offered. Timeliness, intended as a reasonable amount of time necessary to buy for a product, represents another relevant item (59%), followed by cost (58%), in terms of the total product price as well as payment terms. The latter quite surprisingly is not ranked among the most relevant requirements for Millennials. Availability (i.e. no or few out-of-stock situations) closes the group of the most relevant items (56%). While these requirements seem to be something already well-known to researchers and practitioners, the importance of the key features and strengths of online shopping remains the same for new generations of customers approaching ecommerce in recent years. In particular, the accessibility of the website represents a key feature valued by Millennials, while special attention should be also paid to return policies and conditions – these have to meet Millennials' expectations and thus represents an interesting area for winning the online shopping competition.

As far as Millennials' preferred delivery options are concerned, Figure 2 shows that home deliveries via courier is the most preferred (72%), followed by home deliveries arranged by retailers with their own van/lorry (56%). It is interesting to note respondents do not attribute very high importance to the click & collect option (41%) or postal services (36%). Consistent with their expectations for online fulfilment, low levels of preference are attributed to those delivery options that entail collection locations different from the ones to where they placed their order. Again, consistent with their convenience preference Millennials highly value the possibility to reschedule (53%) and redirect (55%) deliveries when required. It appears Millennials perceive couriers as the most qualified actors to offer prompt deliveries and they express a clear preference for delivery options that besides being convenient are simple and easy to manage to suit their potentially changing needs.

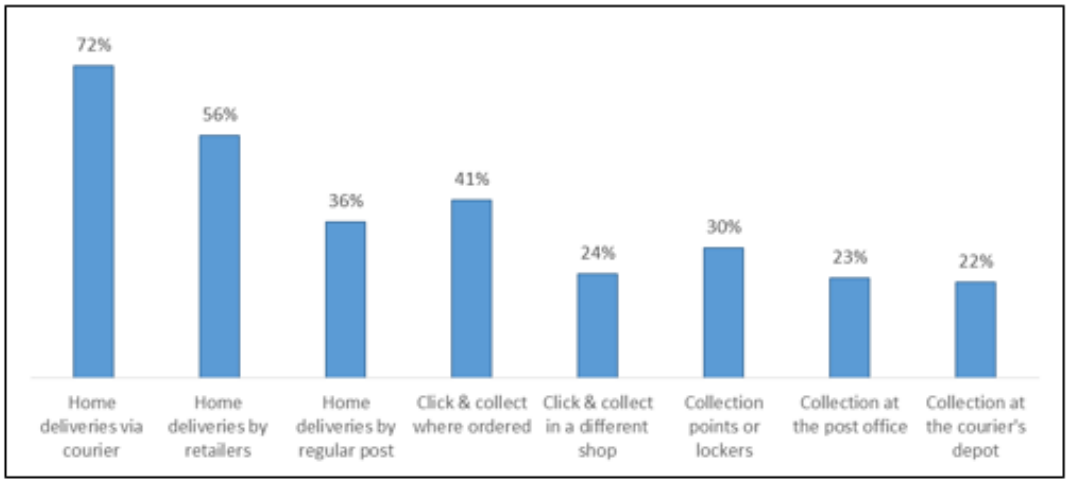


Figure 2: Preferences regarding delivery options

Respondents do not return products in a very frequent fashion as shown in Figure 3; 64% of stated they return products in one of ten orders, 19% in three of ten orders, 7% in five of ten orders, 6% every other order and 5% almost never. Millennials thus do not appear to be casually buying to try and return and seem focused in obtaining what they need in their buying activities. Thus, companies should be providing a tailored online shopping experience to allow Millennials to be satisfied at the outset with purchases.

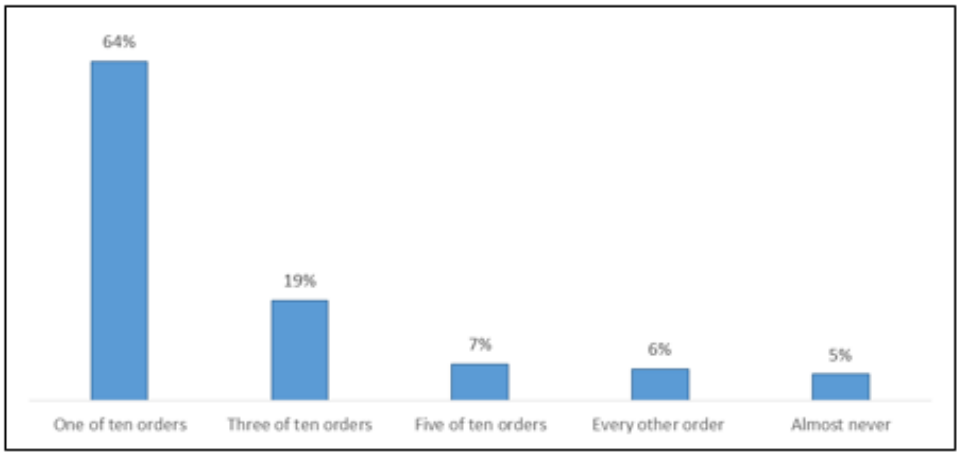


Figure 3: Frequency of returns

This kind of attitude to returns is confirmed by the reasons driving Millennials to returning products as shown in Figure 4. They return products when they are damaged (78%) or different from the one ordered (78%), if they receive a wrong product (73%) or it is defective (73%), and if the quality is poor (73%). Again, Millennials do not appear to be casual buyers and returners but it is evident that they want correct, complete and accurate products. If these expectations are not fully met by the seller, Millennials are very keen to return products and in doing this they want easy, convenient and advantageous policies and conditions.

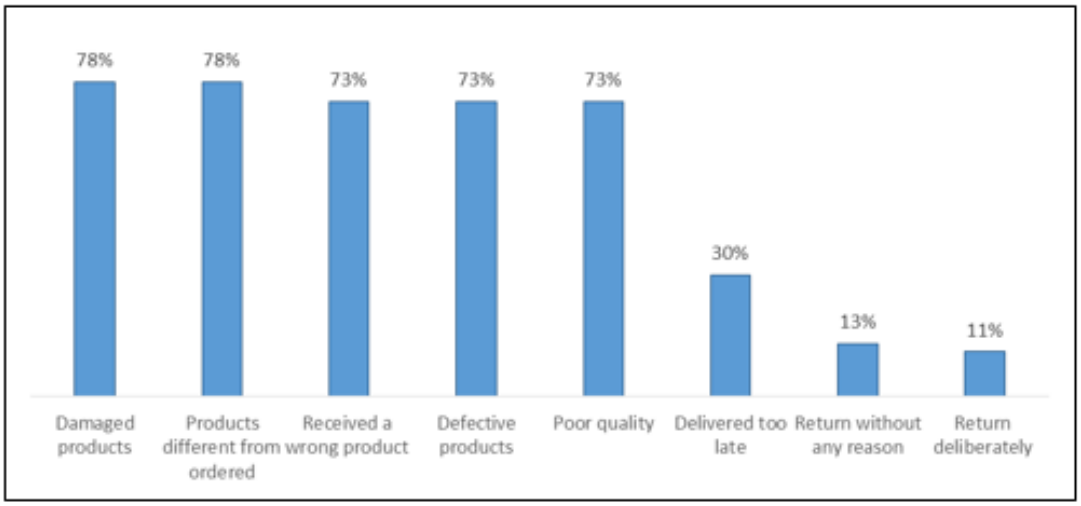


Figure 4: Reasons for returning products

When a Millennials needs to return a product they are crystal clear in terms of preferences as shown in Figure 5: consistent with their inclination for convenience, they favour having a carrier picking up the products they need to return at their address, free of charge (74%). An opposite attitude emerges if they have to pay for this return service (34%). Alternatively, they accept also to drop the product at a physical store of the company (59%) or to a collection and drop-off point, if free of charge (58%). However, if the return at a collection and drop-off point entails a payment, Millennials' level of preference drastically falls (27%). Hence, not surprisingly, Millennials look for convenient services with returns too, and they are like other consumers in not wanting to pay for them. In line with their desire to keep the process simple similar to delivery services, Millennials prefer not to deal with intermediaries or third-parties when arranging a return (33%) but want to have a direct contact with the retailers (71%).

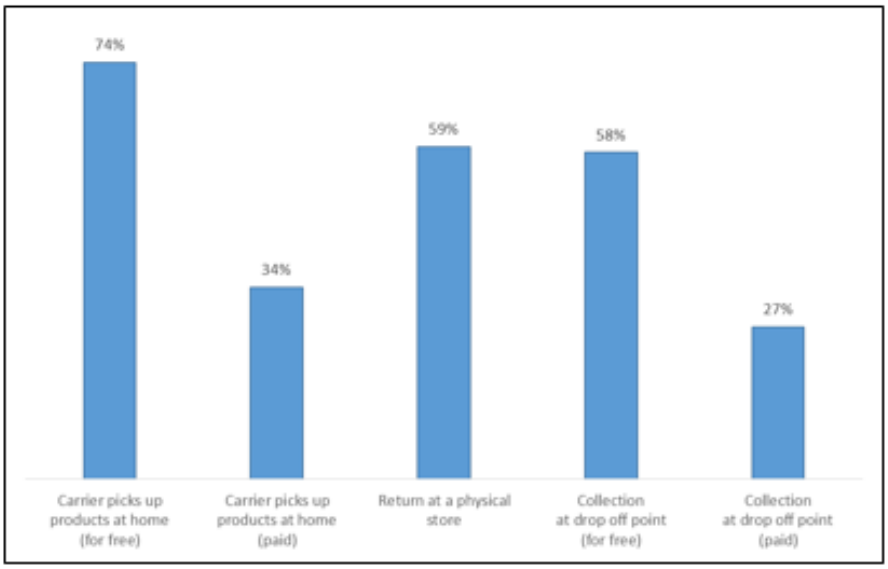


Figure 5: Preferences for returning products

Looking at how Millennials appraise their online shopping and fulfilment overall, the results indicate a good level of satisfaction in general with the services provided by the e-retailer used for their main purchases (77%). Likewise, they are satisfied with the purchased products and related brands (75%). However, they wish other e-retailers were more like their main one (66%) and that other favourite brands were like the ones they purchase online (66%), showing interest for a larger pool of products to buy online via good shopping platforms, providing they have a good experience with them. Apparently connected to their level of satisfaction, Millennials' loyalty seems to be related to good experience with e-retailers and/or brands. Respondents stated that they will probably use same e-retailer again for the main products purchased online (76%) and that they prefer to rely on the same e-retailer used to others in a specific category of products (69%). Likewise, they affirm that they will probably purchase the same brand again for the main products they buy online (62%) and concerning the main products purchased online, they prefer one producer brand to others in a specific category (56%).

Conclusions

The findings of our exploratory study provide some good insights into what Millennials want from their online shopping and fulfilment experiences, which they desire as opposed to transitional B&M retailing for a number of related reasons: convenience in terms of the ordering process and fulfilment; delivery via couriers with the ability to reschedule and redirect as opposed to click & collect; the ability to return products conveniently through home pickup at no charge; and communication primarily with the retailer. The learning here for retailers is to amend their service offering to meet these criteria as by doing so and meeting Millennial needs they will be rewarded with satisfied and loyal customers. However, we note these findings are from a pilot study and so these insights should be viewed with caution as they are preliminary and contextually based in Italy and Romania. The next steps in this study will entail refining the survey instrument to eliminate those questions that did not add value or receive significant responses and then conducting the main study this autumn and winter across several countries in Europe to generate a larger response for more detailed quantitative analysis including looking at country differences and determining if there are any underlying constructs for the entire sample.

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Reverse Logistics and 4P

Relationship between 4PL providers and carriers: A tale of a love-hate relationship

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Introduction

Companies are restructuring their business practices to facilitate 'mass customisation' processes ultimately in the pursuit of sustainable competitive advantage (Capineri et al., 2006). In fact, customers are 'co-creating' value across the supply chain through phenomenon such as 'omni-channel revolution' (Christopher, 2016) by contribution in information, research and innovation. Linked this trend, 'Fourth Party Logistics' (4PL) emerged as the new paradigm to deliver greater value to the customer by providing comprehensive end-to-end SC solutions (Christopher and Holweg, 2011).

The customer driven market environments are erratic in nature (Angkiriwang et al., 2014). These fluctuations are countered using flexible mechanisms (Seebacher and Winkler, 2013). Though 4PL provides these advanced mechanisms, it can only be achieved by 'effective collaboration' (Balcik et al., 2010). 4PLs ought to act in co-ordination with different operations to ensure stability in a relationship and not be simply just another operating agent (Audy et al., 2012). Although there is a plethora of literature around 'what a 4PL should do?' and the 'rules of 4PL', little is published on the complexities in a 4PL relationship. Indeed, the abundant literature focuses on partnerships purely as a medium to reduce costs and very little can be found in 4PL and carrier synergistic collaboration (Vivalidini et al., 2008). Papadapoulou et al (2013) proved that 4PLs have failed to execute effective carrier selection templates. This study attempts to add value to the literature by answering the following research questions:

- RQ1: What factors should be considered before a 4PL embarks on a partnership with carriers?
- RQ2: What are the challenges involved in a 4PL relationship with carriers in obtaining and forwarding positive results to its customers in the supply chain?
- RQ3: What type of flexibility do 4PLs establish with their carriers to construct a successful partnership?

This paper attempts to contribute by addressing this gap and aims to develop a 4PL collaboration model with carriers through the application of n idiographic case study is conducted, in a leading 4PL located in Milton Keynes , UK. This 'Company Y' operates in 16 European countries with 400 facilities. The paper proceeds with a review of relevant literature followed by the methodology section. Subsequently, the findings are presented and the main highlights of the study are discussed in the conclusions section.

4PL literature – gaps and opportunities

4PL is a non-asset based logistics provider which engages in value creation by leveraging the resources of partners. 4PLs can enable vertical and horizontal collaboration across supply chains and markets to achieve 'synergistic collaboration' (Sanchez Rodrigues et al., 2015). 4PL serves a 'one stop hub' to provide value-added supply chain solutions to all its participants which on one hand requires close cooperation with the 3PLs and at the same time needs a trusted relationship with the customer (Fairchild, 2016). The typology adapted from Hingley et al. (2011) offers a methodological process for 4PL to determine the nature of service offering via the type of collaboration (X-axis) while suggesting enhanced value for the customer (Y-axis). The types of relationships 4PL can offer are:

- Type I – Non-critical relationships: 'transactional oriented' and is a low value adding, which includes sub-contractors in providing informational advantages from the ground
- Type II - 'lean flow' – 3PLs providing process efficiency improvements
- Type III – 'agility' – provision of flexibility to response to uncertainty
- Type IV – 'leagile': common industry innovators providing mass customised and highly resilient logistics Critical Success Factors in a Logistical relationship

Appedix 1 summarises the critical success factors for an effective logistics collaboration from SC literature starting 2007 to present (2016). It is seen that the most important factors for a successful SC collaboration are Information sharing & IT systems, Trust and Commitment, Sharing Resources and Risks along with Innovation initiatives, followed by Service differentiation/Flexibility, the need for Goal alignment and finally, Costs and Investments.

Conceptual Framework

A study conducted by Naesens et al (2007) suggested that lack of strategic support framework is one of the key challenges in an effective collaboration, while Matopoulos et al (2007) called for a more nuanced understanding of the SC because of the multiple elements that interact with each other. In retrospect, a systematic procedure has been drawn to analyse the depth of the 4PL relationships in accordance with Ye and Wu (2015) i.e. the key variables for a 4PL partnership should be deciphered and evaluated with respect to different suppliers. Hence, a multi-criteria decision making framework is proposed to identify the most suitable relationship model tailored that reflects the true relationship of cause and effect based on the factors described in Figure 2. Further, the sub-criteria need to be identified that may support root cause analysis and initiate surgical intervention. Therefore, a model is developed (Figure 5) as a mediation for 4PL collaboration with the carriers which will form a base for a critical evaluation.

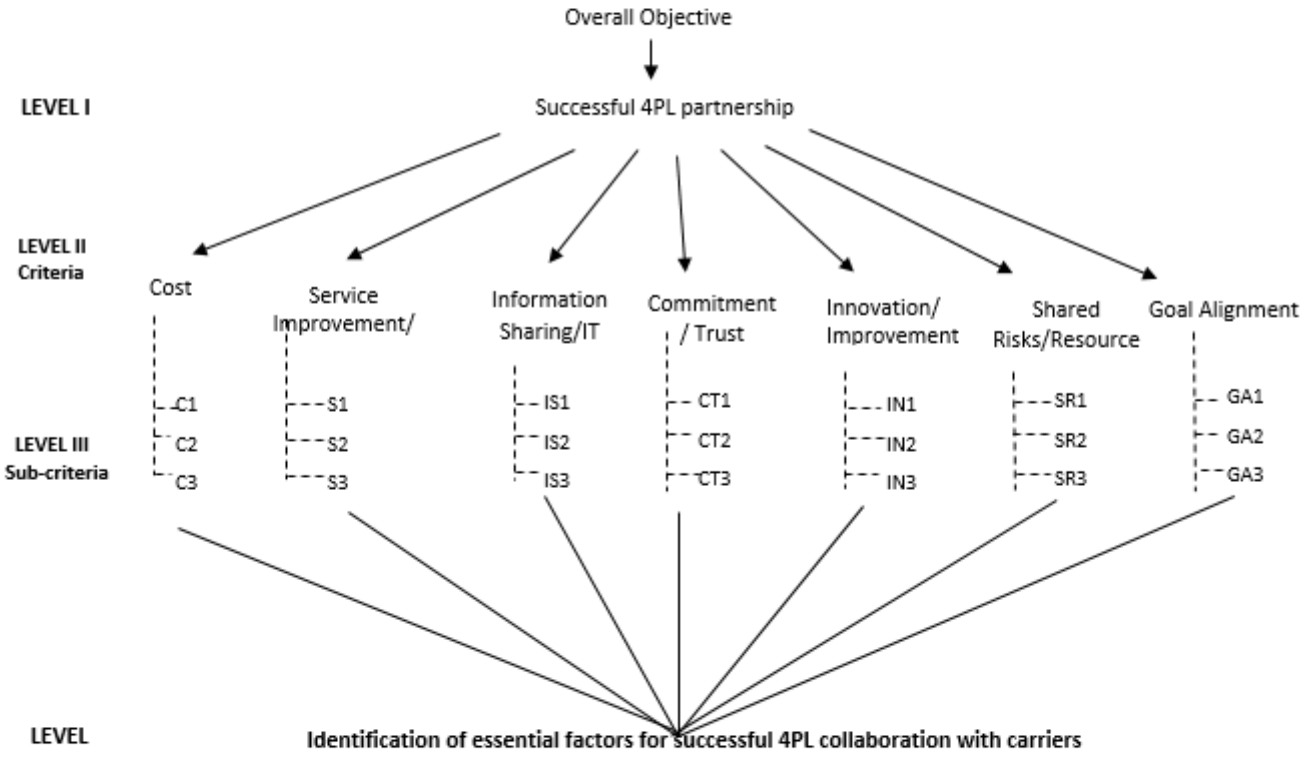


***Figure 5** - Proposed Conceptual Framework for evaluating factors for successful 4PL collaboration*

Methodology

The case study of a leading 4PL (named Company Y) based in the UK is chosen. Company Y has 60 years' experience in the industry with 475 offices worldwide. It is currently involved in liaising with a leading pharma client for 16 European countries. According to Yin (2009), a case study approach is a systematic research tool that allows an in-depth and a thorough examination of the subject for a fair production of analytical conclusions. Further, within the main case study, multiple embedded case studies of the

individual carriers were carried out across three phases to provide a holistic and a detailed picture of the organisational culture and strategy (Yin, 2009). Phase 1 included pilot study with a focus group of 10 respondents from company Y. In Phase 2, the semi-structured telephonic interviews were conducted with company Y and its 4 European In-market secondary distribution carriers across three countries (Germany, France and Italy) over a period of 4 weeks. In Phase 3 follow-up interview, the themes identified from Phase 1 and 2 were cross-checked with company Y. The interviews lasted between 45 minutes to 2 hours. The details of the data collection are seen in Table 2.

Findings gathered from the study

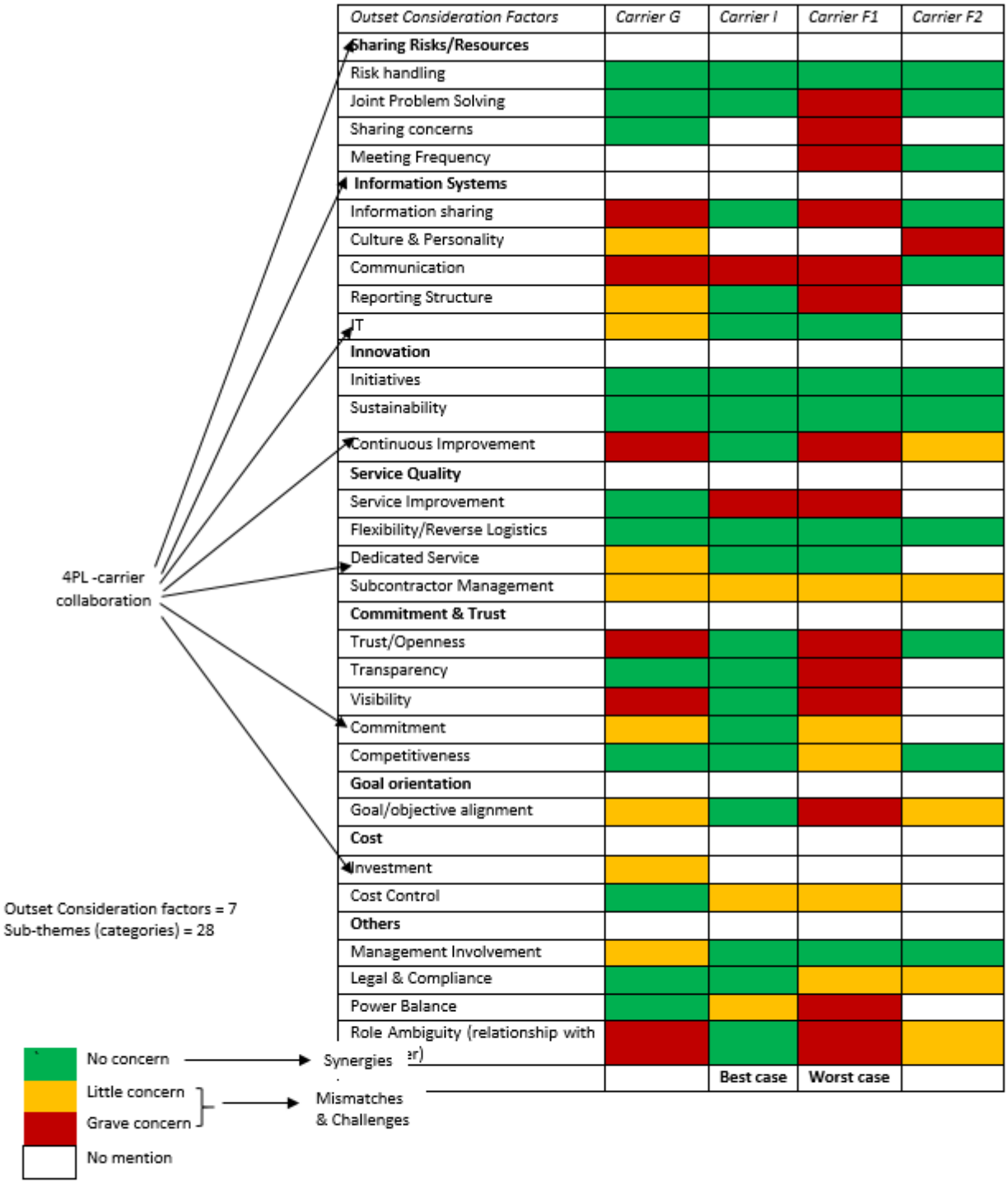
In analysing the data, we could identify 28 sub-criteria under the main criteria initially identified in Chapter 2. Besides the main factors such as Sharing Risks/Resources, Information Systems, Innovation, Service Improvement/Flexibility, Commitment & Trust, Goal orientation and Cost, other key factors such as Power Asymmetry and Role Ambiguity caused due to the carrier's previous or existing relationship with the customer were identified as summarised in Table 4. Further, the mechanisms identified for each factor will be further outlined in detail.

Outset consideration factors: Synergies and Mismatches

The major area of concern was the 'Information Sharing' cluster. Carrier F1 points that the opaqueness of the contracts and the confidentiality of the key timelines between Y and the customer was the main issue. Further, carrier G thinks that "they [company Y] sometimes want to know more things than we can provide". Moreover, in 'sharing risks and resources', the biggest challenge according to F1, was to share with the Y the main picture of the activities. On the other hand, there was a good level of cohesive decision-making especially for carriers like G, I and F2. Further, Carriers G and F1 were seen having problems in 'trusting' company Y. F1 believes that the Y becomes a competitor when F1 gets in direct contact with the customers. In the case of G1, it was seen that there is no mutual trust mainly because of the loose accountability structure.

In terms of Service and flexibility the best case was Carrier I which provided a tailored service for company Y. Carrier F2 and G shared high levels of service exchange with Y, though it was not 'dedicated' specifically for a single customer. Also, it was commonly seen that some carriers (F1, G) expressed problems with the sub-contractor service. Innovation and continuous improvement is significant for a 4PL sustenance. Positively, all the carriers were involved in various innovation initiatives such as renewable energy (G, F2, G) green solutions (F2, G) temperature control designs (F1) and GPS systems (I, G). However, when it came to 'continuous improvement' few carriers (G, F2 and F1) believed there were no significant improvements at all. In fact, F2 stated that their main job is the depository business and therefore finds no difference. 4PL and carriers work for a common goal i.e. customer. However, the response from F1 was not convincing and in fact, emphasised the need for "alignment" 13 times during the whole interview. Whereas, Carrier I and F2 showed high levels of goal alignment and dedication towards Y. Lastly, all carriers preferred quality over cost. It was seen that most of the carriers subjected to cross docking consolidation mechanisms to reduce cost. However, F1 points that the industry best practices regarding costs and quality consolidation needs to be shared amongst the stakeholders which is lacking.

The interview with company Y showed that there was a gap in terms of support and proactivity from the side of the carriers. It was identified that factors like 'carrier relationship with the customer' played a cascading effect on the existing mutual relationship between Y and carriers. This means that such "triangular" relationships lead to loss of role clarity. Moreover, in few cases, (Carrier F1 and I) it was found that this factor led to a 'Power Asymmetry' which was a potential hindrance for an effective collaboration. It was found that in some cases, Y hits a "brick wall" with the carriers. Further, F1 expects Y to be more visible with the information while G is hesitant to leverage excess information to Y.



Outset Consideration Factors	*Carrier G*	*Carrier I*	*Carrier F1*	*Carrier F2*
Sharing Risks/Resources				
Risk handling				
Joint Problem Solving				
Sharing concerns				
Meeting Frequency				
Information Systems				
Information sharing				
Culture & Personality				
Communication				
Reporting Structure				
IT				
Innovation				
Initiatives				
Sustainability				
Continuous Improvement				
Service Quality				
Service Improvement				
Flexibility/Reverse Logistics				
Dedicated Service				
Subcontractor Management				
Commitment & Trust				
Trust/Openness				
Transparency				
Visibility				
Commitment				
Competitiveness				
Goal orientation				
Goal/objective alignment				
Cost				
Investment				
Cost Control				
Others				
Management Involvement				
Legal & Compliance				
Power Balance				
Role Ambiguity (relationship with er)				
		Best case	**Worst case**	

Table 4 - Key areas of synergies, mismatches & challenges between the Company Y (4PL) and the carriers
To summarise, there were few strengths in the relationship such as 'Innovation' and 'Service' clusters, whereas the main weaknesses were in the 'Information', 'Trust' and 'Sharing' clusters. 'Cost' received a

tepid response whereas the explanations in 'goal alignment' cluster were not convincing. The challenges were mainly due to 'Other factors' that were identified such as 'Role ambiguity' and 'Power Imbalance' which rose because of carriers' relationship with the customer. These factors had a direct effect on having a flexible relationship which was least for F1, moderate for G and the highest for I and F2.

Conclusions

The research contributes to the literature by determining the factors necessary before 4PL embarks on a partnership with carriers, thereby answering the gap earlier pointed by Papadapoulou et al (2013). It can be concluded that Trust and Commitment is the most important factor in a relationship between 4PL and a carrier. This is primarily because the relationship dimensions in a 4PL is complex owing to its multiple parties and operating structures and hence demands greater collaboration through deeper commitment. This will further enhance other key factors like information sharing and Risk sharing and resource leverage. Moreover, lack of effective barriers within a relationship may also increase trust. Further, additional factors such as 'Power Symmetry' and 'Role clarity' were identified which was caused due to the carrier's (direct or previous) relationship with customer. 4PL may fail to forward positive value to the customer due to the lack of cohesive support from the carriers. One major factor is the 'skewed' relationships owing to the 'tripartite relationship structure' which may cause plausible drawbacks like competition, parochialism, dyadic partnership and goal dichotomy between the involved parties.

Further, the supply networks of the successful 4PL-carrier partnerships are agile focussed. The models have shifted from yesteryears' lean or cost oriented structures to a more responsive agile synergy models. This helps develop capacity to tackle fluctuations caused due to the changing needs of the customer; for instance, by building an effective reverse logistics system. Also, alignment and adaptability leads to greater agility. Finally, by establishing a mutual agile relationship value can be continuously delivered and replenished to the customer. Lastly, as long as the customer seeks value, 4PLs will need to collaborate efficiently with carriers. Though 4PLs and carriers have sufficient reasons to love and hate each other, however, it may be concluded that one is indispensable for the survival of the other and their collaboration is inevitable for the future of the SC.

Although the critical factors have been discussed previously in literature, this study provides new insights by addressing those additional factors which may reduce the impact of possible inevitable disruptions in intermediary partnerships. This study provides managers enough ground and guidance to revisit strategies before 4PL ventures to collaborate with the carriers. This will improve flexibility and increase scope to tackle complexities by surgical intervention. This will further better horizontal collaboration and higher asset utilisation through mutual trust and commitment to serve a single vision i.e. customer. This strategic alignment within the upper tiers or management level will improve operational efficiencies on ground through efficient information sharing, visibility, greater resource leverage and reduce costs and lag time. This insight is particularly relevant to managers in sourcing: another carrier may offer better price however, it may or may not last long term in terms of sufficing strategic expectation of the 4PL. However, negotiations should be aimed towards achieving longevity of relationships and hence short-term shift in bargaining power towards carriers may be strategically ignored. Moreover, clients and carriers may use this study as a medium to holistically analyse the complex network models of an intermediary in a SC.

To examine the autonomy that a client provides to a 4PL future research may look at studying the relationship between 4PL and client. Also, the companies investigated were under the pan - European leg. It would be beneficial to conduct a cross-case research from diverse range of industries across geographies to increase validity. An 'Action Research' may be conducted to increase the depth as well as breadth (scope) of the critical factors considered for 4PL evaluation. A meta-analysis approach may be considered to conceptually integrate results from multiple studies using statistical tools. Also, this research mainly deals with a pharma client and future research may be particularly directed towards the

'inventory heavy' fashion retailing and beverage industries (Win, 2008) because these industries are specifically modelled for in-house regional clusters than conventional 4PLs.

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Authors → / Attributes ↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total	Description
Costs & Investment	X					X	X			X					X		X		X			X			X	9	There exists a need to support a unified systematic structure for lower support and operations costs
Sharing Resources/Risks					X			X	X	X		X		X			X	X	X	X	X		X	X	X	14	It is pointed that risk/benefit sharing enhances cooperative business, improves supplier participation in joint decision making. This increases performance overall.
Management Involvement														X		X										2	Partnership sometimes relies on organisation-wide employee involvement through commitment & interest
Performance measurement										X						X					X					3	Sometimes there is a need to evaluate performances to better understand the interactions, barriers, influences and factors effecting performance
Simplification & Role distinction	X														X	X										3	A unified systematic structure with simplicity is more important than large size comprehensiveness
Power Balance		X	X														X									3	Power balance is required for long-term orientation and relational behaviours toward partners
Common Goal alignment			X	X				X	X	X	X				X			X				X	X			10	Collaboration occurs when entities form a coalition with the goal or objective of making decisions or synchronising activities that will generate mutual benefits
Service differentiation/ Flexibility	X		X			X	X			X	X		X		X		X					X			X	11	Increased value is reflected in the interdependence of organisations in achieving shorter lead times, greater quality of services, flexibility & responsiveness
Legislation/ Compliance/Check															X			X			X					3	In few cases, adherence to security and legal compliance becomes critical depending on the distribution network
Sustainability & Innovation	X		X	X		X			X												X				X	14	Innovation is a critical capability to enterprise business (or environmental) success through radical or incremental innovation. While radical is 'Disruptive', 'incremental' is continous improvement to develop capacity to to address the rapid changes in the customer demand.
Continuous Improvement							X				X	X	X		X	X							X				
Info sharing and systems integration		X		X		X		X	X	X		X	X	X		X		X	X	X	X		X	X		25	A unified technology solution is critical to maximize clients' value which requires a collaboration between consulting, technology and logistics companies to realize the full desired design, implementation and operation.
Control systems/ IT sharing solutions	X			X	X		X				X	X	X				X							X			
Trust and Commitment		X	X		X			X			X		X	X		X		X	X	X	X	X				18	Trust has a significant influence on collaboration which further improves logistical efficiency. Involving strategic suppliers to get full visibility/ transparency to Inbound information and networks is critical. Mutual trust play an important role in achieving long-term relationship.
Transparency /Visibility	X	X			X				X											X							

Source: 1 - Ye and Wu (2015); 2 - Wu et al. (2014); 3 - Soosay and Hyland, 2015; 4 - Papadopoulou et al., 2013; 5 - Sanchez Rodrigues et al., 2015; 6 – Thatte et al., 2013; 7 - Guan and Rehme, 2012; 8 – Ha et al., 2011; 9 – Cao et al., 2010; 10 – Richey et al., 2010; 11 - Fawcett et al.,2012; 12 – Jüttner et al., 2010; 13 - Olhager and Prajogo (2012); 14 – Maon et al., 2009; 15 - Win (2008); 16 - Fawcett et al.,2011; 17 - Cruijssen et al., 2007; 18 – Audy et al.,2012; 19 – Nyaga et al., 2010; 20 - Hammervoll and Bø, 2010; 21 – Zeng et al., 2012; 22 – Islam and Olsen, 2014; 23 – Badea et al., 2014; 24 – Ramanathan and Gunasekaran (2014); 25 – Subramanian et al.,2016

***Appendix 1**- Summary of the Critical Success Factors for an effective Logistical partnership in a Supply Chain*

Reverse logistics kpis: measuring sustainability performance

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ABSTRACT

Purpose: Managing reverse logistics performance is a challenging task. The purpose of this paper is to develop a conceptual framework of key performance indicators (KPIs) that enhance the understanding of sustainability performance measurement in reverse logistics.

Research Approach: A taxonomy of KPIs has been created showing appropriate indicators in measuring company's sustainability performance. All the indicators and framework structures have taken from journal articles and books within the time range between 1996 and 2017.

Findings: In measuring the sustainability performance, a conceptual framework has been structured according to the divisions of the three pillars - economic, social and environmental. Therefore, the taxonomy can be classified based on criteria which are 1) the economic sustainability through cost, timeliness, productivity and capacity and quality, 2) the environmental sustainability through the dimension of transportation function, company external and company internal and, 3) the social sustainability through the dimension of labour practices, human rights, society and product responsibility.

Originality/Value: This research presents a comprehensive conceptual development of the KPIs taxonomy. The taxonomy demonstrates the sustainability accomplishment through the reverse logistics KPIs.

Research Implication: This taxonomy helps the study of performance measurement in reverse logistics, which is a significant scope but has not been fully investigated by researchers.

Practical Implication: This research will be useful to practitioners to identify the weaknesses and eliminating the unnecessary practices in achieving the highest level of contributions to sustainability. The practitioners can use this framework to understand the best KPIs for measuring their reverse logistics activities. This paper will also help companies create their sustainable competitive advantage by identifying the KPIs that will assist to these advantages.

Keywords: *Key Performance Indicators, Performance Measurement, Reverse Logistics, Sustainability Performance*

Introduction

The essence of the sustainability agenda has expanded the commitment of companies (Gunther, 2015). The commitments are directing to the changes of company's trends. It is because sustainability issue is the current trends in businesses and drive of competitiveness (Litovsky, 2017). The needs from external influences, such as stakeholders have pushed companies applying the sustainability concepts in all supply chains and work environments. Companies are struggling to achieve the maximum contributions to the triple bottom line. The pressure from the sustainability agenda has brought companies creating strategic goals and objectives toward sustainability. Business has applied the concept of reverse logistics as one of their core strategies of supporting the agenda. According to Sarkis et al. (2010), reverse logistics have made a significant contribution to the sustainable initiatives.

According to Rogers and Tibben-Lembke (1999), reverse logistics is "the processes of planning, implementing and controlling the efficient, cost-effective flow of raw material, in-process inventory,

finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or disposal". It is a systematic process system that is efficiently designed to manage parts or products destined for recycling, remanufacturing, disposal and reuse (Dowlatshahi, 2005) hence known as closed-loop supply chain (Jindal and Sangwan, 2013). The framework of the closed-loop supply chain is shown in Figure 1. Reverse logistics is a reactive activity that has less prominence than forward logistics. It is because reverse logistics have been affected from the complex relation of the supply chain (Chan et. al, 2012). Furthermore, the characteristics of reverse logistics are complicated and unpredictable to forecast. Fleischmann (2012) stated it is rigid to forecast because of less homogenous resources. The characteristics of reverse logistics contribute to the difficulties of companies encountered in measuring their performance. Companies are saddled with their commitment to attaining the sustainability agenda. Therefore, this paper aims to develop a generalised conceptualisation of reverse logistics KPIs hence measuring the sustainability performance. The taxonomy will enhance the understanding of companies towards their highest level of contributions in the sustainability.

According to Richey et al. (2009), company performance has relied on the logistics management to evaluate the effectiveness of logistics practices. According to Vedpal and Jain (2011), an efficient reverse logistics handling can take companies having the economic benefits such as cost reduction and improvement in the financial and investment opportunity. However, reverse logistics practices are unable to be measured straightforwardly. The condition of the measurement method of reverse logistics is indistinct. The unexpected plan turned companies having a fuzzy and inconsistent direction in improving their performance. Perfect metrics or performance indicators are needed to ensure the reverse practices are measured properly. KPIs are essential because it was the reflections of the effectiveness of companies in achieving their strategic goals and objectives. According to Piatt (2012), companies typically make mistakes by creating excessive indicators. The author stated good KPIs would deliver long-term value to the business. Furthermore, KPIs will assist to the company's benchmarks that presented their performance tracks.

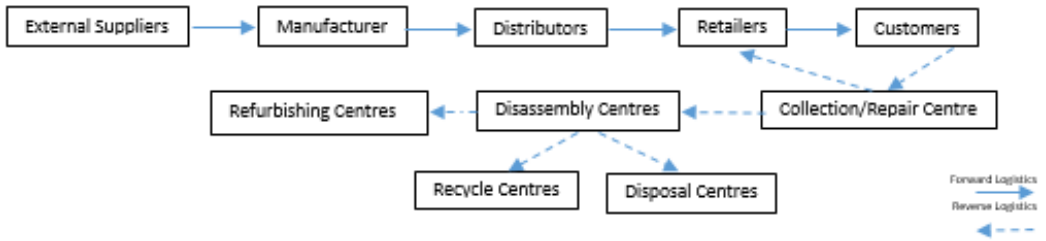


Figure 1: A Generalised Framework for Closed-Loop Supply Chain (Jindal and Sangwan 2013)

Research Approach

The measurement of the sustainability can be divided into three aspects which are, the performance of economic, social and environmental. This paper demonstrated the conceptual framework of reverse logistics performance. It aims to fill the literature gaps which are, build the generalisation of the performance measurement framework based on triple bottom line and focus the social sustainability issue that less has discussed (Agrawal et al., 2015; Garcia et al., 2012; Sarkis et al.,2010). Therefore by using the extant literature, authors has constructed the combination of the structural performance framework. All the indicators and framework structures have taken from the journal articles and books hence the custom time range is between 1996 and 2017. Authors used the keywords of 'reverse logistic performance measurement', 'environmental performance', 'social sustainability' and 'economic performance'. According to Lai et al. (2007) taxonomy is a powerful tool that delivers comprehension and thrifty descriptions of complexity. Authors created a taxonomy to demonstrate the critical aspect of sustainability performance that could be the focus area for company's improvement. The creation of the taxonomy is based on the grouping of the three

different aspects of the sustainability performance. The sustainability taxonomy is in the Figure 2. The further debate of the taxonomy and the three pillars performance indicators in the next sections.

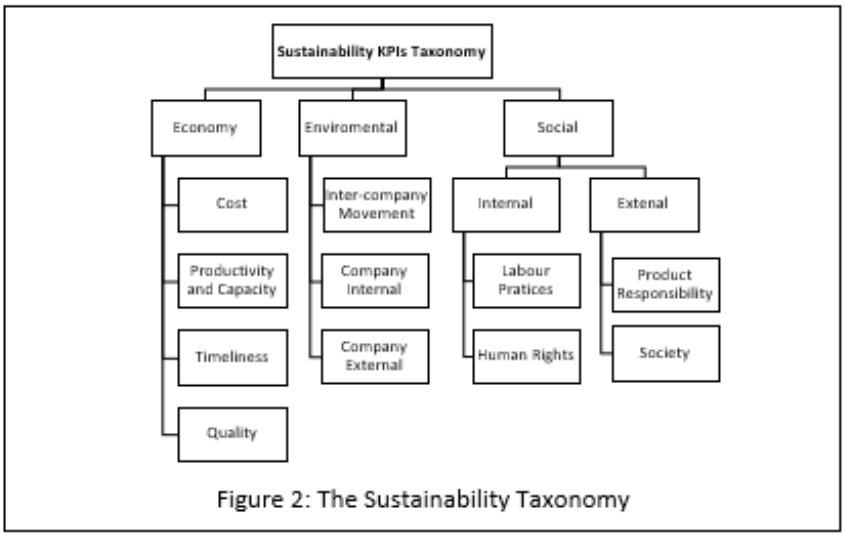


Figure 2: The Sustainability Taxonomy

Measuring the Economic Performance

Economic aspects can be measured directly. Synonymous with the financial perspectives, economics is the fundamental development of the performance system. The economic sustainability is generated from the direct contributions in environmental and social awareness. According to Ferrer and Whybark (2000) and Guide and Van Wassenhove (2003), the primary objective of reverse logistics extends beyond recovering the returned goods. Henceforth, it is also attaching the economic value.

Effect of Reverse Logistics to the Economic

Mangla et al. (2016) listed three economic success factors that related to reverse logistics implementation. The economic factors have reduced the consumption of virgin or raw material, decreased waste generation and financial opportunities. Reverse logistics helped to offer the reduction of the raw material consumption through of the value recovery of the returned products (Seuring and Muller, 2008). Their implementation also drives to the reduction of waste generation (Hung Lau and Wang, 2009). It is because the adoption of the reverse logistics applied the minimization of the disposal percentage. It was supported by Oko et al. (2013) that stated waste management systems demand attention on the reuse of packages that give the obvious economic benefits through of the usage of the nominal amount of resources. Rahman and Subramaniam (2012) argued the adoption of reverse logistics bring economic advantage to the second-hand market. Besides that, each of reverse logistics activities has abilities in perform creating the profitability. For instance, by centralising the inspection and sorting processes, it will minimise the cost of labour and cost of testing equipment (Sangwan, 2017). Bansia et al. (2016) have used Balance Scorecard to develop the reverse logistic performance system and identified the primary factors of the performance measurement. Agrawal et al. (2015) used fuzzy analytical hierarchy process and extent analysis (FAHPEA) approach to evaluate the reverse logistics performance in three electronics companies. Economic performance indexes are the highest compared to social and environmental hence the result shown that return of investment and recapture value are the best performance indicators for the company.

Economic Measurement Indicators

In achieving the highest economic value, companies have to manage the reverse logistics activities efficiently. According to Lai et al. (2007), "financial performance was measured by overall financial performance, return on investment, returns on sales, revenue growth and market share". However,

return on investment are the standard criteria was used in measuring the economic performance. Agrawal et al. (2015) remarked the positive returns on investment are primarily caused by the execution of the reverse logistics. Costing factors are the critical issue in determining the successes of the economic achievement such as labour cost and logistics cost (Garcia et. al, 2012). Weeks et al. (2010) proposed the financial indicators in reverse logistics are machine cost, labour cost, the cost of retooling machine and material costs. Furthermore, vehicle fill and fuel consumption are the essential indicators focused by companies (VCA, 2007). Garcia et al. (2012) underlined there are three levels of the hierarchy in the performance measurement framework. In this paper, authors adapted the structure of the first level KPIs which reflect the global economic performance. The attribution of the economic performance taxonomy was constructed based on four performance attributes of quality, timeliness, cost and productivity and capacity. The KPIs for economic performance in reverse logistics are in Table 1.

Table 1: KPIs for Economic Sustainability

CRITERIA	OBJECTIVES	KPI'S/INDICATORS
COST	Operation cost	Cost per operation hour Warehouse cost Variance against budget
	Labour cost	Average of weekly work Training return on investment Labour productivity
	Maintenance cost	Machine downtime level Operation level effectiveness
	Inventory cost	Return on assets Inventory value Inventory movement
	Logistics cost	Total logistics cost
	Downtime cost	Machine downtime per month Machine downtime level
	Recapture value	Amount of recycling material Volume of returned products Value of retrieved by repurchasing and resale of products
PRODUCTIVITY AND CAPACITY	Resources utilisations	Resources utilisation percentage Recycle efficiency Space utilisation
TIMELINESS	Delivery time	Delivery time cycle On time delivery Speed of delivery
	Production time	Production lead time Processing time
QUALITY	Supplier capabilities	Supplier performance index Supplier time delivery

Measuring the Environmental Performance

The issue of the environment is embedded the discussion of reverse logistics. In accomplishing their responsibility towards the environment, companies must show how they managed their activities efficiently. Furthermore, there are many researchers have done the outstanding research that carried the theme of environmental concern (Flischmann et al., 2001).

Environmental Concern

Pilouk and Koottatep (2017) highlighted the concept of the Eco-Industrial Park (EIP) in Thailand and revealed the potential and concerned issues by key stakeholders. The result showed that environmental performance was the key success of the EIP. Water quality, air quality, waste management, energy management, health and safety and environmental quality are the concerned fields that need to emphasise. Mason (2002) stated communities and customers demand manufacturers accountable the environmental impacts by engaged in reverse logistics. In addition, the consumer is willing to pay more for the products and goods that directly benefits to environmental (Andel and Aichlmayr 2002). Reverse logistics is an active programme. It attempts companies gaining the economic benefits through an efficient administration of the reverse logistics. That support by Blumberg (1999) that argued consumer awareness drive on the increasing of

efficient reverse logistics and handling of hazardous materials. Doherty (1996), discussed government regulation and the pressure from environmental group turned reverse logistics more responsive. Therefore, many acts and directives are protecting the environment hence enhancing the reverse logistics aspects. According to Kumar and Patmen (2008), Hung Lau and Wang (2009) the directives and support from government are important factors for the implementation of the reverse logistics into company's practices. For instance, European regulation applied the end-of-live-vehicles directive to tackle the redundancy of the end of life vehicle. In addition, automobile industry today implemented the environmental pro-incentive in their products through recycling concept. As an example, at least eighty percent of VW car has recycled, and ninety-five percent are recoverable (VW, 2011).

Environmental Measurement Indicators

The issue of carbon emission, pollution and waste management are core objectives outlined in managing the environment. According to Nikolaou et al. (2013), the environmental performance can be measured by the energy used per item, annual fuel consumption and the amount of payload used. Agrawal et al. (2015) highlighted points that help in measuring the environmental performance in different criteria. The arguments entailed the minimum energy consumption, optimum used of raw material, transport optimisation, reduced packaging, use of recycled material and waste reduction. Björklund and Forslund (2012) has grouped the environmental performance measurement into four categories which are, transportation functions, company internal, supplier supply chain (inbound) and customer supply chain (outbound). However, authors have altered the environmental performance structure into three main criteria to minimise the excessive indicators. The taxonomy of environmental performance indicators shown in Table 2.

Table 2: KPIs for Environmental Sustainability

CRITERIA	OBJECTIVES	KPI'S/INDICATORS
INTERCOMPANY MOVEMENT	Transportation services	Vehicles mode Supply mile rate Overall vehicles effectiveness Emission rate
	Transportation consumption	Vehicle fill Fuel consumption mile per gallon rate Empty running rate
COMPANY INTERNAL	Resources consumption	Electric consumption rate Indirect energy used rate Direct energy used rate Gas consumption rate Water consumption rate
	Waste management	Gas emission Waste recycling rate Waste reduction rate Water footprint rate
	Certification compliances	Certification Audit (ISO 19001, ISO 26000:2010)
COMPANY EXTERNAL	Delivery services	Delivery rate Delivery flexibility Delivery mode
	Policies and regulations	No. of policies and regulation Compliance with environmental policies and regulation

Measuring the Social Performance

Social sustainability has discussed less compared with other two sustainability dimensions. Social sustainability consisted of people skills and abilities, institutions, relationships and social value (Ahmed and McQuaid, 2005). Meanwhile, Dyllick and Hockerts (2002) stated social sustainability is a method used by organisations to add the values towards communities and at the same time increasing the community's capital. Sarkis et al. (2010) argued that organisations need to consider their social responsibility for the products or service life cycle. Thus, to attain the social performance, the criteria of life cycle need to be measured.

Social Measurement Indicators

Labuschagne et al. (2005) categorised the social sustainability of reverse logistics issues in four main areas which are internal human resources, external population, stakeholder participation and macro social issues. However, Nikolaou et al. (2013) divided the social indicators into four dimensions. Their conceptual model of social responsibility quality reverse logistics was separated the social aspects to the labour practices and decent work, human rights, society and product responsibility. Sarkis et al. (2010) proposed some indicators such as employment stability, employment practices, human capital, productive capital, and stakeholder influence. British Safety Council (2014) suggested safety audit, safety inspection, occupational health and safety training are the method of measuring the health and safety issues. Meanwhile, Dozie Ilozer et al. (2002) argued training return on investment and staff understanding of the work setting are the KPIs of the training and development. Guimaraes and Solomon (2015) discussed the citizenship programmes. The reverse logistics programme drives the social and environmental acts and the employment creation. The measurement of social and environmental attributes could be measured through the number of reverse logistics projects involved by communities and the number of complaints related to the public's impacts. The number of people participating in the social project, reverse channel, and training program counted under the employment criteria. There are many indicators of social sustainability performance found in the literature. However, it still gets the less attention in organisational debated (Ahi and Searcy, 2015). The division of social performance measurement are varied and not been discuss explicitly. The authors applied the social dimension as suggested by Nikolaou et al. (2013) hence GRI-Global reporting identified it can be grouped as internal and external. The KPI's of social measurement are in Table 3.

Table 3: KPIs for Social Sustainability

SCOPE	CRITERIA	OBJECTIVES	KPI'S/INDICATORS
INTERNAL	**Labour Practices and Decent Work**	Employee management	Personnel turnover Unplanned Absenteeism Workers satisfaction
		Organisational policy and mission	Understanding level of employees with policy and mission
		Health and safety issues	Safety practices Safety Audit Safety Inspections Occupational health and safety training
		Training and development	Staff training Staff understanding with work setting
	Human Rights	Security practices	Percentage of security personnel trained in the organization's policies
EXTERNAL	**Product Responsibility**	Customer health and safety	Product safety certification
	Society	Employment stability	Job opportunity
		Community health	Health rate

Conclusion

This paper discussed the performance measurement of reverse logistics through the literature-based approach. The concept of reverse logistics is ambiguous when it comes to evaluating its performance. The novelty of this paper is to demonstrate a comprehensive conceptual KPIs in measuring the sustainability performance. However, the authors have not debated the topic regarding any particular industry. This topic can extend in future through exploring the competitive industries such as food and automobile industry. As for the research implications, the taxonomy will help enhance the study of the reverse logistics performance. Next, this paper will be useful to guide practitioners to identifying companies' weaknesses and eliminating the unnecessary practices in achieving the highest level of contributions in sustainability.

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Shipping and port management

The role of customs in removing bottlenecks in international logistics: the case of customs division of Ghana revenue authority and Ghana ports and harbours authority, tema

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Abstract

Due to globalization, many countries have resorted to international trade with the aim of transporting goods rapidly, safely, reliably and economically from the point of origin to the point of consumption at the right time, right place and in the right condition. However, it is argued that inefficient ports, particularly in Africa have slowed down international trade. Even seemingly efficient ports are tainted with a myriad of bottlenecks that hinder the free flow of goods. The purpose of this study was to find the causes of these bottlenecks, the role of Customs and challenges it faces in removing the bottlenecks to facilitate international trade. The study revealed that the congestion at the port, the bureaucracy, lack of operational space, corrupt practices and the frequent systems failure of the Ghana Community Network (GCNet) are some of the bottlenecks affecting the clearing procedures at the port. These are caused by excessive documentation in the clearance procedure, too many government institutions conducting physical examinations of goods and frequent system breakdown.

1.0 Introduction

Due to globalization, many countries have resorted to international trade, putting more pressure on international logistics with the main aim of transporting goods rapidly, safely, reliably and economically from the point of origin to the point of consumption at the right time, right place and in the right condition. This aims at facilitating trade and boosts profitability and success of the business in the nation. However, inefficient ports, particularly in Africa have acted as a brake on international trading. The authors maintained that this will continue to be so unless the capacity and efficiency of ports are improved.

According to Hummels (2001), time is an important trade barrier in trade facilitation that indicates that each extra time consumed in transportation decreases the likelihood that the United States sources industrial products from a particular nation by1.5%, and projects that such a day is worth 0.8% *ad valoren* for this kind of goods. According to Amanfu (2010), there is a tremendous increase in the volumes of cargoes that many port terminals in Africa receive monthly and thus these volumes of cargoes impede the efficiency of ports in Africa. In Ghana, importers suffer at the hands of Customs officers and other government agencies in terms of delay in clearing time. The reasons are that when goods arrive at the port they have to pass through so many cumbersome clearing processes, for example an importer has to go through customs, Ghana Port and Harbour Authority, the shipping companies, and other government agencies such as Ghana Standard Authority (GSA), Environmental Protection Agency (EPA), Food and Drug Authority (FDA) etc. The importer has to meet all these agencies requirements before he or she can get access to the goods.

Additionally, a personal observation at the operations of the GHPA indicated that there was a lot of paper work involved in the clearing process at each stage to be undertaken before goods were cleared. These included an Import Declaration Form, Inspection report, Certificate of Permit from the relevant regulatory bodies. All these lead to delays in clearance time and additional transactional cost. It is in the light of these, that this study was designed to examine the current clearing bottlenecks at the Tema

Port, their causes and examine the role of customs in removing bottlenecks in international logistics and promoting certainty and predictability at the Tema Port.

2.0 Review of Literature

2.1 Trade Facilitation in International Logistics

In the heart of all government's trade and investment promotion agenda is trade facilitation. Woo and Wilson (2000) as cited by Caesar (2010) defined trade facilitation as improved efficiency in the administration procedures and logistics at ports and customs points. This covers efficient supervisory environment, deeper harmonization of standards, and conformity to international regulations. Even though WTO is focused on border procedures, factors such as the role of the individuals in the supply chain, efficient port infrastructure, good transportation system, efficient payment system (including electronic payments for duties and taxes), and other similar services are all important in ensuring effective trade facilitation. There is a positive correlation between efficient trade facilitation and effective collection of revenue from trade (Engman, 2009). for a country to attract direct foreign investment, trade facilitation must be positively effective and efficient (Yasui and Engman, 2009). Over the past years, the importance of trade facilitation has improved considerably with the necessity to decreasing cost associated with transaction and administration, in addition to speeding up cargo movement creating the principal element. According to the Economic Commission for Africa (2004), trade facilitation can lead to benefits to governments and business in such areas as increased effectiveness of control method, more effective and efficient deployment of resources, correct revenue yields, improved trader compliance, enhanced economic development and encouragement of direct foreign investments. Efficient trade facilitation can help lower trade transaction cost and, hence, reduce the margin between domestic and international prices to benefit consumers and producers (Milner, Morrissey, Zgovu, 2008). The prospects of development through international trade have encouraged governments to deploy EDI (Electronic Data Interface) systems and information technology to modernize customs processes and facilitate trade (Chaturvedi, 2009).

2.2 Role of Different Government Agencies in Trade Facilitation

Customs is not the only government agency responsible for trade facilitation (Zhang, 2009 and Arvis et al., 2010). The World Bank has acknowledged the role of other agencies in 2010 Logistics Performance Index. (LPI). In facilitating trade an integrated approach of combining the efficiency and effort of government agencies, private parties, and individuals are needed. The World Bank's Logistics Performance Indicators (LPIs) indicate that one-third of delays encountered at the border can be attributed to Customs authorities and also a greater part to other government agencies (McLinden, 2011). All these government agencies have different procedures and policies that have impact on clearing process. The Environmental Protection Agency (EPA), the Food and Drugs Board (FDA) the Ghana Standards Authority (GSA) and Port Health are all at the ports duplicating each other's roles and charging fees to the discomfort of the consumer. These duplications of roles cause delays and additional cost.

2.4 Empirical Evidence on Clearing Bottlenecks in Ghana

The Tema Port until recent times suffered from low berth productivity as a result of lack of gantry cranes (Asuliwonno, 2011). Similarly, Nsiah (2014) argues that the increasing volumes of containers has forced carriers to wait for several hours before berthing and in turn, impose congestion charges on importers and shippers. Similarly, Amanfu (2010) argues that cargo handling demand has exceeded the handling capacity of the terminals, thus causing berth congestion and forcing carriers to impose penalty surcharges. According to Amanfu (2010), the inconceivably large increase in international trade over the past years has led to many challenges at the ports. Notable among these challenges are: inadequate facilities at the port, lack of infrastructure to handle the teaming number of vessels that arrive at the two ports for offloading and loading. Another important challenge identified by the Ghana Ports and Harbour Authority (2006) is the cumbersome procedure and bureaucratic clearing process which results to vessel traffic and delays in cargo flows and eventually leads to corruption at the port. Similarly, the USAID (2010) reported that the major challenge that confronts the clearance of cargoes at the ports is the lack of automation and complex clearing procedures at the port.

Similarly, Obibe-Odei (2006) argues that congestion at the Tema Port has gradually become a persistent phenomenon with tie ups been partially blamed on increase containerization of cargoes. In the manual system of Customs operations, Customs, which is expected to become facilitators of trade end up creating cost for traders at the borders and ports of their respective countries as far as border-related cost are concerned. a study by Djankov, (2008) revealed that each day of delay at Customs is equivalent to a country distancing itself from its trading partners by an additional 85km. According to Baina (2008), the increasing volume of cargo handled by the ports had overwhelmed Customs, Ghana Ports and Habours Authority, clearing agents, freight forwarders and other port agencies resulting in inefficiencies at the ports in their operations and subsequent effect on revenue mobilization by Customs.

2.4 Custom Procedures in Port Operations in Ghana

Customs clearance is the procedure by which goods are allowed by Customs Authority to enter or leave the territory of a country. Customs clearance procedures at the port comprises of Customs Division of GRA, shipping agents, Ghana Port and Habour Authority, clearing agents or freight forwarders and Customs Classification and Valuation Report (CCVR). Legislative Instrument 1178 (Customs House Agent Licensing Regulation) of 1978 instructs all importers to engage the services of licensed Customs House for the clearance of cargo at freight station in Ghana. In the attempt to removing bottlenecks in the clearance system, it is necessary to consider the fact that Customs clearance in emerging economies is growing. Appels et al. (1998) describes three stages of development in Customs: firstly, the Customs authority concentrates on physical inspection and paper works. Again, customs works is to reducing internal checks and process management and finally development of electronic data exchange such as GCNet. According to McLinden (2005), reports from emerging nations often mention multifaceted customs clearance procedures, processes and documentation as creating serious bottlenecks that impede prompt delivery of imports and exports. The processes of customs clearance are currently not efficient and it is the subject of complaints by business community and donors who report problems including Customs staff not being able to process documents. Another drawback is the large number of signatures required. Many authors and bodies have evaluated and written much about trade logistics and the modernisation of customs operations (Avris, 2007; McTieman, 2006).

3. 0 Methodology

This study employed the case study and descriptive research approach. A case study because it involved a pragmatic examination with a detailed investigation that allows the dynamics of a particular system, also case study extant an enquiry that are systematic into an event or a group of related events targeting at describing and clarifying a particular phenomenon of interest to the researcher. The Tema Port was selected because it is one of the largest and busiest ports in West Africa, serving three landlocked countries at the moment, namely Burkina Faso, Mali and Niger. Data collected were basically primary from a population comprising of the Customs Division of Ghana Revenue Authority at Tema Port, Ghana Port and Harbours Authority, shipping and clearing agents and freight forwarders. A total sample size of one hundred and sixteen (116), of which one hundred (100) were retrieved. Questionnaire was designed and administered to all 116 respondents. But to ensure reliability of instrument and validity of data, 15 informants were selected from the population and questionnaire pre-tested to ensure that the questionnaire was understood by the various respondents and that the answers to the questions suited the requirement of the study.

4.0 Results and Discussion

4.1 The bottlenecks in the Clearing Procedures

As indicated in figure 1, the respondents were asked to indicate their level of agreement regarding the bottlenecks in the clearing procedures at Tema Port, with the exception of Damage of Cargo/ containers (-0.61) and rampant missing documents (-0.55), the rest of the indicators were agreed upon.

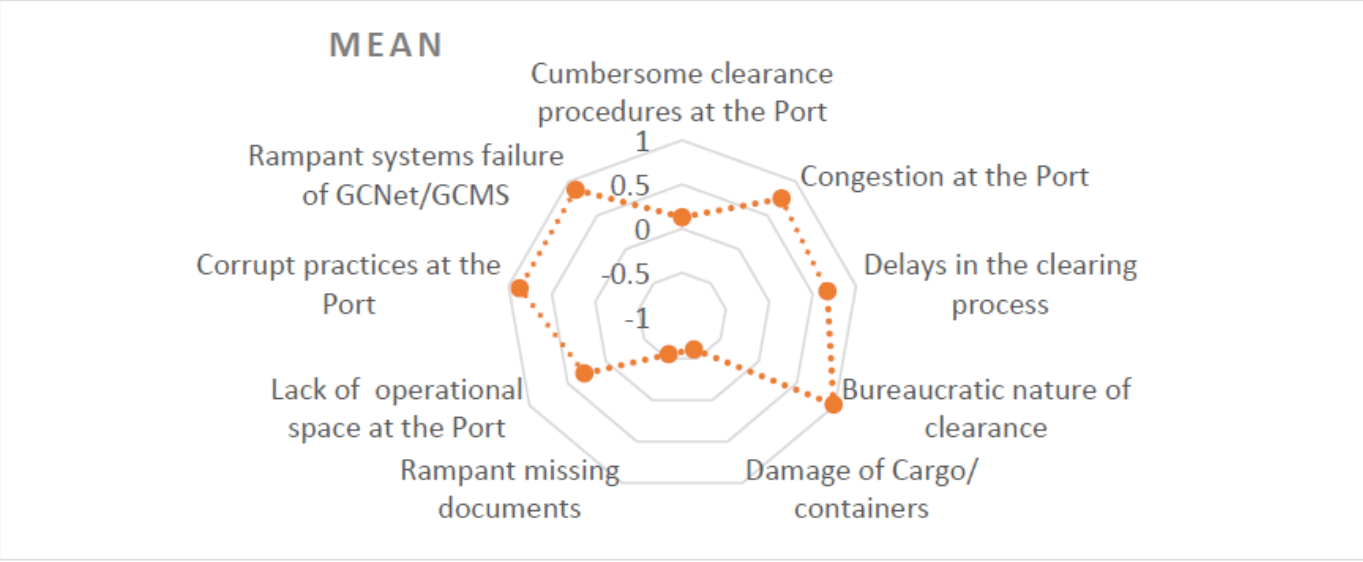


Figure 1: The bottlenecks in the clearing procedures

Figure 1: The bottlenecks in the clearing procedures

This result confirms the earlier findings of Wilson (2007) who reported that the cumbersome customs and administrative procedures have resulted to a challenge for developing countries in exporting and importing to developed and other developing countries. The GPHA (2006) also argued that the cumbersome procedure and bureaucratic clearing process which results to vessel traffic and delays in cargo flows and eventually leads to corruption at the port. Additionally, Obibe-Odei (2006), reported that congestion at the Tema Port has gradually become a persistent phenomenon with tie ups been partially blamed on increase containerization of cargoes. This result can be considered as a normal situation in the GPHA since the Burkina Faso, Mali and Niger channel and clear their goods for import and export through Tema Port. The delays and congestion at the port are also attributed to, the lack of space at the port and that all importers and exporters have to access the Ghana Community Network (GCNet) before their tax liabilities can be assessed by the Customs, coupled frequent system breakdown.

4.2 **Administrative and Operational causes of the bottlenecks at the Port**

4.2.1 Causes of Administrative bottlenecks at the Port

The study further ascertained the administrative and operational activities that cause bottlenecks at the Port. Of all the indicators measured to determine the administrative causes of bottleneck at the port, falsification of documents such as invoices, permit and exemptions by importers and exporters and by freight forwarders were found not to be causes of clearing bottlenecks at the port, as indicated in figure 2. But what is so obvious from this study as a major cause of bottleneck in the clearing process is the overlapping roles of government agencies like the Bureau of National Investigation and the President's Special Task Force operatives causing administrative delays in all stages of the clearing system. Ironically, the government of Ghana in its attempt to check smuggling of goods and underpayment of excise duties stationed these two security operatives at the port but clearly, as found by this study, their presence is rather becoming nuisance especially to the clearing process and procedures.

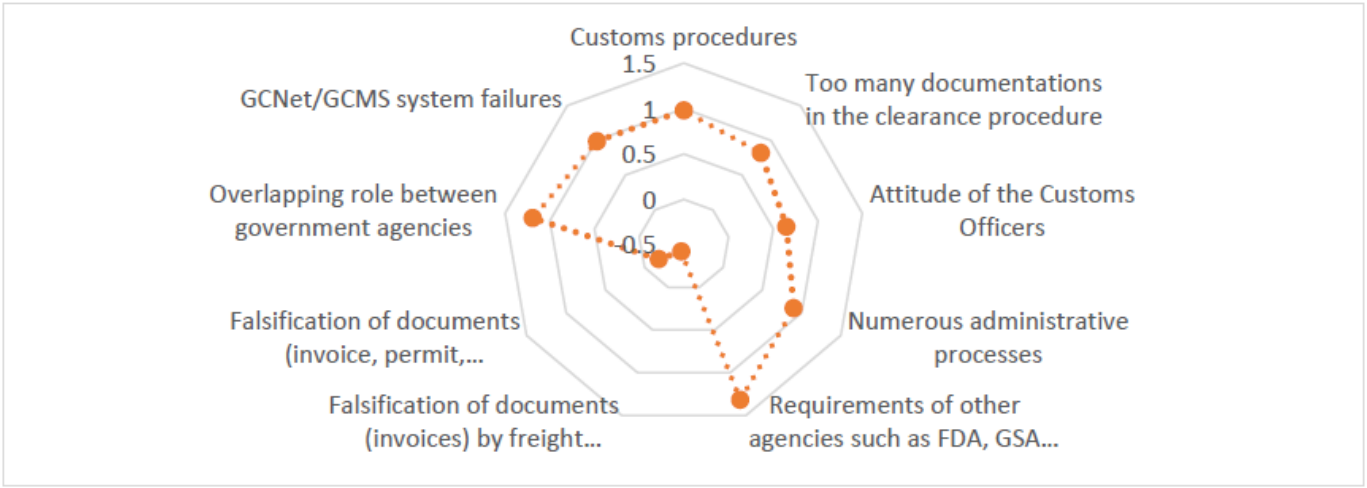


Figure 2: Administrative Causes of bottlenecks

The results presented above confirm earlier findings that relates to the study. For instance, McLinder (2005), reported that developing countries are often confronted with complex customs clearance processes, procedures and documentation as creating serious bottlenecks that impede prompt delivery of imports and exports. The author further accounted that the processes of customs clearance was not efficient and it was the subject of complaints by both the population sector and donors who reported problems including customs staff not being able to process documents. Pattykewitch (2007) also argued that another drawback is the large number of signatures required which often delays clearance which raised the problem of exorbitant demurrage fees.

4.2.2 **Causes of operational bottlenecks at the Port**

All the indicators measured to find out the causes of operational bottlenecks were found to contribute to the operational bottlenecks at the port. Meaning there exist a lot of challenges pertaining to the port operations.

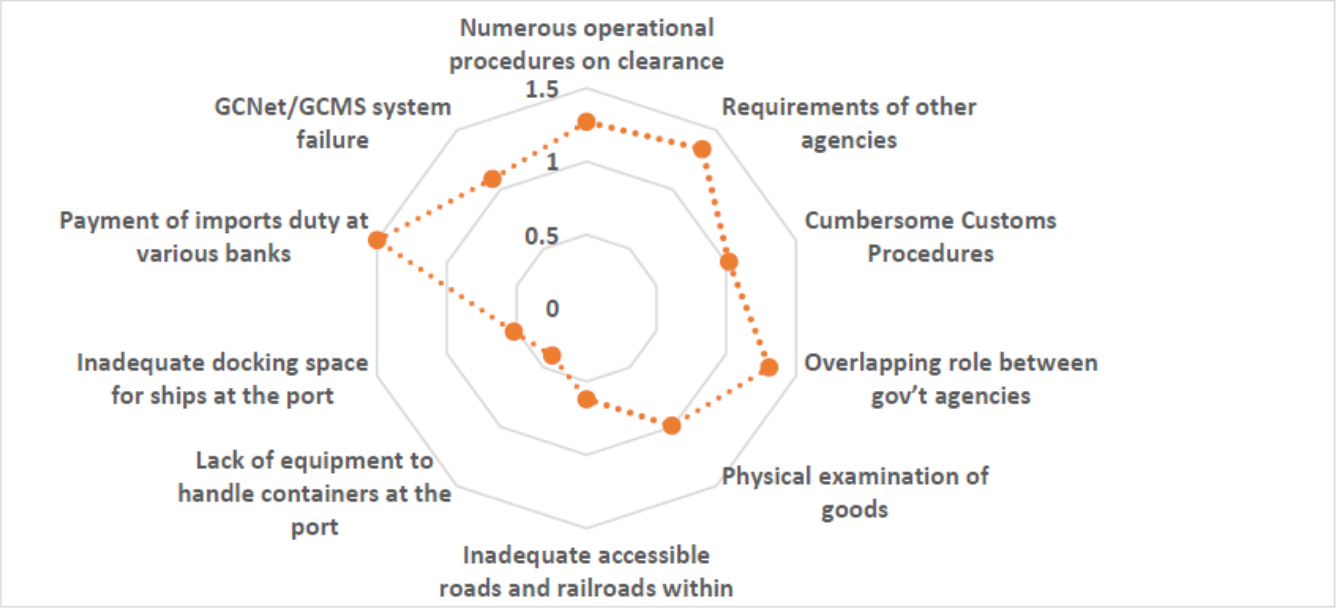


Figure 3: Operational Causes of bottlenecks

Notable among them as shown in figure 3 are 1) Payment of imports duty at various banks, 2) Requirements of other agency such as FDA, GSA and EPA, 3) numerous operational procedures on clearance, 4) Overlapping role of various government agencies at the port and 5) GCNet/GCMS system failure. Interestingly and contrary to most research findings at the Tema port over the years is the adequacy of equipment to handle and clear goods at port. The result fairly agreed to almost all earlier findings. For instance, Asuliwonno (2011) found out that the Tema Port has suffered from low berth productivity as a result of lack of gantry cranes. Emerghara (2008) also reported that the delays of clearance of goods at the ports can be attributed to inadequacies of berths, lack of cargo handling equipment, insufficient depth of the entry channel and inadequate manpower, and finally Nsiah (2014) established that inadequate facilities at the port and lack of infrastructure to handle the teaming number of vessels at the ports causes bottlenecks at the ports which mostly leads to delays

4.3 The Role of Customs in Removing Bottlenecks at the Port

After the respondents provided the various administrative and operational bottlenecks at the Tema Port and their causes, they were asked to suggest how Customs as an institution and major stakeholder in the clearing process would do to reduce, if not eliminate completely, these bottlenecks and challenges at the port to aid free flow of goods. The indicators as shown in figure 4 are suggestions and recommendations from recent studies on port operations in Africa and other developing countries which share similar challenges as Tema port

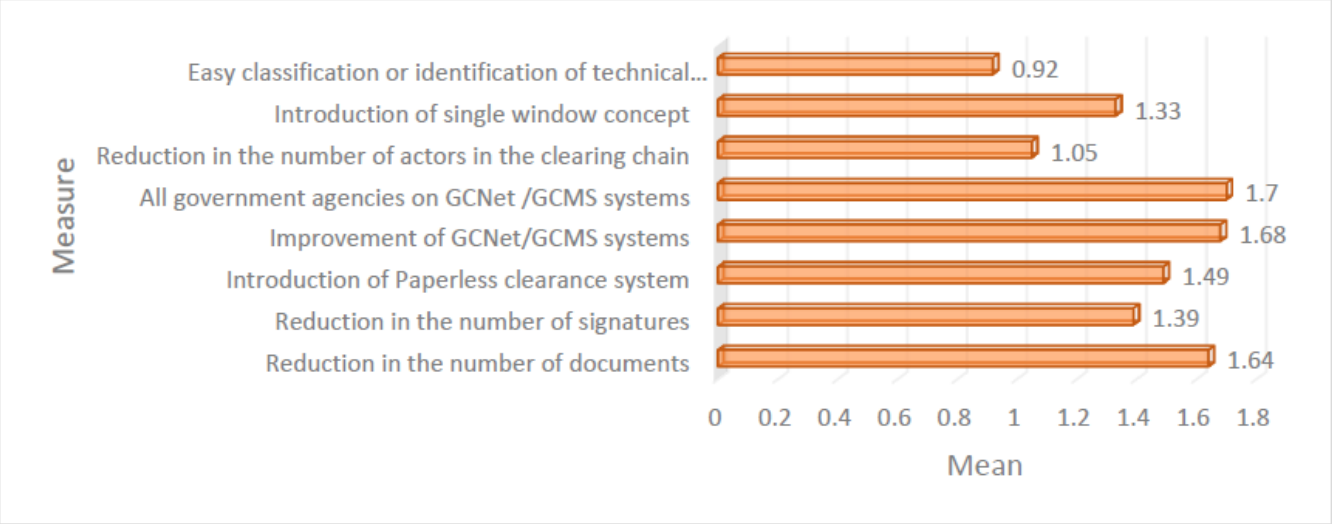


Fig 4: Role of Customs in Removing Bottlenecks

Obviously, all the indicators were agreed on by the respondents as Customs' role in removing both administrative and operational bottlenecks at Tema port. The result is a clear manifestation that either little attempt has been made by Custom to clear the mess in spite of several suggestions and recommendations by various authors or the strategies are simply not working.

4.4 Challenges in implementing strategies to dealing with the bottlenecks

Customs, as, indicated above have made efforts to curb the situation at the port but is presently facing taunting challenges in their quest to remove the bottlenecks. As presented in figure 5, all the measured indicators tend to exist as implementation challenges, but notably among them are lack of support from other stakeholders in the clearing process at the port, inadequate skills development modules for customs officers and physical examination conducted by so many companies. In addition, the Customs as an institution does not have its own communication infrastructure but have to rely on the Telcos for internet service provision and the last but not the least is the fact that there are only two banks at port importers and exporters are expected to make any form of payment. This result in importers and exporters or agents queuing at these, thus causing congestion and delays at the port.

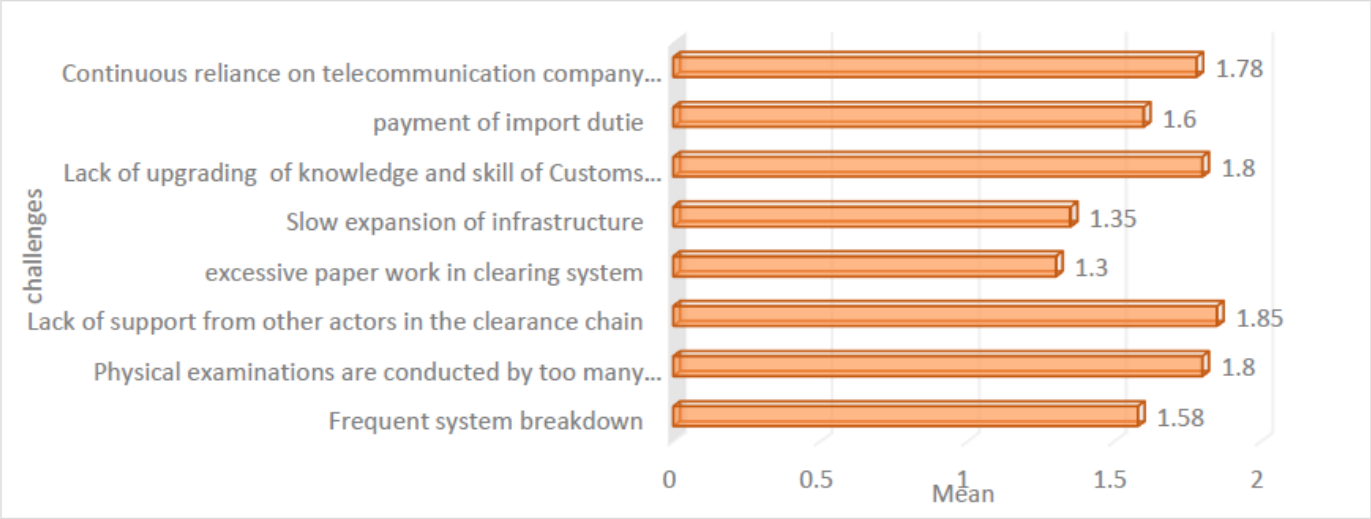


Figure 5: Challenges faced by Customs in implementing the strategy to deal with the bottlenecks

5.0 Conclusion

Many institutions and organisations have evaluated and written much about trade logistics and the modernisation of customs operations, specifically in developing countries. The World Bank leads this effort on a number of fronts with the general aims of consolidation economic performance and the attractiveness of emerging nations in global trade network. In spite of the numerous attempts by stakeholders in the clearance procedures, especially the government's investments in the sector, these challenges are still prevailing, hampering the free flow and clearance of goods at the port, leading to loss of revenue, low productivity and insecurity in the international trade. This study was designed to examine the current clearing bottlenecks at the Tema Port, their causes and examine the role of Customs in removing these bottlenecks in international logistics and promoting certainty and predictability at the Tema Port. The study found Bureaucratic nature of clearance, Congestion at the Port, Rampant systems failure of GCNet/GCMS and Corrupt practices at the Port as major bottlenecks confronting Tema port, which are caused by Overlapping role of government agencies, too many documentations in the clearance procedure and Requirements of other agencies. The rest are excessive physical examination of goods, payment of imports duty at only two banks, and numerous operational procedures and cumbersome Customs Procedures. The study further revealed a number of challenges that prevented the customs officers from reducing or eliminating the bottlenecks at the Tema Port. These challenges included frequent system breakdown, too many government institutions conducting physical examinations of goods, unwillingness of management to abolish paper work system, lack of support from other actors in the clearance chain and the slow expansion of infrastructure. The rest are lack of upgrading of knowledge and skill of Customs officer, unwillingness on the part of management to allow payment of import duties in other banks, apart from GCB and Ecobank and the continuous reliance on telecommunication company as internet providers. The study therefore recommends among other things the following suggestions as a mean of reducing or eliminating the various bottlenecks at the port: a reduction in the number of documents needed to clear goods, a reduction in the number of signatures for goods clearance, an introduction of paperless clearance system, improvement in the GCNet systems and the integration of all government agencies into the GCNet /GCMS systems. The other suggestions offered includes a reduction in the number of institutions, agencies, individuals and actors in the clearing chain and the adoption of a standardized method of classifying technical goods.

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Inventory-control based empty tank container repositioning with uncertain tank container cleaning

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Abstract

Purpose

This research explores tank container (TC) asset management with empty tank container repositioning (ETCR) and decision-making on customer demands. Unlike the widely studied dry container sector, the TC sector has the following features that are not well captured in the existing researches. First, TC operators (TCOs) as the owners of TCs do not normally operate vessels, so that ETCR operations are more expensive and uncertain. Two, there are significant uncertainties during container return due to strict cleaning requirements. Three, the quotation-booking process incurs a long gap between new demands being received and executed. By incorporating these features, this paper is aimed at developing an inventory-control based policy for better job fulfilment and ETCR assignments.

Research Approach

A quantitative approach is adopted by constructing a simulation and optimization model. According to the research objective, the addressed research problem will be mathematically formulated and optimized through Genetic Algorithm with the help of Matlab 2016.

Findings and Originality

The research addresses features of the TC sector that are not addressed by the wider body of literature on shipping container management in the dry container sector. First, with the proposed model, TCOs can quantify the influence of uncertainties coming from container return, allowing them to investigate the degree of impact on profit by changing different distribution conditions of the stochastic samples. Second, the model provides insight into the influence of fleet sizes over the effectiveness of the inventory-control based policies. Third, the model provides insight into the influence of different ETCR policies over the effectiveness of the inventory-control based policies.

Research Impact

It has explored seldom studied aspects of TC operations, such as container quotation-booking with the time-gap consideration, dynamic rolling-horizon planning, and uncertain container cleaning durations etc. It has not only filled up the research blanks, but also expanded the application of some approaches for broader use.

Practical Impact

The research has shown how TCOs can improve the performance of their businesses, particularly profit, through improved control of the flow of their TCs, inventory policies and decisions on accepting customer demands.

Key words

Tank container operation, Quotation-booking process, Dynamic rolling-horizon, Uncertain container cleaning, Empty tank container repositioning

Introduction

The petrochemical industry is on a steady increase in the past decades, and up to 2014, the size of the global petrochemical market reached to 490.5 million tons and is expected to grow at an estimated compound annual growth rate (CAGR) of 5.1% from 2015 to 2022 (Grand View Research, 2016). In this industry, tank container operators (TCOs) are the ones who provide full logistics services. Customers and TCOs are interacted through a so-called "*quotation-booking*" process (Erera et al., 2005). Although some issues of this process are addressed by previous studies, it still challenges TCOs' operation. First, there is a time gap in between customer demand receiving date and the order execution date. Customer normally need the quotation back soon after they placed the demands, but it challenges TCOs to develop better quotations on their own interests when considering uncertainties within the time gap. Two, the trade pattern in this industry is imbalanced but TCOs need to use external resources for shipping-related empty tank container repositioning (ETCR), and in turn, it becomes a constraint for cross-regional ETCR as the cost is too high. Three, due to the specialty of the commodity that tank containers (TCs) carrying, high standard and complex processes are associated with TC cleaning. Uncertain cleaning duration is the norm in this industry.

Hence, to tackle above challenges, this study is going to help TCOs maintain effective container flows and obtain better job fulfilments with setting up proper inventory-control based policies. The rest of this paper is organized as follow: In section 2, relevant literatures will be discussed and the research gaps will be highlighted. In section 3, the underlying problems will be discussed in more details. In section 4, the problem would be formulated mathematically and solved by selected method. In section 5, a numerical test will be carried to demonstrate the results and the associated discussions will be given as well. Finally, in section 6, a conclusion will be present to summarize the main outcomes of this research and indicate the future work as well.

Literature review

For the past decades, container operation management, especially empty container repositioning (ECR) has drawn a great attention from the academic world. Meng and Wang (2011) developed a mixed-integer linear programming for shipping routes design and ECR problems; Song and Dong (2013) have jointly consider route structure design, ship deployment and ECR in a three-stage optimization; These papers have either investigated ECR problem only or jointly considered ECR with other operational issues. Although various topics are addressed by above papers, it would be challenging to directly apply the research outcomes of those papers to the tank container realm. The industrial traits of TCs are barely included by above papers. For the most relevant studies in tank container industry, Erera et al. (2005) and Karimi et al. (2005) have both identified the significance and uniqueness of TCs. But their studies are all carried under a deterministic setting while the industrial related uncertainties are not considered. As discussed in previous section, uncertainties undermined during the container return and quotation-booking are not neglected. According to Song and Dong (2015), without capturing the uncertain attributes of the research questions, deterministic models may not easy to achieve the direct application of its solution in practice due to the discrepancies between model and the reality. Therefore, realistic problems such as unexpected TC stockouts or over ETCR activities may happen if the direct application of above models. Hence, it is intrinsic to consider the stochastic nature of TC operation when carrying decision-makings, especially when the decisions are at the operational level.

Instead, another group of studies have included the stochastic natures within their researched problems. Cheung and Chen (1998) applied a stochastic quasi-gradient method and a stochastic hybrid approximation procedure to deal with uncertainties in their two-stage optimization. Erera et al. (2009) used the adjusted robust optimization framework for dynamic empty repositioning while the demands

and future supplies are uncertain. The researched questions for above papers are formulated and solved by mathematical programming which are questioned with the computational tractability especially in solving large instances (Song and Dong, 2015).

Alternatively, computational tractability for container management problems can be enhanced by simulation based studies. Lam et al. (2007) used a simulation-based approximate policy iteration algorithm to obtain an optimal average cost for their addressed ECR problem over an infinite planning horizon. Dong and Song (2009) used a control policy to find the optimal container fleet size and ECR deployment with stochastic demands. These papers normally consist of a number of decision-making rules associated with system dynamic states such as inventory levels of empty containers, and implement the decisions at the same time period when the associated decisions are made. However, very few papers have formulated their problems that the order execution should be consistency with its plan while the plan was decided before the execution date. In the study of Erera et al. (2005), the detail of the quotation-booking process is introduced while the time-gap is not included, neither the industrial related uncertainties are captured. Moreover, although container leasing issue is explicitly or implicitly studied by different literatures (i.e. Moon et al., 2010; Dong and Song, 2012), they barely discussed the difference for planned leasing and emergent leasing. From the tank container lessors' viewpoints, when their customers leasing demands are closer to the execution dates, they are more certain with the demands. Hence, a cheaper price is normally associated with pre-booked leasing containers (planned leasing) than emergent leasing containers. Such concept can be referred to the advanced purchase discount model which is widely applied in the airline industry or asset leasing activities (Dana, 1998). Take above gaps into consideration, our research is carried accordingly in filling up the research blanks.

Problem description and the proposed solution

In the daily operation, customer demands are placed to TCOs including the information of job start date, origin and destination. TCOs need to plan on these demands by developing corresponding quotations. Specifically, TCOs exploit the known information about costs and profits to decide how much they need to ask for from their customers and how these demands would be served. In addition, none of all the new received demands will be executed on their receiving date. Instead, every demand is associated with a demand receiving date and a demand execution date, and the gap between the demand receiving date and the execution date is different from one demand to another. For every customer demand in this study, it can be served by self-owned container (it will be defined as self-container job), or plan leased containers (it will be defined as planned-leasing job). Also, once the plan is made on its receiving date, it needs to be executed as how it is planned on the execution date, only except when there is not enough inventory for self-container jobs, they will be served by emergent-leasing containers instead with higher costs. For all the demands received on the same date, their execution dates will jointly form the planning horizon because plans (quotation) for those demands are decided at the same time (the demand receiving date). In overall, such process is named as the quotation-booking and it is illustrated as below (figure.1):

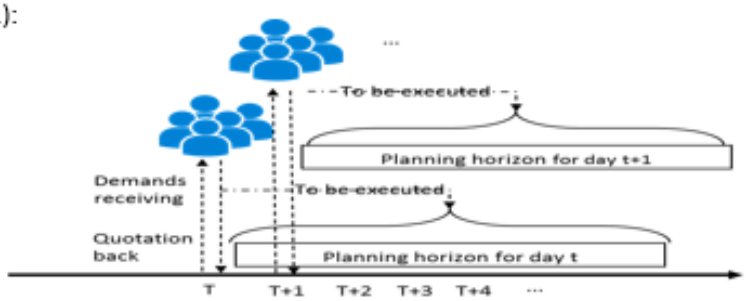


Figure 1. the quotation-booking process

During this process, two key tasks need to be decided. One, how would the new received customer demands be fulfilled with the choice of self-owned containers or planned-leasing containers. Two, how would TCOs arrange ETCR activities to balance the overall container flows. Nevertheless, uncertainties are significant, especially the container cleaning process. Hence, TCOs need also to consider an effective inventory policies to buffer unexpected uncertainties.

In this research, an inventory-control based simulation and optimization will be established. Specifically, a double-threshold inventory model will be optimized through a rolling-horizon like fashion. Unlike the normal rolling-horizon models, the rolling-horizon in this model is dynamic as the length of each horizon is different. The planning is happened daily if there are new demands received, and the horizon length is defined by how far the furthest execution date (M_i^t) of the new received customer demands. At every decision-making point, the plans are made for the horizon (t, t+M_i^t). Such new rolling-horizon is tailored to match the tank container quotation-booking process. Furthermore, within every planning horizon, the new received demands will be simulated on the execution dates and their job fulfilments will be decided with established rules. For the ETCR activities, they will be triggered by the inventory-control based policies with a cost-effective way.

In practice, TC operations can be different in many aspects. We make the following assumptions to simplify the problems we are addressing:

1. Only one type of containers, 20-foot equivalent unit (TEU) TC is considered.
2. TC Lessors at any depot have infinite container fleet and any leasing can be met immediately.
3. ETCR is only carried intra-regionally but transport route is available between any two depots among all the regions.
4. All the unloaded containers should be cleaned prior to return.
5. The execution dates of customers' booking requests will always later than their received dates.
6. The emergent leasing is always more expensive than planned leasing and the leased containers will be returned immediately after their jobs are finished.
7. We always use self-owned TCs to meet customer demands first.

The mathematical models

The following notations are introduced for formulating our proposed research problems.

SETS

T Set of continuous time periods

R Set of regions.

P Set of depots. The depot indices $i, j \in P, i \neq j$.

N Set of containers

D Set of customer demands. For a customer demand, it is a tuple d which contains the information of journey origin & destination, demand receiving date & job start date, and the amount of this demand associated containers. It is denoted as $(O_d, D_d, S_d, T_d, M_d)$. Since no demand will be executed on the same date, $S_d < T_d$.

Input data

C_i^h The inventory holding cost per TEU per day at depot i

C_{ij}^p The penalty cost for unmet demands per TEU from depot i to j

C_i^o The lifting-on cost per TEU at depot i

C_i^f The lifting-off cost per TEU at depot i

C_{ij} The transportation cost per TEU (for both laden and empty) from depot i to depot j

C_i^c The tank container cleaning cost per TEU at depot i

C_i^l The preplanned leasing cost per TEU per day at depot i

C_i^{le} The emergent leasing cost per TEU per day at depot i

E_d The revenue of demand $(O_d, D_d, S_d, T_d, M_d)$

a_{ij} Transportation time in days from depot i to j

b_i Cleaning duration at depot i, b_i is a random variable

M_i^t The furthest execution date of the demands received on day t at depot i

State variables and indicator functions

$S_i(t)$ The inventory level of depot i at the beginning of the day t

$S_i^m(t)$ The modified inventory level of depot i on day t

Decision variables

X_d^p A binary variable for demand d if it is **planned** to be delivered by self-container

X_d^a A binary variable for demand d if it is **delivered** by self-container on day t

Y_{ij}^t The amount of ETCR containers from depot i to depot j on day t.

Z_d^p A binary variable for demand d if it is **planned** to be delivered by leased container

Z_d^e A binary variable for demand d if it is delivered by **emergent-leasing** container on day t

$[L_i, U_i]$ The upper bound and lower bound of inventory control policy at depot$i$.

The whole model includes four major events, and each event mathematically formulated as follow:
a) Inbound flow on day t

This event is taken place at the beginning of day t. The inventory level for depot i is firstly updated by adding arrived ETCR containers and returned containers onto the inventory from last day. Since all the returned containers are cleaned, the cleaning durations are already known and treated as realization inputs. If Ω is the state space of b_i, then σ is a realization value of the random variable b_i at a point $\omega \in \Omega$, $\sigma = b_i(\omega)$.

$$S_i(t)' = S_i(t) + \sum_{j \in P} Y_{ji}^{t-a_{ji}} + \sum_{d \in D} \sum_{D_d = i} \sum_{O_d = j, j \in P} \sum_{T_d = t-\sigma-a_{ji}} X_d^a; \quad (1)$$

b) Job associated outbound flow on day t

After all container inflows are updated, the second event is to update the inventory level with planned container outflows. Since uncertainties are existed, the actual inventory level may not be able to satisfy all planned container outflows, emergent leasing is thereby required. Because those jobs are confirmed with customers that they are accepted, while TCOs didn't negotiate with container lessors in advance in respect to those jobs. If the emergent leasing is required, the most cost-effective way to assign the emergent-leased-container jobs and self-container jobs need to be determined.

$$S_i(t)'' = \max\{0, S_i(t)' - \sum_{d\in D}\sum_{O_d=i}\sum_{D_d=j,j\in P}\sum_{T_d=t} X_d^p\}; \quad (2)$$

Variable X_d^a and Z_d^e are then decided by the value of $S_i(t)''$, when not enough inventory to satisfy the planned self-container jobs. They are determined by a cost-effective optimization.

c) ETCR arrangements

The ETCR deployments will be carried in this event. First, the current inventory needs to be modified as self-containers on the way to this depot and the known future container outflows need to be considered to keep from over repositioning. The furthest execution day of received demands will be used as the inventory modification horizon length. Second, the modification components need to be calculated. Within the determined horizon, the future container arrival and confirmed container outflow are the main components. The future container arrival comes from finished jobs and previous ETCR activities. For any depot *i*, the future container arrival of previous ETCR is calculated by summing up all the departed ETCR from other depots to depot *i* before the decision-making day, and will arrive depot *i* within the horizon. Container arrival from finished jobs could have two scenarios. Since the cleaning duration is a random parameter, some containers may have arrived at depot *i* before the decision-making day and the cleaning is already started, while some of them may come after the decision-making day. Hence, the cleaning duration is realised if it started already and if it is not started, the cleaning duration can only be estimated (figure 2). To simplify this component, the cleaning durations are all treated as estimated values, which is the mean of the parameter's populations. Third, since no customer demand will be rejected, the overall container outflows are the demands arrived on and before the decision-making day while their execution dates are within the planning horizon.

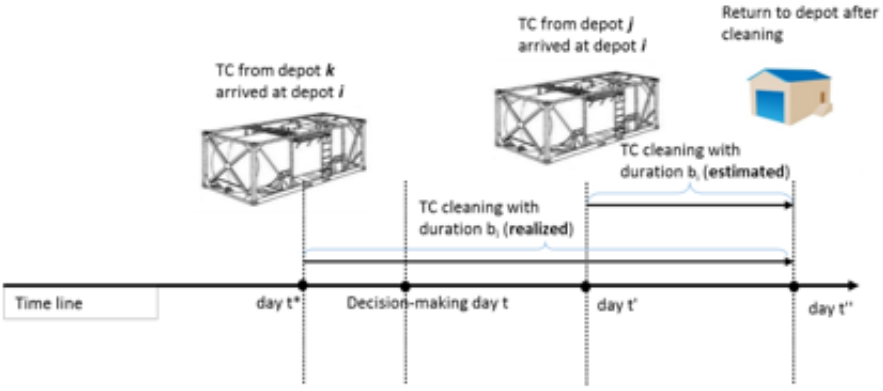


Figure 2. two scenarios of container return after cleaning

Follow above discussion, the mathematical expression for the modified inventory level is as below:

$$EXP\ S_i^m(t) = S_i(t)'' + \sum_j \sum_{t=\min\{t+M_i^f-a_{ji},t\}} Y_{ji}^t + \sum_{d\in D}\sum_{D_d=i}\sum_{O_d=j,j\in P}\sum_{S_d<t}\sum_{T_d=t+1-\bar{b}_i-a_{ji}}^{T_d=t+M_i^f-\bar{b}_i-a_{ji}} X_d^a +$$
$$\sum_{d\in D}\sum_{D_d=i}\sum_{O_d=j,j\in P}\sum_{S_d=t}\sum_{T_d=t+1-\bar{b}_i-a_{ji}}^{T_d=t+M_i^f-\bar{b}_i-a_{ji}} X_d^p - \sum_{O_d=i}\sum_{S_d\le t}\sum_{T_d=t+1}^{T_d=t+M_i^t} M_d; \quad (3)$$

Next, we take one region as an example for deciding the ETCR amount. If we take Ω as a set of surplus depots in region r, and any depot ω of Ω needs to be $\{\omega \in \Omega | EXP\ S_{\omega}^{m}(t)\text{-}U_{\omega} > 0\}$. Likewise, if Ψ is the set of deficit depots in the same region, any depot ψ of Ψ should be $\{\psi \in \Psi | U_{\psi} - EXP\ S_{\psi}^{m}(t) > 0\}$. Moreover, we use function $f(\omega)$ for identifying the total available amount of empty TCs that can be repositioned out of depot ω, and function $g(\psi)$ as the total amount of empty TCs that depot ψ asks for. The ETCR assignments are determined as follow:

$$\text{Min } C=\sum_{i\in\Omega}\sum_{j\in\Psi} Y_{ij}^{t} * C_{ij}; \quad (4)$$

s.t

$$\sum_{i\in\Omega}\sum_{j\in\Psi} Y_{ij}^{t} = Min\ [\sum_{\omega\in\Omega} f(\omega)\ , \sum_{\psi\in\Psi} g(\psi)\ ]; \quad (5)$$

If inventory *i* is a surplus depot and it is also required to reposition some TCs out of the inventory, then the inventory level will be:

$$S_i(t)''' = S_i(t)'' - \sum_{j\in\Psi} Y_{ij}^{t}; \quad (6)$$

d) decisions towards new demands

For a series of new demands, the rules for their planning is defined as: decisions are made from the earliest execution date until the last one subsequently. Then, within the planning horizon, if depot *i* has demands to be executed on day t+q, the inventory level of depot *i* is firstly updated per all the known information. If the updated self-containers are enough to cover all the to-be-executed demands at that depot, those demands are planned as self-container jobs. If not, planned-leasing containers are needed. Mathematically, the assignments are described as below:

$$EXP\ S_i(t+q)' = EXP\ S_i(t)''' + \sum_j \sum_{t=t+1-a_{ji}}^{t=t+q-a_{ji}} Y_{ji}^{t} + EXP\ \sum_{d\in D}\sum_{D_d=i}\sum_{o_d=j,j\in P}\sum_{S_d<t}\sum_{T_d=t+1-\bar{b}_i-a_{ji}}^{T_d=t+q-\bar{b}_i-a_{ji}} X_d^{a} +$$
$$EXP\ \sum_{d\in D}\sum_{D_d=i}\sum_{o_d=j,j\in P}\sum_{S_d=t}\sum_{T_d=t+1-\bar{b}_i-a_{ji}}^{T_d=t+q-\bar{b}_i-a_{ji}} X_d^{p} - \sum_{d\in D}\sum_{o_d=i}\sum_{D_d=j,j\in P}\sum_{S_d\le t}\sum_{T_d=t+1}^{T_d=t+q} X_d^{p}; \quad (7)$$

Then, similar to event b, the variable X_d^p and Z_d^p are determined by gauging inventory $S_i(t+q)'$ with total demands in that depot and that day, and if there are not enough self-owned containers. A cost-effective optimization is conducted to jointly determine the value of X_d^p and Z_d^p.

At last, the objective of this this model is optimizing the threshold values that lead to the maximized operational profit:

$$\text{Max EXP } \{F([L_i, U_i])\} = \text{Max EXP } \{\sum_{d\in D} M_d * E_d - \sum_{d\in D}\sum_{i\in o_d}\sum_{T_d\in T} S_i^{T_d} * C_i^{h} -$$
$$\sum_{d\in D}\sum_{o_d=i,i\in P}\sum_{D_d=j,j\in P}\sum_{T_d\in T} M_d * C_{ij} - \sum_i\sum_j\sum_{t\in T} Y_{ij}^{t} * C_{ij} - \sum_{d\in D}\sum_{o_d=i,i\in P}\sum_{D_d=j,j\in P}\sum_{T_d\in T} M_d *$$
$$C_i^{o} - \sum_{d\in D}\sum_{o_d=i,i\in P}\sum_{D_d=j,j\in P}\sum_{T_d\in T} M_d * C_i^{f} - \sum_{d\in D}\sum_{o_d=i,i\in P}\sum_{D_d=j,j\in P}\sum_{T_d\in T} X_d^{a} * C_j^{c} -$$
$$\sum_{d\in D}\sum_{o_d=i,i\in P}\sum_{D_d=j,j\in P}\sum_{T_d\in T} Z_d^{p} * C_{ij}^{l} * a_{ij} - \sum_{d\in D}\sum_{o_d=i,i\in P}\sum_{D_d=j,j\in P}\sum_{T_d\in T} Z_d^{a} * C_{ij}^{le} * a_{ij})\}; \quad (8)$$

Numerical experiments and analysis

The mathematical model is simulated by Matlab, and optimized by Genetic Algorithm (GA). The data of the numerical tests are provided by a UK based TCO and the simulating shows a great profit increase and cost decrease after the introduction of the optimization. Also, through the simulating of different scenarios, the following results showed the effectiveness of the inventory-control based policy and its sensitivities to different fleet sizes, different reposition frequency and the degree of uncertainties.

	ETCR container cleaning duration $b_i \sim U(3,7)$						ETCR container cleaning duration $b_i \sim N(5,3)$	ETCR container cleaning duration $b_i \sim N(5,1)$
Fleet size	0.5*N		1*N		1.5*N		1*N	1*N
ETCR policy	Daily	Weekly	Daily	Weekly	Daily	Weekly	Daily	Daily
Total self-container jobs	500	422	570	578	727	719	584	636
Total emergent-leasing jobs	127	158	72	85	19	23	144	102
Total planned-leasing jobs	161	208	146	125	42	46	60	50
Total cost	£160k	£266k	£136k	£179k	£111k	£107k	£106k	£104k
Total profits	£556k	£ 449k	£580k	£537k	£604k	£610k	£609k	£612k
Total inventory cost	£2,043	£1,902	£6,994	£5,946	£15,291	£15,452	£6,759	£6,612
Total ETCR cost	£17,655	£5,595	£14,865	£10,395	£20,835	£16,440	£12,975	£11,040
Planned-leasing cost	£53,375	£97,250	£34,675	£25,550	£24,450	£23,325	£31,775	£26,950
Emergent-leasing cost	£56,500	£137,500	£32,200	£91,400	£15,835.	£16,440	£25,400	£21,700

Table 1. The key results

As the table 1 indicated, for the original fleet size, less frequent ETCR activities is more likely to have the issue with emergent-leasing jobs, which in turn, raise the overall costs and decrease the potential profits. When the fleet size is greater than the demands (1.5*N), ETCR frequency has less influence in countering leasing jobs, while instead, the more frequent ETCR deployments lead to higher ETCR costs and decrease the overall profits. When fleet size is smaller than the demands (0.5*N), the different frequencies of ETCR deployments made a great difference in reducing both planed-leasing and emergent-leasing jobs. As a result, the overall profits are greatly retained by the increase of ETCR efforts.

Through the comparison of different stochastic distributions, there is evidence supports that less fluctuated container cleaning duration would result in more effective ETCR deployments and the inventory-control based policies. As the statistics shows, the less spread out distribution uncertainty, the less total costs and higher profits can be achieved. Which implies, tank container operators need to on one hand improve the container flow related operation, and on the other hand, increase the reliability and certainty of container cleaning process for better operational performance.

Conclusions

Through the simulating of the TC quotation-booking process, this research tried to answer how TCOs could arrange their job fulfilments and ETCRs for better profit in coping with the time-gap constraint, non-cross-regional ETCR and the container cleaning uncertainty. As the simulating results indicated, the effectiveness of the proposed policy is determined by proper ETCR frequency and fleet size in dealing with overall demand volumes, and influenced by the reliability of container cleaning duration as well.

The next focus of our research would focus on the strategic decision-making on freight forwarders. Since TCOs need external resources to conduct sea mode transport. The transaction is normally intermediated through freight forwarders. In shipping industry, different service levels of freight forwarders provide different slot booking successful rates but the costs are different as well. Hence it is worth researching how TCOs make trade-off decisions towards the freight forwarder choices for cargo freight and ETCR deployments.

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Shipping management

UK container shipping flows to 2045: Delphi perceptions

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Introduction

Total world seaborne trade in 2012 increased by 4% over the previous year to 8.7 billion tonnes of annual cargo movements, and Stopford (2010) predicted ongoing compound annual growth (CAG) of 2.4% in global sea trade to 2060. Conventional forecasting methods typically include demographic changes, political factors such as World Trade Organisation trade agreements and economic factors such as future Gross Domestic Product (GDP; Neise, 2017). Estimates predicted potential 5-year annual growth rates in maritime container flows between 5% (Boston Consulting Group, 2009, 11) and 8% (Heymann, 2008). It is uncertain whether this increase in container shipping could be sustained long-term due to political and economic risks, stricter regulations on emissions, capacity problems at ports, and rising fuel prices. Longer-term forecasting is even more problematic and Havenga & van Eeden (2011) point out that long-range extrapolated forecasts can overestimate container handling by 300% over a 20-year period. Rowland (2007) highlighted U.K. National Ports Council estimates in the 1970s which failed to consider the growth in unitised traffic, the effects of globalisation on industrial production and closer European integration. This paper introduces phase II of a project to investigate the practice of forecasting UK container flows, using a quantitative Delphi instrument to tap the perceptions of career committed knowledgeable specialists regarding changes in items (I1:I8) worthy of debate relating to UK container flows to 2045.

Expected global and UK flows through container ports

Items for debate include the expected volume of global and UK container flows through ports, including quantitative perceptions of developments 2015-2030 (period α), and from 2030-2045 (β). Global historical containerized cargo movements substantially exceeded GDP growth (Stopford 2009, 516) but what rate will future global growth in full containers shipped internationally, excluding empties be? For the period 2015-2030 which growth rate is most appropriate: 1982-2002 rates of 8.5% CAR [UNESCAP, 29]; 2000-2014 rates slightly below 7% CAR (Woodburn, 2017, 190); or trebling (7.6% CAR) (I1a)? Economic growth raises shipping demand, but increasing dematerialization whereby technical advances reduce the materials input required per unit of output, and reducing energy intensities as production processes require less energy per unit output, tend to reduce flows. Longer term predictions of slowing global annual GDP growth rates of 3.4% in 1996-2010 (OECD 2016, 62), 3.6% in 2010-2020, 3.4% in 2020-2030, 3.1% in 2030-2040 and 2.6% in 2040-2050 (Braconier et. al, 2014) may imply slowing growth in container traffic. However, increasing global trade integration will raise exports as a percentage of UK GDP from 23% in 2010 to 30% in 2060, and proportionately more elsewhere (Braconier et. al, 2014). Taken overall, do specialists perceive similar global container flow growth in periods α and β (I1b)?

UK containerized traffic growth rates are substantially lower and reducing compared to rates globally, in a developed economy also traditionally reliant on extensive international roll-on roll-off flows of unitized loads. From 1990-2004, UK port container traffic increased from 3.97MTEU (million Twenty Foot Equivalent Units) to 7.99MTEU (CAR=5.1%) (Woodburn, 2007, 315). Before the 2008 global

recession MDS Transmodal (2006, 46) predicted 80% TEU growth (α=4.01%CAR) in Great Britain's containerized traffic. Do specialists perceive that UK flows will double in 15 years (α=β=4.73%CAR) (I2a, I2b)?

Effective investment planning for port facilities and access systems involves detailed sectoral and regional estimates including mode share and environmental impacts (Sanchez-Rodriguez et al, 2014; Monios, 2017). Between 2010-2015 total UK major port container imports TEU grew 18.7% and exports grew 19.0%, compared with 46.2% and 45.1% respectively for 2000-2015, affected by recession (Dft, 2016). Given ongoing containerization and industrial specialization, are overall estimates that total import container flows through UK ports will double in both periods (α,I2c; β, I2d), and likewise export flows (α,I2e; β,I2f), acceptable to specialists?

As liner shipping networks change, megaports will compete to host one single regional call by one megaship. Megaports will necessitate second tier international transhipment to intra-regional feeder ports, from whence third tier intra-national coastal movements will serve smaller ports (Kim et. al, 2016; Notteboom, 2010; Monios, 2017). In the service based UK economy, second tier imports from Rotterdam may increase, as may third tier onward distribution. In 2015, 12.6% of UK load-on load-off inbound port containers (TEU) arrived from the Netherlands, and 7.2% were domestic, compared with 14.3% destined for the Netherlands outbound and 7.3% domestic (Dft, 2016). Do specialists expect changes (α, β) in the percentage of total UK imports in containers through UK ports transhipped from the Netherlands (I3a, I3b), and those transhipped to other UK ports (I3c, I3d)? Over time, the size of containers passing through UK ports has increased (Woodburn 2017; 2007) and larger containers imply fewer but heavier movements. Comparing 2000 to 2015, the percentage of twenty-foot units fell from 44.0 to 30.4 (Dft, 2016). It is debatable how quickly the percentage of total UK port container imports in sea containers will change (α, I4a; β, I4b), and similarly the percentage of exports in sea containers (α, I4c; β, I4d).

Investment planning and master plans for ports and access corridors often incorporate sectoral and geographic economic modelling (Sanchez Rodriguez et al 2014; Asteris et al., 2012). However, specialists' perceptions of specific ports may colour future business decisions (Shaw et al., 2016). Although forecasts expected total GB containerized flows (in TEU) to double 2004-2020 (MDS Transmodal, 2006, 46) variable regional growth raises issues regarding perceptions of estimates that total container flows would double in each period (α, β) through each container port namely Felixstowe (I5a,I5b), Southampton (I5c,I5d), London (I5e,I5f) and Liverpool (I5g:I5h). Despite increasing concentration of flows towards container ports which service urban conurbations in South East England (MDS Transmodal, 2006) investment in new container port capacity and regional upgrades in rail loading gauges will also influence future flows (Woodburn, 2017). After showing specialists the percentage share of total UK port container traffic at each major port in 2015, what changes will they estimate in market shares in 2030 and 2045 for Felixstowe (I6a,I6f), Southampton (I6b,I6g), London (I6c,I6h), Liverpool (I6d,I6i) and "other" ports (I6e, I6j)?

How important are various drivers of changes in the volume of total UK imports in containers through ports (Notteboom, 2016; 2010)? These include UK total GDP (Stopford, 2009; I7a), upgrading of rail tunnels and bridges to accommodate sea containers (Woodburn 2013; I7b); the strength of Great Britain's currency (Stopford, 2009; I7c) and port charges (Fung et al., 2003; I7d). Similarly, how

important are drivers of change in the volume of total UK exports in containers through ports including UK industrial productivity (Stopford, 2009; I8a); rail infrastructure upgrades (I8b); the strength of the currency (I8c) and port charges (I8d)?

Methodology

This paper reports stage 2 of a mixed methods approach using a sequential exploratory design (Bennett et al, 2016). Data extracted from recent articles spanning socio-economic and shipping drivers of UK maritime container flows were refined into draft statements guided by established and tested Delphi instruments (Dinwoodie et al., 2013; 2014). Instruments aimed to tap the quantitative perceptions of emerging specialists regarding future developments (α, β). All statements included an "unable to comment" option to nullify any compulsion to participate. To reduce the burden of unnecessary repetition of Round 1 (R1) responses, non-response in Round 2 (R2) was explicitly stated as implying confirmation of R1 data. Further, because an evaluation is required to ensure criterion validity, by equating non-response in R2 to an evaluation, criterion validity is enhanced. Following further refining of statements, a Delphi panel was convened to complete the online Qualtrics survey instrument. On most questions, panellists were invited to respond to quantitative statements about their perceptions of developments for periods α and β using a 5-point Likert scale supplemented by an 'unable to comment' response. Although some respondents felt 'unable to comment' on time-distant β comparisons and response rates were slightly reduced, it was not felt necessary in this study to merge α, β evaluations into one single period. Panellists were asked to estimate future container flows and component flow proportions by selecting a group lying within 25, 50 or 67% of expected mean values. Panellists also estimated percentage market shares and used a 5-point Likert scale to indicate the perceived importance of drivers of changing trade volumes.

Criteria to assess constructivist dimensions of processes involved in this Delphi study include credibility and trustworthiness. Multiple evaluations imply credibility established through two rounds of evaluation, to avoid fatigue (Dinwoodie et al, 2013; 2014). Issues of trustworthiness include confirmability related to processes for gathering and analysing data, dependability related to panel selection, and verification of findings to establish transferability. To compare the perceptions of panellists most effectively, a classic quantitative instrument design was selected (Hasson and Keeney, 2011). Anonymity amongst panellists ensures that no one individual or viewpoint communicates with other panellists, and removes any scope for influencing or dominating others. Each participating expert is offered only controlled feedback, iteratively (Linstone and Turoff, 1975). Following R1, a mean evaluation was computed for each statement and fed back to other panellists in R2, when each panellist was asked if they wished to revise their initial evaluation. The breadth of issues raised in R1 reduced both the scope for raising additional issues in later rounds and the need for "responses to revised responses". Panel membership was by invitation only, to avoid any self-selection bias and all panellists were knowledgeable about container shipping flows and had acquired at least specialist postgraduate level academic knowledge. In total, 25 out of 77 invited specialist postgraduates who had completed the taught part of their Masters course at Plymouth University, responded to emails and two reminders sent in March 2015 inviting them to complete an online Qualtrics R1 survey. In May, an individualized R2 response was fed back which generated 23 responses after two reminder emails. Email is flexible, convenient and enables a message to engage a recipient who can respond when convenient, via MS Word attachments. An overall invitation to participation rate of 3.2 exceeds average rates of 4.4 (Nowack et al. 2010). Panellists identified diverse specialist interests and

represented sectoral interests including logistics and supply chain management, shipping and research or academic knowledge of container trades. They were drawn from four continents (Table 1). Over half had worked in industry for at least two years, and one-quarter had worked for over five years. Mean estimates were fed back to panellists in R2 alongside an opportunity to revise their individual initial opinions.

Trait	*Group*	*%*	*Group*	*%*
Nationality	Non-UK Europe	44	Asia	24
	UK	16	Africa	8
	Other	8		
Sector	Logistics/ supply chain	40	Academia / research	36
	Shipping	16	Other	8
Experience	Two years	48	Two to five years	24
	Six to ten years	20	Over ten years	8

Table 1: Profile of panelists

To test for differences in the central tendency of the distributions of responses between sub-groupings, non-parametric independent samples Mann-Witney U-tests were conducted. A non-parametric test was selected because the skewness of seven distributions exceeded unity and although inferentially slightly less powerful, they ensure consistency across all variables. Two comparative tests were undertaken. Firstly, were panelists' responses related to where they studied initially, namely in the UK or the Netherlands? Comparisons revealed no significant differences ($p<0.05$) on any statement. Secondly, are early respondents' replies consistent with those of late respondents? Comparisons of the first quartile of early responses with the last quartile of late respondents who had received additional reminders and may exhibit similar characteristics to non-respondents, again revealed no statistically significant differences ($p<0.05$) on any statement, implying that non-response bias is unlikely (Piecyk and McKinnon, 2010).

Results/ analysis

Both the mean and standard deviation (mean R1 minus mean R2, % fall in sd.) of panellists' considered estimates of freight demand growth for container shipping flows were less than for initial statements. Estimates that global container flows through ports would treble (7.06%CAR) in 15 years were considered slightly excessive (α=7.7%; β=20.9%; α=6.80%CAR, β=5.24%CAR) and non-response increased after 2030. Similarly, more modest estimates that total container flows through UK ports would double in 15 years (4.73%CAR) were slightly too high (α=12.8%; β=21.3%; α=3.76%CAR; β= 3.07%CAR). R2 estimates of imports through UK container ports were expected to grow more quickly initially (α=4.40%CAR; β=3.07%CAR) but the pattern reversed for exports (α=3.23%CAR; β=3.36%CAR). Non-response rates rose in both rounds further into the future as expected.

As mega-container ships increase in number and size, and assuming that a global economy attains, fewer calls in each global region are likely, necessitating increased transhipment. Perhaps predictably emerging career specialists' perceived ever increasing transhipment both at the European and national scales. R2 perceptions that the percentage of total UK port container imports from the Netherlands will grow exponentially (α=1.23%CAR, β=1.48%CAR) which were canvassed pre-Brexit, imply an ever increasing dominance of Rotterdam to service intercontinental megaship calls to Europe, generating more container ship services feeding into UK East coast ports. R2 estimates of the proportion of UK port container imports which are transhipped to other UK ports increase, but rates tend towards stabilization after 2030 (α=1.30%CAR, β=1.04%CAR). If correct, such a trend would imply a three level container ship network, perhaps with ever larger feeder ships plying between Rotterdam and a few key UK container ports, and an expanding network of third level coastal container movements around the UK, particularly for exports. The impacts on perceptions of any post-survey trends towards regionalization remain a moot point.

The survey yielded interesting information relating to the perceived size of containers. R2 estimates of the percentage of total UK port container imports in sea containers imply a slowly increasing proportion which slows further after 2030 (α=1.73%CAR, β=1.31%CAR). However, R2 estimates of the percentage of total UK port container exports in sea containers imply an almost static proportion, which increases slightly after 2030 (α=0.33%CAR, β=0.43%CAR). These perceptions may be coloured by knowledge that larger sea containers offer slightly lower transportation costs per tonne but that Britain has limited plans to upgrade its rail infrastructure to transport them. Consequently, the growth in import proportions will eventually slow, but exceed a slowly growing export proportion.

To test perceptions of any shifts in the growth and market shares of the UK's main container ports, panellists were asked to assess the accuracy of estimates that container flows through particular ports would double (CAR=4.73%) in 2015-2030 and again in 2030-2045. Individual assessments were requested for Felixstowe, Southampton, London and Liverpool. In R2 estimates, the growth rate at Felixstowe was perceived to remain relatively constant through to 2045 (α=4.26 %CAR, β=4.27%CAR), to remain high and constant at Liverpool (α=4.57%CAR; β= 4.60%CAR), and to slow slightly in London after 2030 (α=4.37%CAR; β= 4.28%CAR), with slightly lower and slowing growth at Southampton (α=4.06%CAR; β= 3.77%CAR). If correct, then following initial high growth in Liverpool, London, and Felixstowe, future growth beyond 2030 will be strongest at Liverpool. Well publicized recent container terminal investment at Liverpool may have influenced panellists' perceptions but any effects are impossible to identify in this study. Even if non-response rates of 24% to 44% occurred because some international panellists may have been uncertain about the detailed future prospects of specific UK ports, these perceptions remain pertinent because such views may be indicative of their future port selection decisions as practitioners.

Only at this juncture were panellists presented with data showing the actual percentage share of the total UK port container traffic in 2015 at the named ports, dominated by Felixstowe (42%). They were then asked to estimate what the shares would be in 2030 and 2045. Mean R2 estimates revealed a slight initial dip in market share at Felixstowe but the market share will be retained after 2030. Substantial early growth in London, perhaps reflects the expected rapid growth and investment associated with London Gateway. A strong increase in upcoming market share at Liverpool is expected to stabilize; a slight decline in market share is expected at Southampton with substantial early

reductions at other ports. These estimates are consistent with perceptions of a shift to a three tier global container shipping network serviced by megaships visiting Rotterdam, and occasionally a few UK ports, but principally with feeder services from Rotterdam focusing on a few UK container ports which undertake major investments. Third level coastal cabotage services would then account for a reducing national market share. To gain insights into panellists' perceptions of the drivers of change in the volume of total container movements through UK ports, they were asked to rate the importance of named factors which affect imports and exports. Import container movements were thought to be driven by the levels of UK economic activity, port charges, strength of the currency and loading gauge upgrades. Export container movements were driven by industrial productivity, strength of the currency, port charges and loading gauge upgrades but there was relatively little differentiation between the last three, and some instability in rankings between rounds of questioning. Coupled with 32% non-response rates in R2, this finding indicates limited awareness amongst specialist logisticians relating to macro-economic issues and implies a need to recruit a multidisciplinary panel when canvassing perceptions relating to longer term policy issues.

Discussion

Delphi methods aim to generate useful estimates of long-term market developments independently of medium term trend based statistical predictions but their grounding in human behaviour generates methodological criticisms [Stopford, 2009]. Regarding panel selection, non-commitment bias may arise if panellists are not fully committed to implementing their stated preferences (Linstone and Turoff, 1975). To counter such effects panel recruitment in this study targeted emerging specialists likely to work as committed practitioners throughout the study period. As specialist postgraduate students, panellists represented the specialist perceptions of knowledgeable professionals, and as an international group drawn from several industries, their viewpoints were diverse. In relation to instrument design, temptations to offer respondents precise but wrong answers because they appear more authoritative than vague but more accurate answers, were countered by offering no precise response categories. By omitting statements about short term developments, risks of projecting bias arising from short-termism and myopic interpretations of current events into long term contexts, were avoided. Finally, because long term forecasting in volatile markets is risky, high levels of nonresponse and incorrect predictions are inevitable, because nobody knows what will happen in future and claims to certainty would be irrational.

Conclusion

Since the 1950's containerization has transformed international trade, facilitated globalization and reshaped ships and ports. Specialist logistician panellists expected growth in container flows through ports to slow slightly after 2030, but every 15 years global flows will almost treble, and UK flows will almost double. As container ships increase in size and call at fewer ports in a three-tier global container shipping network dominated by megaships and megaports, UK container ports will probably function either as intra-regional feeder hubs linked to Rotterdam, or will host coastal services linked to UK hubs. Individual port prospects will depend on publicizing facilities on offer internationally, as much as investing in them. Within this intensely competitive environment the operational worth of traditional statistical forecasting techniques and market shares modelling will depend on dubious assumptions that the shipping system and its fundamental components will remain relatively unchanged. Ad hoc Delphi panels offer an alternative approach to long term forecasting. Important issues remain to stimulate future debate including recent geopolitical trends towards on-shoring, regionalization and

protectionism which have potentially fundamental implications for the volumes and spatial configuration of global container flows. However sunk investment globally in ULVCs and port handling facilities, and deep-water ports in fixed locations create countervailing inertia. Similarly, increasing regulatory controls on maritime operations relating to shipping's atmospheric emissions, ballast water exchange and requirements to verify the gross mass of each container under Safety of Life at Sea Regulations (IMO, 2016) generate further uncertainty. Within this complex environment, traditional trend-based statistical forecasting techniques invite supplementary studies based on opinion-based surveys of specialists, to judge the perceived impact of unexpected drivers of change, long-term. Thirty-year quantitative Delphi projections gleaned from knowledgeable specialists with long-term career commitments offer invaluable insights to supplement statistical forecasts and strategic plans devised by established professionals with only limited future long-term career commitment.

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Who will save the Salvors? The decline in salvage income and the emergence of the Ultra Large Container Ship and how these phenomena create uncertainty

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Introduction

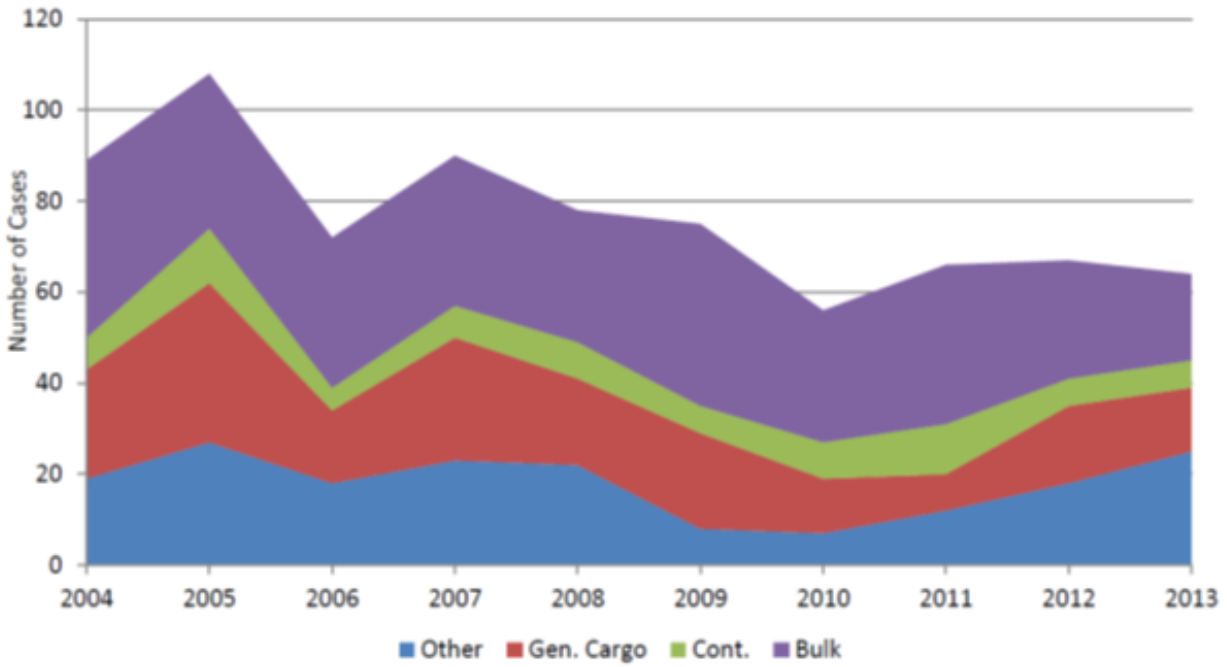
The International Salvage Union (ISU) are the body that collectively represents commercial marine salvage companies operating internationally. In 2008 the ISU began the process, unsuccessfully, of getting the International Salvage Convention 1989 (herein referred to as the Convention) and therefore international salvage law amended to include, for the first time, an award for environmental salvage. The ISU sought a new salvage award and a new source of income as the environmental aspect of ship salvage has become ever more important and "*plays a far larger part in today's salvage operation than was anticipated when the text of the Convention was envisaged*" (Bishop 2012). Success in securing the new salvage award was important as traditional sources of salvage income have been declining at a time when significant investment is needed by the salvage industry to deal with the operational challenges of dealing with a casualty involving an ULCS or a very large cruise ship.

Trends in salvage income/awards

It is difficult to get accurate figures for salvage awards as the salvage industry has become increasingly sensitive to publishing the details of awards. The monetary details of cases that settle amicably remain confidential to the parties involved. However, writing in 2010, the then President of the International Salvage Union, Todd Busch, gave an insight in to the salvage industries income for 2008, when he revealed that "*income world wide of all members was just over $550 million*." (Busch 2010). The latest statistics on earnings, from all activities, for members of the ISU shows a decline in income to US$ 380 million for 2016 (ISU 2017a).

The decline in income can be attributed to two significant factors, the first is that shipping has become safer and the number of accidents requiring salvors intervention has declined and secondly, insurers have become increasingly risk averse and are less likely to contract on "open" terms i.e. use the traditional salvage contract Lloyd's Open Form (LOF). Only about 30% of salvage is carried out on LOF terms (Lloyd's Agency 2015). Of that 30% a high percentage of cases are settled amicably, for example, between 1 January 2004 and 31st December 2013 this constituted 78% of LOF cases reported to the Salvage Arbitration Branch (SAB) of Lloyd's Agency (Lloyd's Agency 2015). The individual settlements which the salvors received in these cases was not be made public. Figure 1 illustrates the year-by-year trend of LOF cases reported to Lloyd's during the period 1 January 2004 to 31st December 2013, it shows a general decline in the use of LOF as the contract of choice for salvage activities.

Figure 1 - Year by Year Trend of LOF Cases by Vessel Type



Source: Lloyd's Agency Lloyd's Open Form Report 2015

The decline of LOF cases reported to the SAB during the period under scrutiny does not necessarily indicate that there has been a decline in the number of salvage cases overall during that period. The salvage industry is increasingly carrying out salvage operations using fixed or lump sum payment contracts as insurers, concerned by the rising cost of individual salvage and wreck removal projects, are under pressure to control their costs. The most expensive salvage/wreck removal project to date, the Costa Concordia wreck removal, cost in the region of US$1.3 billion, and was carried out by using fixed or lump sum payment contracts (ISU 2017b). Kendall-Marsden (2017), states "*insurers are careful in choosing the right salvor and salvage agreement as a mechanism to control costs*" explaining that there is a "*growing appetite for change at the rising costs*". He acknowledged that the rising costs were not as a result of the rise in salvage awards or profit for the salvors but rather a reflection of the increasing costs of dealing with a salvage incident as coastal authorities are now much more prescriptive about how the incident is dealt with largely due, as Bishop (2012) said, to rising environmental concern.

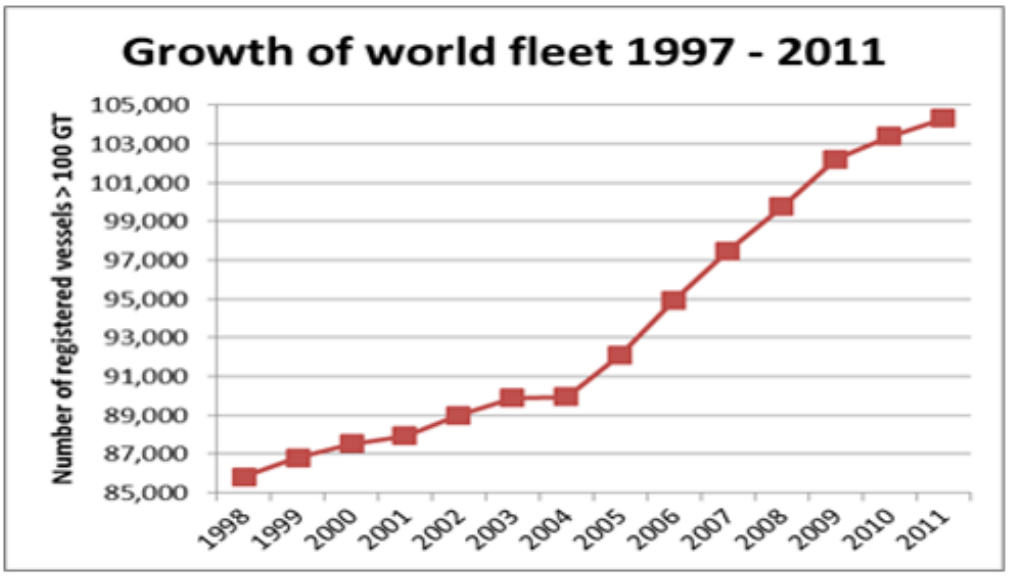
It appears that the risk of dealing with ship salvage, or at least a significant proportion of it, traditionally the domain of the insurer, is now passed to the salvor. Concern about this growing phenomena has been expressed by the current ISU president, John Witte (2017), who has asked "*if we are expected to share the risk how is this business viable?*" Unless the number of salvage events are such that the salvage industry can take a win some-lose some approach to salvage and wreck removal projects with a healthy aggregate profit overall the insurers approach of transferring the risk to a diminishing number of salvors does not make sense for the future certainty for the salvors, ship-owners and their insurers.

The growth in the size of the merchant fleet has not resulted in an increase in accidents

Ships have been getting larger and more complex in design and the number of operational ships has also risen dramatically (Pike, et al 2013). Figure 2 illustrates the rise in the world fleet between 1997 and 2011, in particular after China became a member of the World Trade Organisation on the

11 December 2001 (WTO 2017). It took a couple of years for this to show in the world fleet numbers due to the lead time for the ship building yards to deliver the new vessels ordered. The number of registered ships over 100 gross tonnes rose significantly during this period but has not continued to rise at the same rate in fact according to the largest global shipbroker Clarksons the world fleet was 5% smaller at the start of March 2017 than in March 2011 (Clarksons 2017).

Figure 2 – Growth of the World Fleet 1997-2011



Source: Pike K., et al, 2013. 15 years of shipping accidents: a review for WWF

The increase in the number of ships did not lead to an increase in the number of casualties. Figure 3 illustrates that the number of total losses has been declining. The author was involved in a study that examined shipping accidents over a fifteen-year period (1997-2011) one of the significant findings of this study was that as the shipping industry is now so highly regulated in matters of operational safety and pollution prevention that there has been a decline in the number of ship losses both the number of actual losses and loss as a percentage of the overall fleet (Pike, et al 2013).

Figure 3 – Total Loses by Year a Declining Trend



Source: Allianz Global Corporate & Speciality Shipping Review 2015

The causes of shipping accidents are complex. There has been significant research over many years in to the major causes of shipping accidents among them mechanical failure, fire and human error (EMSA 2014). In spite of efforts on the part of the shipping industry and the regulatory bodies eradicating accidents completely has proven highly challenging. There remains a need for an economically sustainable salvage industry to be able to respond when casualties occur in the future.

The rapid growth in container ship size to meet the demands of the supply chain

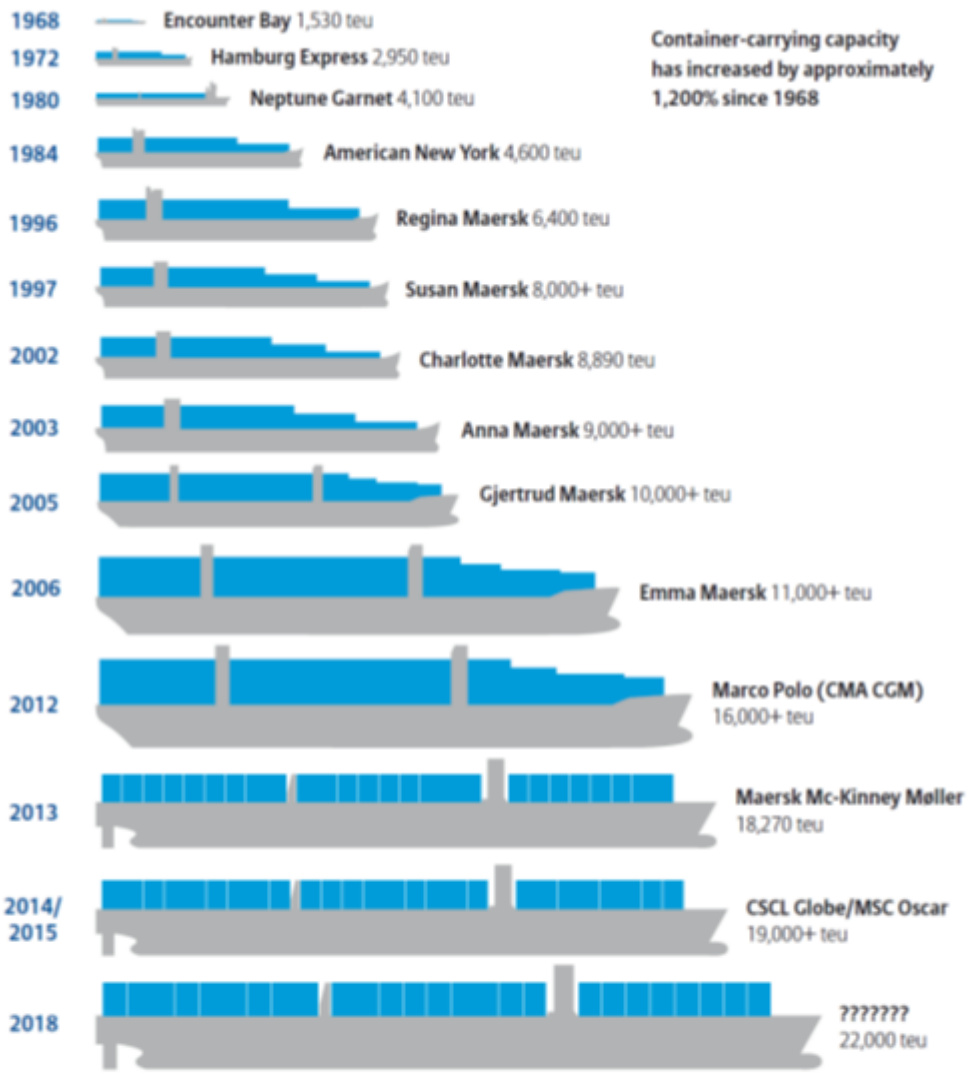
Container ships are categorised by how many twenty foot equivalent units or TEU's they are able to carry. In the first six months of 2017 the title of largest container ship moved rapidly from the MOL Triumph (20,170 TEU) to the Maersk Madrid (20,568 TEU) to, at the time of writing, the OOCL Hong Kong. The OOCL Hong Kong is 400 metres in length, has a width of 58.8 metres, and can transport 21,413 TEUs. Vessels of this size are referred to as an Ultra Large Container Ship (ULCS).

Container ships have developed rapidly since 2013 when Maersk Line launched the first of their Triple E Class vessels the 18,270 TEU Maersk McKinney-Moller (Maersk *nd*). Maersk Line started what would quickly become an industry standard for liner companies seeking to keep up with or outdo their rivals. Maersk were open about their intentions in launching these larger vessels, they were looking to increase economies of scale, increase operational efficiency and reduce CO2 emissions (Maersk *nd*). In an increasingly competitive and regulated market no ship owner could be criticised for seeking an advantage over their rivals. When launching such large vessels Maersk Line, or their parent group AP Moller-Maersk, considered how salvors would deal with an incident involving one of their Triple E Class vessels. In 2013 Svitzer Salvage, part of the AP Moller-Maersk group, developed a crane that would enable containers to be off loaded on to an adjacent ship or barge and encouraged the rest of the salvage industry to invest in this system (TradeWinds 2014). The salvage industry expressed reservations about this method as the Svitzer crane could only operate on vessels that remain upright and have not listed; the crane would not be useful and provide a workable solution in many salvage scenarios involving large container ships (Lange 2015).

One company, or company group cannot bear the financial risk of developing and investing in the equipment needed to cope with the bigger ships now operating. Such specialist equipment may never be used and may become obsolete in a short number of years. In 2015 Svitzer Salvage changed its business model when AP Moller-Maersk agreed with Crowley Marine Corp. to merge Svitzer and Titan Salvage, a wholly owned subsidiary of Crowley Marine Corp., to form a new salvage giant Ardent (Ardent 2015). These two salvage operators were large companies before their merger Svitzer Salvage bringing its expertise in emergency response and Titan Salvage its expertise in wreck removal to the newly formed Ardent; it was Titan Salvage that dealt with the wreck removal of the cruise ship Costa Concordia. Ardent benefits from the pooling of experience, equipment and knowledge and commercially from the economies pooling resources brings (Bennett 2017).This may be the future of the salvage industry, fewer but bigger operators.

The size of container ships has almost tripled over the past twenty years (Allianz Global 2015). Figure 4 illustrates just how dramatic this growth has been. The question how much larger container ships can grow has been considered by DNV GL the Norwegian/German classification society. They published the results of a study that found that vessels of 26,300 TEU would be technically feasible (Bergmann *nd*). From the DNV GL study we can conclude that the main limiting factors to vessels of this size would not be structural safety concerns of the vessel but would be the limitations of physical infrastructure e.g. port, bridge and major canal restrictions, and the economic demand generated by world trade.

Figure 4 - Fifty Years of Container Ship Growth



Source: Allianz Global Corporate & Speciality Shipping Review 2015

There are, however, risk management issues to consider with ULCS. A large hull and machinery insurance provider, Allianz Global Corporate & Speciality, have warned of the risk management problems of dealing with such large container ships and believe that the insurance industry should "*prepare for a $ 1bn+ loss in the future*" stating that it could take two years "*to remove all of the containers from an 19,000+ teu vessel in the event of an incident, assuming it was possible at all.*" (Allianz 2015).

The challenges of salving an Ultra Large Container Ship and the need for greater investment in the salvage industry

"*The shipping industry is not ready to cope with a large boxship casualty, and its ability to respond to a cruise ship grounding is also questionable*" (McMahon 2013). This was the premise of an article published in Lloyd's List, the daily shipping journal, in December 2013 at a time when the largest container ship was just over 18,000 TEU. This was not news to those involved with ship casualties. Both the International Salvage Union and Lloyd's Joint Hull Committee (the industry panel that represents the major ship hull and machinery underwriters) had warned the shipping industry that commercial salvors would struggle to deal with a casualty involving one of the new, larger container ships. Container ships have continued to grow in size since 2013 and salvors are still pondering the problem of how they will effectively respond to an ULCS casualty. The challenges the salvage industry will face in dealing with an ULCS casualty can be seen by examining a relatively modest sized container ship casualty that occurred in 2012 the MSC Flaminia.

Case study - The MSC Flaminia

The MSC Flaminia was not an ULCS container ship, her story is illustrative of the problem salvors may face if an ULCS is in distress and requires assistance. The MSC Flaminia had a TEU capacity of 6,750 although according to the official report carried out by the German Federal Bureau of Maritime Casualty Investigation (2014) she was carrying only 2,876 containers, 149 of them carrying dangerous goods, when she was badly damaged by an explosion and subsequent fire in a cargo hold mid Atlantic in July 2012 (HM Coastguard 2012). It took the Dutch salvors, SMIT International, a few weeks to extinguish the fire and board the vessel to stabilise her ready for towing to a place of refuge (SMIT *nd*). It took considerably longer for the vessels owners, insurers and salvors to find a port willing and able to take the MSC Flaminia in her stricken state. Many coastal states were either not willing to offer a port of refuge or did not have a port suitable for the MSC Flaminia; she was eventually taken to Wilhelmshaven, Germany, in September 2012 (Mai 2015). When a ship requires a place of refuge there are a great many interested parties concerned about the effect providing a place of refuge will have on their interests; these interests have to be balanced against the need to deal with the aftermath of a casualty. There will be an official investigation as to the cause of the accident and depending on the jurisdiction and facts there may also criminal proceedings; for each inquiry evidence and testimony will need to be gathered and physical evidence preserved whilst investigations are carried out.

Surviving and damaged containers, particularly containers carrying hazardous cargo or containers that have become contaminated as a result of the accident will need specialised handling and storage, and will need to go through a process of de-contamination before they can be disposed of. In the case of the MSC Flaminia fire damaged containers had become contaminated by the contents of neighbouring containers and by the water used to extinguish the fire, much of it still in the vessels holds. Handling of this this waste had to comply with Wilhelmshaven Port Authority's own requirements, local law, German federal law and EU waste and environmental legislation (Mai 2015). To do this safely and effectively the port had to dedicate space on the terminal away from all other commercial operations, space that was needed for many months. The terminal itself needed to be prepared before any salvage operations could take place and cleaned afterward as the terminal surface becomes contaminated by the clean-up process. The salvage and clean-up costs of the MSC Flaminia far exceeded the vessels value although the total cost has not been disclosed it is known that cargo worth in excess of 115 US$ million was damaged as a result of the fire (Angell 2017).

The case of the MSC Flaminia, a fraction of the size of the containerships now in operation, demonstrates how complex and costly it can be to deal with a container ship casualty. This challenge will be greater when dealing with a ULCS casualty due to the much larger number of containers. The challenge of finding a port with sufficient draft and terminal space available and is prepared to disrupt its commercial operations to allow a stricken ULCS and her cargo to enter and stay for the salvage and clean-up process cannot be underestimated.

There has not yet been a serious accident involving an ULCS however the grounding of the CSCL Indian Ocean on a sandbank in the River Elbe in Germany in February 2016 was a timely reminder to the shipping industry just how difficult dealing with an ULCS incident will be. The CSCL Indian Ocean (19,100 TEU) was travelling from Felixstowe to Hamburg when she suffered power failure and grounded on a sandbank in the river Elbe. Luckily, she had suffered no breaches to her hull nor any underwater damage when she hit the sandbank, but she was hard grounded. Numerous unsuccessful attempts were made to re-float her. She was eventually re-floated on the spring tide with the assistance of twelve tugs and after the river had been dredged alongside her (World Maritime News 2016a).

The rapid development in size of vessels in the container ship sector coupled with the development of ever larger passenger ships in the cruise sector has created a capability gap between the services salvors can provide in terms of specialist place and equipment to deal with these “mega” ships and what the ship-owning community and their insurers need. The challenge is not limited to the ULCS sector. Consider, for example, even a minor incident requiring the services of a salvor to Royal Caribbean’s Harmony of the Seas launched in 2016. At the time of writing she is the largest cruise ship ever built with an overall length of 1,188ft, she is 226,963 gross tonnes and was built to hold a population of 8,880 passengers and crew (Hall 2016). In the event of a serious casualty a salvor could realistically do no more than marshal the ships own lifeboats away from the stricken vessel before dealing with the ship itself.

There is a further area of concern for salvors, perhaps not yet as immediate as the one presented by the “mega” ships but nonetheless as potentially important. It is the prospect of commercially viable shipping in the arctic regions both the Northwest Passage and the Northern Sea Route. Here we may see the challenges faced in dealing with “mega” ship casualties but in much more remote, environmentally sensitive and hostile environments. O’Leary (2010) has argued that it is in the interests of the Arctic’s many stakeholders that generous salvage awards are needed to ensure lives and maritime property are saved and damage to the Arctic’s fragile ecosystems is prevented or minimised. This was what salvors had in mind when they sought amendments to the Convention. They were unsuccessful in securing those amendments in 2008. Given the challenges modern shipping presents is it now time to re-think how we reward salvors?

Conclusion

The challenges facing the commercial salvage industry are real. We can safely assume that on past evidence accidents will continue to occur, albeit fewer of them, but an accident may well involve one of the ULCS now in operation. Commercial salvors are a special breed of people, innovative, courageous and with a distinctive flair for problem solving but it remains to be seen how well they will rise to meet the challenges ahead. The salvage industry itself has sounded the warning bell about its preparedness to handle an ULCS casualty. With declining income levels the ability of commercial salvors to deal with the challenges that modern shipping presents is uncertain. The law concerning salvage remuneration should be examined again if it is to encourage salvors to remain in the industry, expand their business and invest for the future.

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Soft Systems

Logistics demonstrations as a participatory research design

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1. Introduction

Knowledge creation through research in logistics and supply chain management (SCM) builds inherently upon close interaction between scholars and practitioners. A common view of strengthening the knowledge creation in the field is by increased rigor (e.g. Mentzer and Kahn, 1995), and focus on theory development by using a variety of methodological perspectives (Arlbjørn and Halldorsson, 2002; Näslund, 2002; Gammelgaard, 2002). Recently, however, *relevance* and *impact* -- i.e. advancing practice -- of research has become important as well, a quest put forward by various stakeholders but which has also grown out of other academic disciplines. This notion rests on at least three pillars. First, increased focus on relevance and impact has materialized in firm demand from funding bodies that favour research projects with high technology readiness level (e.g. TRL 6 - "technology demonstrated in relevant environment", and TRL 7 - "system prototype demonstration in operational environment") which implies a strong focus on *demonstration* of certain artefacts, e.g. technology, in a relevant environment. Second, the logistics discipline has also started responding to this quest for increasing relevance and impact: Näslund (2002) advocated increased use of participatory research methods. In a discussion of rigour versus relevance of research in the field, Mentzer (2008) takes on a wider approach by suggesting "input of students" from teaching (i.e. an instructional process) and "application/consulting/services" as means to disseminate knowledge to practitioners. Klaus (2010) is less concerned with the scholar-practitioner interaction, but encourages the scholar to use new insight from practice to question assumptions commonly held by the field. Halldórsson et al. (2015) build further upon Boyer (1990) and Klaus (2010), and suggest that such question of assumption as well as scholarship of application through action-oriented research methods has become an important part of theorizing in logistics and SCM. The involvement of practitioners in consulting researchers to identify what is of interest is further echoed by Goldsby and Zinn (2016). However, despite this development in the field that is fully in line with the funding bodies, the way by which to operationalise this is not clear. Other related fields have advanced their use of e.g. action research, and conceptualised the research process in terms of e.g. "engaged scholarship" (Van de Ven and Poole, 2006). Reed (2009) calls for a more "dialogical" rather than linear approach to knowledge creation and dissemination so as to balance polarisation between "theory-driven research" and "practice-driven application". Third, by extending the system boundaries for analysis to the supply chain, researchers have the opportunity to address complex problems, and include the view of more actors in their investigation of physical structures as well as socio-technic elements. This in turn calls for organisational/behavioural understanding, and a level of sensitivity to the empirical context (see e.g. Flick, 2014) that must be operationalized through a research design that entails co-creation of new knowledge through an interaction between scholars and practitioners. Scholars in logistics and SCM have an opportunity to make use of demonstrations as research design, which as described in this paper, has similarities with action research, but is not well developed as a research design. Given this background, the purpose of this paper is to explain how demonstrations can be used as research design, in this paper illustrated by demonstrations within the domain of logistics/SCM.

2. Conceptual approach: features of demonstrations as a research design

Commonly used field research strategies in logistics call for proximity to the empirical context, and even allow for intervention by the researcher. *Case studies* investigate "contemporary phenomena" in a "real life context", and are therefore suitable in early exploratory investigations when there is little known about a phenomena (Eisenhardt, 1989; Yin, 1994). When using an abductive logic (Spens and Kovács, 2005), the researcher is expected to present managerial implications as a distinct outcome. *Action research* (e.g. Coughlan and Coghlan, 2002; Näslund, 2002; Näslund et al. 2010) goes further in the interaction with the field in its participatory focus and development of "practical knowing" and solutions (Reason and Bradbury, 2001). Here, the investigation becomes research "in action" rather than "about action", and intervention into processes studied becomes an inherent part of the research design. In *design science*, "the researcher is interested in developing "a means to an end", an artefact to solve a problem" (Holmström et al. 2009). Here, focus is on an artefact, e.g. constructs, models, methods, or instantiations that are intended to solve organizational problems (Von Alan et al., 2004, Holmström et al., 2009). Finally, *laboratory experiments* in logistics entail the creation of a system "in which behaviour can be observed and replicated" (Deck and Smith, 2013). Intervention takes place, but in a created and controlled environment.

Demonstrations as research design are not well defined or conceptualised in literature, but have recently gained increased attention (e.g. Friedman and Wyatt, 2006). These studies have a strong resemblance to the aforementioned characteristics of action research, and can to a large extent be underpinned by the same methodological considerations and within logistics be justified by the same arguments as proposed by Näslund (2002). Our attempt to clarify the concept is relative to the four designs mentioned above. In general, demonstrations in logistics can have a wide meaning, and refer both to demonstration of a method or a process, and/or an outcome achieved by a these methods and processes. Our initial attempt to characterise demonstration as research design is by the following (further refinement of this understanding is achieved in the subsequent sections of the paper): (1) Knowledge about key constructs and focus *prior* to data collection (lean towards deduction in that respect). (2) A "temporary, created context": Building of a new logistics system, or a modified version of the current one for the purpose of the investigation (a "created context"). (3) Transferability: This creation is a simplified version of a fully operative system, but should allow for replicability (i.e. not idiosyncratic to the demonstration as design and setting) and scalability (i.e. possible to scale up). (4) Intervention takes place to some extent in a controlled system due to the small-scale nature. (5) For unit of analysis, these studies are structured around a *means* that lead to an outcome (e.g. method, process, use of particular technology in these) and/or the outcome itself. (6) Abductive: allow the investigators and other participants to learn from errors, and make changes such as behaviour or the attributes of the setting. (7) Change - not all factors known from the outset: Urge the investigator to ask questions such as "what adaptations are needed?"

Hence, demonstrations are *deliberately created* by a team of researchers and actors at a particular level in the supply chain, and allow for a particular focus on precision in control and measurement in variables related to the behaviour in and of the system that has been created for the investigative purpose. Compared with action research, which is concerned with intervention into current system, demonstrations have a larger level of novelty. Derived from this we suggest the following definition of demonstrations as research design in logistics: The testing of a new logistics solution (e.g. vehicle, transport mode, technological advancement, concept) that could potentially contribute to more efficient and effective logistics, tested in (deliberately created) real life settings by industrial actors, under a limited period of time and (jointly) evaluated by practitioners and researchers.

3. Method and approach

The framework for managing demonstrations as research design is built on related literature on action research (in particular Coughlan and Coghlan, 2002; Näslund et al., 2010; and Sein et al., 2011) as well as learnings from and reflections on two recently performed demonstrations. We suggest a three stage framework, consisting of (1) design of the demonstration, (2) collecting and analysing data (3) the path from demonstration to a new system. Demonstrations as research design shares characteristics with action research, yet with distinct features that must be understood in order to make use of demonstrations as a rigorous research design.

The scope of the two demonstrations (Demo A and Demo B) was to test new logistics solutions of urban and inland waterway transport. Both were funded as part of larger research projects, which set conditions regarding the geographical scope of the demonstrations. Demo A used a barge-tugboat setup to demonstrate urban waterway transport of parcels and waste in combination, and was operated for two weeks. The parcels were loaded into two 1 m^3-containers supplied by a third-party logistics provider near the city centre in Gothenburg and transported to the city centre. Transportation to final customers was done by one electric vehicle and one city cargo bike. Waste was transported from the city centre in two containers (9 m^3) to a combined heat and power plant outside the city centre. Demo B consisted of transporting twelve 20-foot containers between Göteborg (port of Surte) and Vänersborg along the Göta-Älv river and was run for one time only.

In order to underpin the framework, the demonstrations have been analysed with respect to both (1) the process of designing, performing and evaluation and (2) the actual understanding generated from the demonstrations regarding how to make use of more waterway shipping in the studied contexts. The empirical evidence consists of notes from planning meetings, smaller investigations shaping the design of the demonstrations, interviews with involved actors, observations and video recordings during demonstrations, as well as notes from captains' logbooks. Investigations prior to the demonstration included observations and measurement of waterways, which set conditions for the demonstrations in terms of barge selection and loading plans. Prior to the demonstrations, interviews were held with actors involved in planning of as well as carrying out the demonstration (5 in Demo A and 2 in Demo B). The interviews were semi-structured and covered the planning process, expectations and performance measures. Interviews were also held afterwards (5 in Demo A and 4 in Demo B), and these covered the performance of the demonstration from the actor's perspectives, their view on the difference between the demonstrations and a scaled up solution as well as the path in between. All interviews have been transcribed to enable data analysis using NVivo to code and categorise the data.

4. Analysis - Developing a framework for demonstrations as research design

4.1. Design aspects

The process of arriving at the deliberately and temporarily created settings needs to be documented to justify the demonstration as rigorous research design. In particular, the following aspects are important:

Stating contextual information enables the receiver to understand and assess transferability of results

A rich contextual description is essential within both case studies (Yin, 1994) and action research (Coughlan and Coghlan, 2002; Näslund et al., 2010), in order to facilitate understanding for the reader as well as transferability of the results. Similarly to Näslund et al. (2010) who advocated providing information such as location, time frame and historical information, we emphasize that contextual information should be described; e.g. how the problem owners shaped the planning process and hence the design of the demonstration. Within Demo B, the logistics operator had the main responsibility for designing the demonstration. Even though a modal shift is preferable from an environmental perspective, their main driver for the demonstration was to attract business customers, which in the end shaped the design of the demonstration. For example, in order to ensure that the barge was on time for unloading, the entire demonstration was performed with extra slack time, which obstructed data collection on time efficiency during the operation. In comparison, within Demo B, municipal actors within both waste handling and traffic planning were a part of the project group, and had a major influence on the design. They emphasized the importance of sustainability issues, which shaped the design, e.g. in the sense that diesel powered equipment should not be used for loading and unloading, which limited the options in the selection of loading units, and eventually lead to the use of small containers. Hence, problem owner preferences (e.g. economic vs environmental) shape the design of the demonstration and are examples of contextual information that must be stated for reader understanding and transferability.

Identification of unit of analysis

Describing the unit of analysis is a key aspect in order to justify rigorousness of action research (Näslund et al., 2010). We suggest that an inherent feature of demonstration as a research design is that the novel aspect of the demonstration per se is the unit of analysis. However, defining such is not straightforward, but the participatory feature of demonstration as research method facilitates such identification. Within Demo A, the consensus was that demonstrating the use of urban waterways was new, but the barge operator narrowed it down to "according to a fixed time-schedule", and similarly, the 3PL operator from their perspective added that "it was done with maintained delivery service". In addition, the last-mile bike operator added that the container used had not been tested before in an intermodal perspective, which hence led to an embedded unit of analysis within the study. Hence, the participatory feature of demonstrations as a research method, i.e. using the actors' view and experience to pin down the unit of analysis in relation to their ordinary operations is valuable.

A demonstration should have one objective - and potentially several research questions

Research questions are central within research design as they directly link to other components such as validity and framework (Maxwell, 2005), acting as a control mechanism and in the end determine the success of qualitative research (Flick, 2014). Näslund et al. (2010) proposed action research as a suitable research strategy to answer case study research questions, which, as defined by Ellram (1996) are comprised of "the what, how, and why questions pertaining to a given situation". However, whereas action research is "in action" (Coughlan and Coghlan, 2002), a demonstration is a temporary event in a created context. Therefore, it is desirable to have an overarching purpose or objective, i.e. to do a demonstration on the unit of analysis, which in turn can be used to potentially address different types of research questions. Within Demo A, the rich amount of quantitative data made it possible to investigate efficiency aspects, e.g. regarding loading and handling, which in turn could be used to address RQs on the future system such as "which factors shape the design of a new system". In comparison, Demo B had limits within collection of quantitative operational data, rather, the objective of the demonstration was to show actors and society that containers could be transported on Göta älv. However, we argue that the tangibility of the demonstration enabled actors to reflect upon issues such as barriers towards the new system. Hence, the scope of the RQ was the path to rather than the design of a new system. In brief, a demonstration could therefore be useful to answer RQs of different nature.

Limitations, delimitations and trade-offs need to be stated and followed up in analysis

In comparison to action research which is fundamentally about change in existing business firms and other organizations (Coughlan and Coghlan, 2002), a demonstration is temporary, and numerous design decisions need to be made. Within Demo A, it was not feasible to develop a purpose built vessel, due to budget restrictions. Instead, a barge used for bulk material, in combination with a tugboat, had to be adapted to be suitable for the demonstration. Similarly, in Demo B, budget constraints made it necessary to use an available barge-tug combination instead of a better suited inland waterway vessel. Also, since it was not possible to invest in new loading equipment in ports, existing non-optimal loading equipment was used. Hence, such limitations, (and also delimitations and different trade-offs) need to be pinpointed, both for data analysis and transferability of results.

4.2. Data collection and analysis aspects

In line with Sein et al. (2011) who argue that evaluation (analysing a design artefact) is not a separate stage of the research process, but rather should be done throughout the entire process, we suggest that data collection and analysis can be *staged*, i.e. take place before, during and after the demonstration. Guidelines for data collection and analysis are well defined for other research designs and can be applied for demonstrations as well. Both case studies (Yin, 1994) as well as action research (Näslund et al., 2010) advocate rigor in data collection, e.g. by keeping a case study protocol to document the process. Also, depending on data collections methods, there are numerous techniques that can be used for data analysis, such as coding to analyse interviews (Näslund et al., 2010). Furthermore, guidelines for assessing the quality of the research can be drawn from both case studies (see e.g. Seuring, 2008) and action research (see Näslund et al., 2010). In relation and in addition, we suggest the following be taken into account:

Investigations for designing demonstrations can be seen as data collection

The design process for the demonstrations required different investigations such as measuring waterway characteristics (e.g. air draught and depth), which we argue should be seen as part of the data collection. Within Demo A, the municipality involved was responsible for finding suitable quays for unloading the waste. The preconception was that there were multiple potential quays for unloading the waste along the river. However, based on an investigation of all quays along the river near the power plant, which included assessment of each quay's bearing capacity, only one quay (with poor characteristics) was found, prompting a need for investments if the system is to be commercialized. Thus, investigations prior to the demonstrations can serve as data collection, for which conclusions regarding future system design can be drawn, which exemplify why learning should take place at several stages of the demonstrations.

Analyse both operational data from the actual demonstration as well as the overall process

Analysing the overall process was found as a useful complement to the data analysis of the performance of the demonstrations' operations, rendering different types of learnings. By reflecting on obstacles and challenges of the overall process of designing and performing the demonstration, triangulation was achieved by asking interviewees about problems and challenges in designing and performing the demonstration, and different aspects of the path towards implementation of the new system. For example, in Demo B it was initially challenging to find actors who were willing to use the demonstration for transport of their goods. However, a demonstration of the unloading activities at an event held as part of the demonstration, attracted a group of about a hundred people (including port representatives, goods owners, municipal employees) and contributed to a significant growing interest among actors to start to make use of inland waterways for container transport. Hence, analysing the overall process is useful as a complement to operational data from the actual demonstration, identify both barriers towards, as well as drivers for, which are key components of the path towards implementation of a new system.

Learning curves must be acknowledged when analysing data

A feature of the demonstrations were the learning curves, which must be taken into account when analysing data such as that regarding the operational performance. For Demo A, the time spent unloading the waste containers the last time was half of the time spent the first time, highlighting a steep learning curve. Similarly, the barge operator stated that operations in Demo B would have gone much faster if it was run a second time. Hence, a snapshot analysis of the demonstration may not reveal the full performance potential of the demonstration.

4.3 The path from demonstration to a new system

To reiterate, action research takes place in action, whereas the demonstration is performed under deliberately, temporarily created settings, which justifies a need to investigate both the path from demonstration to implementation of the new system, as well as the design of the new system. The following aspects are of interest:

Addressing the difference between the demonstration and the new system

The limitations within the demonstrations need to be addressed in some way, to identify the potential of the new system in relation to the demonstration. As shown by the time studies done in Demo A, personnel cost as a function of time was a crucial parameter within transportation, in particular the time at each stop which consisted of up to twenty different activities (positioning, personnel movement, waiting, handling, etc.) To indicate the improvement potential, a benchmarking study was done, comparing the demonstration with urban waterway passenger transport system. Such systems have purpose-built ferries and quays, and it was shown that in comparison to the barge of Demo A, the passenger ferries only needed half the time for positioning against the quay. Hence, as a way of addressing limitations, delimitations and trade-offs, benchmarking can be suitable to identify the performance potential of a new adapted system.

Using the demonstration as an intermediate step between the current system and a future system to identify paths for research

A demonstration can be used to reveal potentially crucial design aspects that would need additional research for development of a future, new system. In both demonstrations, observations and interviewee responses raised the concern of hedging for unexpected events, which were manifested in the unforeseen closure of the passage under a bridge due to dredging, as well as a grounding of another ship within the fairways that made the passage more challenging (the barge could only pass during a certain time slot). The need for a potential backup system is therefore a relevant path to investigate in future research. This justifies demonstrations as research design in terms of an intermediate step between a current and future system, to detect unexpected events that could not have been foreseen by means of other research design, revealing issues in supply chain design that need to be addressed in research.

Complementary studies and theories are useful

The path towards as well as the design of new systems cannot be answered by the demonstrations as research design solely. However, we found it useful to use the demonstrations as tangible cases for complementary studies, investigated through various research designs and theoretical lenses. In Demo A, a study of a potential business model, in particular informed by the framework on business models (c.f. Osterwalder and Pigneur, 2010) and a separate study on modal shift as a socio-technical transition (c.f. Geels, 2012), revealed barriers and drivers between the current system and the new system. In Demo B, a socio-economic analysis compared today's transport solutions with a) the demonstration and b) a future solution with newer technology as an option in a new system, which pinpointed differences between the different solutions and the value for society of a new system. Hence, additional studies, underpinned by theories (not limited to the aforementioned ones), could serve as a complement to demonstrations as research design.

5. Concluding discussion

Albeit demonstration studies are common practice in development of logistics solutions, they are rarely reflected upon to be used as a distinct research design. As a consequence, the potential of performing a demonstration study in creating new knowledge of logistics systems needs further development. The purpose of this paper was to explain how demonstrations can be used as research design. This was done by borrowing methodological logic from action research, case studies and design science research, and underpinning this with learnings from two recently performed urban and inland waterways demonstrations. The outcome of the paper is a framework that describes a recipe for undertaking demonstration research, conceptualized into three main stages: (1) the design phase; (2) data collection and analysis; and (3) the path from demonstration towards scaling up the demonstration to a commercialized new system.

One strength of the demonstration as research design lies in its intermediate nature - it overlaps both with the current system as well as a future system. By doing so, it allows for data collection which is not feasible by means of other research designs. In particular, it includes: (1) *intervention* with the surrounding system that may reveal aspects that could not be deducted in a theoretical study (e.g. observing unexpected and unanticipated events, which may be central for designing a future system, provides direction research and development); (2) a demonstration is something tangible for involved actors to reflect upon, facilitating their *identification of important parameters* in the design of future systems; (3) a key feature of the demonstration is both the *operational data* on the actual demonstration, as well as taking a *reflective approach*, analysing the overall process of performing the demonstration, in which the challenges posed in design of the demonstrations may be major barriers towards future implementation of a new system; and (4) *time* studies on logistics performance.

The framework suggested in this paper was underpinned by two demonstrations of new waterway concepts, yet should also be relevant for other contexts, concepts and technology. The demonstrations were aimed at testing new logistics concepts in a real life context, in which it was revealed that technical innovations or adaptations such as new barges or quays may be needed. However, demonstrations could also have a technological focus as their starting point, for example testing newly developed electric trucks in an existing logistics system. Such technological focus may raise other difficulties such as problems of limited capacity due to the weight of the battery or logistics implications from stops at re-charging infrastructure placed along the route, disrupting the logistics distribution schedule. Hence, demonstrations could start from either a system innovation perspective or a technical perspective, which will set different aspects in focus, and the framework developed in this paper could serve as a starting point for both approaches.

Whereas case studies take the researcher's perspective by focusing on extant literature and the empirical focus (e.g. interview guide, a survey instrument) is designed through the lenses of concepts and frameworks, the demonstration designs are more practitioner-centric. They design the new system to be investigated from the parameters of a practical (i.e. performance of the logistics system) perspective rather than from the researcher positioning the system relative to current literature. Further, outcomes are intended to be directly useful for practitioners in the system. Mentzer (2008) promotes regular interaction between scholars and practitioners through forums such as “educators conference” or “practitioner conference”. Both of these are external to the research process, compared with demonstrations, where the scholar and the practitioner meet and interact *in* the process. By viewing demonstrations as a research design, this practitioner-centric feature can be combined with the researcher’s aim to create new knowledge; when successfully executed, both groups have learned, new constellations have arisen, and new insights have emerged.

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Sustainable Business Improvement within Supply Chain Organisations

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1. Introduction

This paper aims to highlight and discuss the preliminary findings of a Doctoral study (PhD), which has an overall aim to investigate and make recommendations (through the development of a model) for sustaining business improvement within a supply chain context.

The preliminary findings reflect the primary stages of a systematic literature review (SLR), which aims to investigate potential gaps in the literature between the strategic leadership of organisations and business improvement strategies and methods. The results of the primary findings will inform further direction of the SLR, which upon completion will inform the direction and scope of the Doctoral study, regarding key areas of focus for the generation of new knowledge through empirical research. Initial primary research informed by the SLR will be in the form of inductive pilot studies with sample organisations.

The research will build on previous work from various authors including doctoral studies and publications, notably the work of Christopher (2011), Marshall (2012) and Seddon (2008), in areas specific to sustaining business improvement interventions through strategic leadership, with a focus on Systems Thinking as a methodology for business improvement.

2. Current challenges

The need to continually review and attempt to improve the performance of business operations is a necessity to sustain short and long term success (Slack, 2008) regarding financial performance, customer retention and customer satisfaction. Arguably this is especially relevant in the context of goods and services provided to customers and consumers through the constantly evolving retail channels. This is demonstrated by the rising customer expectation with regard to procurement and delivery of goods and the subsequent emergence of Omni channel Logistics (customer viewed as one entity across all retail channels, i.e., on-line, shop, phone), highlighting how organisations working within supply chain sectors are having to improve their operations for business sustainability. For example, according to renowned sector analysts IMRG & Blackbay (2014), failure of first time delivery could have potentially cost e-retailers in the region of £771 million during 2014.

3. Initial literature Search

According to Christopher (2011) the concept of Supply Chain Management (SCM) was in its infancy less than 25 years ago, with proceeding years evoking a shift in thinking towards what creates competitive advantage and a now much higher level of strategic thinking towards the management of supply chains. Cabral (2012) links competitive advantage to the supply chain as a whole, but argues that few people have discussed the combined application of improvement methods such as Lean, Agile, Resilience and Green (LARG) as one model across the supply chain.

Christopher (2011) discusses many facets of SCM, including strategy, and offers sound discussion for building the foundations of a supply chain operation. However, the literature does not consider in any detail methodologies for sustainable business improvement and subsequent leadership strategies. Whilst Cabral (2012) does address the application of improvement methods, the

leadership of such interventions is not discussed. Christopher (2011) follows a similar approach to other authors, where the supply chain is broken down into sections and strategies formulated for each section, this approach arguably does not view the supply chain as a 'system' (Seddon, 2008) and therefore highlights the potential to explore and exploit a Systems Thinking methodology for business improvement within future supply chain literature and application to such organisations.

Seddon (2008) devised a systems thinking model for measuring and improving organisational performance, based in the context of what good performance looks like from the customer's perspective. The work builds on successful implementation of Quality Management methodologies developed by Deming and the Toyota Motor Company (amongst others) and argues that performance targets drive negative behavior, specifically in the service sector. Seddon (2008) argues strongly against the use of 'tools' for understanding and measuring processes, however, Seddon's method does advocate process mapping and statistical process control, which in other methods such as lean are classed as tools.

4. Review Methods

The full doctoral study will adopt a systematic literature review (SLR) as a method for research and review of relevant literature. Denyer and Tranfield (2009) – cited in Garza-Reyes (2015, p19) identify the following 5 consecutive steps for undertaking an SLR : *"(1) Question formulation , (2) Locating studies, (3) study selection and evaluations, (4) analysis and synthesis, and (5) reporting and using results"*.

The aim of the full PhD research is to investigate and make recommendations for sustaining business improvement within a supply chain context. In particular, to investigate potential gaps between the strategic leadership of organisations and business improvement strategies and methods. The following two questions are formulated as Stage 1 of the SLR :

What are the emerging themes regarding the strategic application, strategic sustainability and leadership of business improvement methods within a supply chain context?

What areas of focus should be considered for further research in the areas of leading and sustaining business improvement within supply chain related organisations?

Location of studies

This paper highlights the initial searches and outcomes of stage 2 of the SLR. Each subject area is mapped in a systematic way to identify initial search criteria and specific wording for search criteria, Fig 1 is a systematic mind map to identify the search criteria's, this will be expanded and further categorised as the main PhD study progresses.



Figure 1 – Systematic Mind Map of Subject Search Criteria

5. Initial findings

Systems Thinking in Supply Chains

Building on previous research of John Seddon's (The Vanguard Method) systems thinking methodology (Marshall, 2013 ; Seddon & Caulkin, 2007; Smith & Galimore, 2015) initial searches indicate that whilst Seddon's methodology has been applied and subsequently researched in areas such as social housing repairs, there is minimal evidence of research or application of Seddon's methodology to the 'supply chain' sector. Whilst Ayham & Backhouse (2016) discuss the involvement of the customer and the notion of 'clean demand' in forward and reverse logistics, the logistics operations are within the housing repairs sector. The paper recognises the value of the application of the Vanguard method in other Logistics settings.

The PhD research undertaken to date highlights that whilst the application and research of systems thinking methods within a supply chain context does exist, the volume is minimal and reflects different methods of systems thinking. For example, Moon & Kim (2005) apply an individual systems thinking ability to measure how a person views the dynamics of a supply chain with a view to viewing such dynamics in a holistic way. Whilst this method potentially evokes a holistic approach (Senge 1991), it is very scenario based and does not offer any strategic dimension for sustaining or leading such an approach.

Ghadge et al (2013) discuss the notion of a systems thinking approach in the context of supply chain risk management (SCRM) and suggest that using a *"systems thinking based approach is largely unexplored "* and that such an approach could *"provide a methodological and structured approach to risk management due to its ability to consider the systemic environments within the larger system"* (p523). Whilst the research does link to the informing of strategy and forms part of the continuous improvement cycle, the application is specific with regard to SCRM. The approach discussed by Ghadge et al reflects a hard systems approach (Jackson, 1993) and incorporates simulation modelling with analysis of quantitative data, whilst the research does discuss the organisation with regard to culture and human resources, discussion and recognition with regard to the strategic management of sustaining the methodology is minimal.

Systems Thinking – ideas and concepts

Marshall (2012) cites the work of Capra (1996) to help define systems thinking:

"The more we study the major problems of our time, the more we come to realise that they cannot be understood in isolation. They are systemic problems which mean they are interconnected and interdependent".

The work of Marshall offers a high level of evaluation of the different approaches to systems thinking and cites the work of Jackson (2007) as a method of contrasting such approaches (Fig 2).

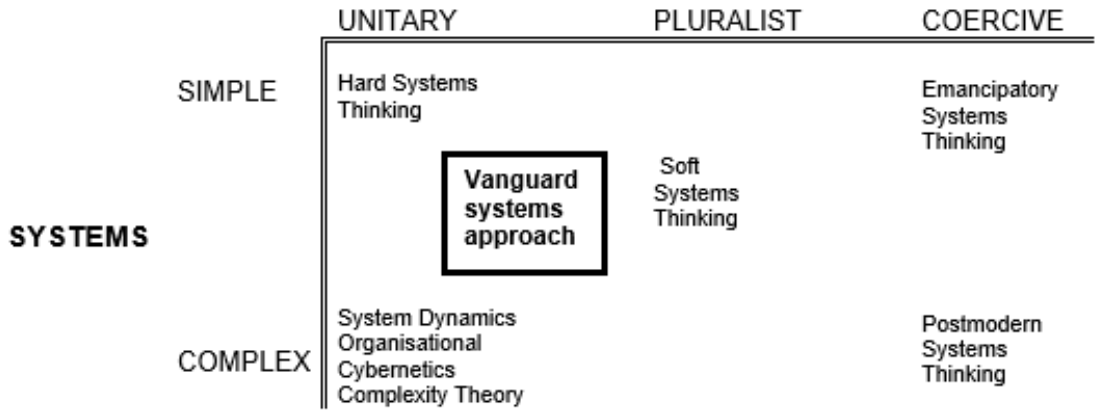


Figure 2 - Positioning of Systems Thinking approaches, Marshall (2012, p87) – adapted from Jackson (2007)

In particular Marshall highlights the positioning of the Vanguard Systems Thinking approach (Seddon's methodology) between a 'hard' systems approach a 'soft' systems thinking approach (Jackson, 1993). This reflects Seddon's Check-Plan-Do methodology which incorporates a mix of quantitative date capture and analysis (i.e. demand requests) and the consequent application to process design ('hard' systems approach), together with the consideration of people, their influence on the system and the development of a systems mindset or culture ('soft' systems approach).

Whilst Seddon (2008) offers a 'check' model for business improvement that enables true performance to be measured and analysed, there is a gap in the literature with regard to sustaining business improvement, especially in the context of supply chain operations. Marshall (2012) challenges the strategic management of Seddon's model and highlights a lack of sustainability for a

range of reasons, including conflicts of interest with local operations and business priorities, together with incompatibilities between different ways of management thinking.

Supply Chain Business Improvement

Broadening the search criteria to a more generic 'Supply chain business improvement' generated a wider range of available literature. Initial analysis indicates that whilst several research areas include strategy, business improvement or leadership within the title, the use of all 3 terms within a title is not evident. For example, Clifford et al (2010) use a metrics for measuring the impact of leadership type (i.e. transformational) against supply chain performance. Whilst there are no clear links made between leadership and sustainable business strategy for business improvement, Clifford et al cite the work of Lambert et al (1998) in recognising that to avoid 'chaos', one organisation needs to assume a leadership role with the supply chain for strategic decision making.

Clifford et al also highlight the need for holistic thinking with regard to reward based performance management, suggesting that performance should be measured and rewarded across the whole supply chain rather than on an individual organisation results. This approach can be likened to systems thinking methodologies with regard to holistic shared goals and vision, however, Seddon (2008) advocates the total removal of reward based performance targets to avoid such individual performance based reward and the negative effect they can have on having a systems thinking mindset.

Skipworth et al (2016) links supply chain alignment with business performance and the strategic fit of supply chain `partners', highlighting that a lack of alignment can create *'functional Silos'* (Skipworth ,2016; Seddon 2008). Such alignment incorporates an element of systems thinking regarding how one element of the supply chain can impact another, Skipworth cites the research of Baier et al (2008) who identify through research of 141 organisations that business strategy and purchasing strategy is *"key to achieving superior financial performance"* (p513). However, it could be argued that improved financial performance is not a definitive measure of sustainable business improvement.

Strategy - Seminal texts

Initial research of seminal texts with regard to organisational strategy highlighted some common themes with regard to structure and approach to discussing the subjects, however, the term `business improvement' (BI) is not evident in the areas of the texts reviewed. The more common term of 'strategic change' is often used to link approaches to managing change and identifying the type of change, i.e. evolution or revolution (Balogun & Hope Hailey, 2004). Whilst leadership approaches are discussed for delivering strategy, there is less discussion regarding leading of strategy formulation for business improvement methods.

This prompts the question of where does BI fit on the strategy ladder? For example, should it be confined to business level strategic decision making, or should there be a culture or flow driven from a corporate level? Whilst Dewit and Mayer (2004) discuss the high level strategic leadership of change, it is discussed in generic terms with no reference to specific improvement methodologies. Dewit and Mayer do however make reference to a *'business system'* which is defined as a *"specific configuration of resources, value adding activities and the product /service offerings directed at creating value for customers"* (p165). Whilst identifying an *'Organizational system'* as *"how individuals populating the firm have been configured, and relate to one another ……"* (p165)

Mintzberg et al (1998, p5) state that *"strategy is the pattern or plan that integrates an organisations major goals, policies, and action sequences into a cohesive whole"* and highlight that managers that

lead at '*unit*' level with regard to the creation and maintenance of culture. This suggests that managers would be responsible for creating and maintaining a culture for business improvement, or indeed other changes in culture required to progress change interventions, which could arguably inhibit the germination of ideas and opportunities that could be developed from the 'bottom up' within an organisation. This contrasts with Balogun & Hope Hailey (2004) who refer to Johnson et al (2008) ideas lens, which suggests that organisations contain many different people with many different ideas, where "*changes bubble up from within an organisation rather than being conceived by senior managers*" (p224).

6. Conclusion

With regard to research question 1 - *What are the emerging themes regarding the strategic application, strategic sustainability and leadership of business improvement methods within a supply chain context?*

The primary stages of the systematic literature review indicate that there are gaps in the literature with regard to sustaining business improvement methods within a supply chain context, particularly with regard to the application and sustainability of John Seddon's systems thinking methodology. The general sustainability of Seddon's method is challenged by Marshall (2012) after analysis of substantial empirical research, indicating that sustaining the methodology and mind-set post intervention is not always successful. Future adaptation of Seddon's methodology into a broader model would necessitate a change in thinking with regard to sustained strategic planning and leadership of business improvement interventions.

Whilst there is more volume of literature with regard to generic business improvement approaches (e.g. Lean), initial analysis indicates that the research tends to measure specifics, for example, Leadership (Clifford et al, 2010), Supply Chain alignment (Skipworth et al, 2015); highlighting gaps in the literature with regard to sustained application of business improvement methods and strategies. Whilst initial findings indicate gaps in the literature with regard to linkages and interdependencies of strategy, leadership and business improvement in a supply chain context, initial broader searches of literature indicate that gaps potentially exist in the wider business context.

The next steps of the research reflect research question 2 - *What areas of focus should be considered for further research in the areas of leading and sustaining business improvement within supply chain related organisations?*

The next steps of this study will further investigate the subject areas identified in Fig 1 for the purpose of giving thorough review and analysis of additional literature to inform the next stage of the research (a pilot study leading to the main study). More breadth and depth to researching the linkages and interdependencies of strategy, leadership and business improvement in a supply chain context will contribute to the formulation of primary research questions, methods and selection of appropriate organisations for empirical research.

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Strategic process alignment

Engaging in the process of dynamic business - supply chain strategic alignment

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Introduction:

The topic of **engaging in the process of dynamic business-supply chain strategic alignment** sits within the academic domain of supply chain management, a sub-discipline of operations management (Holweg and Helo, 2014:230), defined as 'any combination of processes, functions, activities, relationships and pathways along which products, services, information and financial transactions flow in and between enterprises, in both directions, end-to-end' (Gattorna, 2015:9). The complexity of this discipline has been compounded by globalisation along the dimensions of replenishment, time and distance (Christopher and Towill, 2002:1), and vulnerabilities to disruptions have increased as supply chains 'become more lengthy and complex due to globalisation and vertical integrations' (Rajesh and Rao, 2015:238). Recent events have promoted supply chain management to critical importance. 'During 2008 the world changed in a precipitous way as the global financial crisis hit and the ensuing global recession affected people around the world' (Gattorna, 2010:1). This has led to a volatile operating environment, 'fraught with greater demand uncertainty, higher risk, and increasing competitive intensity' (Roh, et. al., 2014:198). 'Increasingly, organisations are finding themselves at the center of un-plannable events (crises, disasters, breakdowns) that interrupt and threaten their global supply chains' (Gattorna, 2015:340). Breakdowns are at the operational level of disruption. Such disruptions can include uncertain customer demand, quality issues, transportation delays, poor supplier performance, equipment malfunctions, inventory and capacity issues, IS breakdowns, and increasing competitive intensity (Kleindorfer and Saad, 2005:53; Sylla, 2014:19; Roh, et. al, 2014:198). These result in severe stock and operating under-performance and should be a high priority for the TMT and shareholders (Kleindorfer and Saad, 2005:54), 'with costs and other consequences even more challenging than terrorist acts, as they have a greater cumulative effect over time' (Sylla, 2014:20) and have a disproportionate effect on demand (Sheffi, 2001:3).

A more emergent importance of this research lies in the fact that the threat of disruption from forces such as globalisation, climate change and technology, is accelerating beyond our ability to adapt (Friedman, 2016) at a rate that suggests 'any company designed for success in the 20TH century is doomed to failure in the 21ST' (Rose, 2014). The manner in which an organisation manages and strategically responds to supply chain disruptions has a direct impact on 'reputation, consistency in earning and ability to increase shareholder returns' (Rajesh and Rao, 2015:238). It has long been argued that 'strategic priorities at the functional level should be aligned with business level strategies' (Rebolledo and Jobin, 2013:219) and therefore the strategic response to disruptions should not be uni-dimensional and dichotomous, thereby broadening SCM to a wider perspective (Wu, et. al., 2014:220). Strategic alignment is contextual, situational, evolutionary and dynamic, in that existing internal and external firm-specific competences need to be explored and exploited at several organisational levels to address changing environments (Burn, 1993:206-8; Henderson and Venkatraman, 1993:473; Teece et al, 1997:512:516; Luftman, 2000:2:20:39; Balhareth et al, 2012:2). However complex this may be, 'by searching for patterns in the behaviour of organisations, one can describe and even predict the process of organisational adaptation' (Miles and Snow, 1978:547). The context of this paper is operational disruption in Irish organisations and how the supply chain strategic response is aligned to business goals. The research is part of the early stages of a doctoral thesis. In order to explore strategic alignment issues

identified in organisations, the IDF has been chosen as an in-depth case study to demonstrate this organisational challenge.

Literature review:

The traditional role of supply chain management is that of strategic execution, and the prevailing age of accelerating forces such as globalisation, climate change and technology demand a more responsive and agile approach through bridging the gap of pain (Heaslip and Barber, 2014) between corporate (business) and supply chain strategic goals. This paper aims to both increase our understanding of supply chain managers' engagement in the process of dynamic business - supply chain strategic alignment, within the context of supply chain disruption, and contribute to the broadening of supply chain management to an integrated perspective across the top management team rather than a uni-dimensional and dichotomous view. In exploring the research question of 'how supply chain managers engage in the process of dynamic business-supply chain strategic alignment', the literature review demonstrates that:

- Strategy is a continuous process of power mobilisation within the senior leadership team in relation to dilemmas facing the organisation (Pettigrew, 1977:80)
- The strategic renewal process can take the form of several journey types such as the *directed* perspective of this paper, and the response to disruption has a phased approach
- Although directed, there is a degree of *shaping* or *re-framing* of strategies to resolve challenges and to align with situational needs, without moving outside the boundaries of the organisations' core competencies (Floyd and Lane, 2000:154)
- A reconciliation between strategic formulation and implementation is still needed (Pelletier and Raymond, 2014:1:2)

The nature of strategic renewal within the top management team:

A top management team (TMT) member is a 'senior executive responsible for one or more functions in their organisation' (Menz, 2012:45) and a key participant in the strategic renewal process (Floyd and Lane, 2000:160; Menz, 2012:59). Strategic renewal includes the 'perennially unfinished' and 'ongoing journey of activities a firm undertakes to alter its path dependence' (Iszatt-White, 2010:409; Volberda, et. al., 2001:160) or alternatively the 'process, content, and outcome of refreshment or replacement of attributes of an organisation that have the potential to substantially affect its long-term prospects' (Agarwal and Helfat, 2009:281). The TMT composition can include a Chief Executive Officer, Chief Financial Officer, Chief Operating Officer, Chief Marketing Officer, Chief Strategy Manager and a Chief Information Officer. Supply chain managers are positioned to gather new information from both internal and external sources, and the manner in which this information is communicated to the TMT is subject to middle management interpretation, often manipulated due to personal agendas. In fact, strategy formulation has been described as a process of political decision-making whereby strategic demands are 'politically feasible only if sufficient power can be mobilised and committed to it' (Pettigrew, 1977:80). How the TMT responds to the tensions of competing demands through their actions, rhetoric and decisions can create organisational context and they must also simultaneously balance strategic exploitation and exploration, profit maximisation and social welfare, integrating globally and adapting globally (Smith, 2014:58). Strategy has been described as a process that is both continuous (Pyburn, 1983:3) and dynamic, operating in an open system (Mintzberg, et. al., 1976:263) and this view has remained a constant to the present day. Miles and Snow (1978:547) defined an organisation as 'both an articulated purpose and an established mechanism for achieving it', a reflection of the central importance of strategy. The strategic renewal process was said to be dynamic and complex, maintaining a balance between environmental and internal interdependencies. This could be penetrated by

searching for patterns that could predict the future, although limited by a strategic-choice perspective in that the choices that the TMT made were the critical determinants of organisational structure and process in what was called the adaptive cycle (Miles and Snow, 1978:547). Strategic exploration, an *adaptive* perspective, is necessary when forces such as globalisation, new technologies and new competition threaten the organisation, whilst exploitation, a *selective* perspective, brings stability to short-term competitive challenges (Volberda, et. al., 2001:160). Strategy not only consists of formulation and implementation that requires TMT functional alignment, but also the simultaneous sub-processes of competence definition, modification and deployment, each having a different perspective for the TMT, middle management and operations management (Floyd and Lane, 2000:156). Within the definition sub-process, TMT members perform the role of ratification, articulating *strategic intent*, monitoring progress and endorsing and supporting decisions. During the modification stage, they recognise strategic potential, set strategic direction and empower and enable decisions. Finally, the TMT performs a director's role during the deployment sub-process, planning, deploying resources and commanding middle management. Conversely, through the sub-process stages, middle management champion, synthesise, facilitate and implement strategy, while operations management experiment, adjust and conform. This complexity is heightened considering a recent trend of increased involvement by boards of directors in the strategic decision-making process, due to the liberalisation of financial markets and the resulting need for transparency and accountability, and this poses an additional challenge to the TMT (Pugliese, 2009:292). Volberda, et. al. (2001:161:170) identified four journeys within the strategic renewal process, emergent, directed, facilitated and transformational, and went beyond the parameters of exploitation and exploration to include co-evolution across multiple business units that aligns competencies with the environment. The directed journey is a focus of this paper. This assumes full TMT control over purposeful and adaptive strategic formulation and implementation with little to no autonomy enjoyed by middle management. This requires in-depth TMT industry knowledge but can be restrictive in a dynamic and disruptive business environment because exhaustive analysis is needed before action is taken.

The nature of strategic alignment:

Borrowing from business-information systems strategic alignment literature, due to an apparent absence of a corresponding perspective in the supply chain management academic domain, the author notes that functional alignment of strategy and enterprise systems operates within the dynamic and complex internal and external confines of this physical, social and political process and a key participant is the Chief Information Officer (CIO), a TMT position that has increased in number since the late nineteen eighties, reflecting an increasing importance of IT as a functional area (Menz, 2012:47). The CIO holds the greatest organisational power to influence the exploitation of IT (Li and Tan, 2013:248) but there are a number of factors that determine how successfully he can enact this influence. A close relationship between the CIO and CEO is crucial (Li and Ye, 1999:43; Peppard 2011:33) and this extends to solidarity between the CIO and all functional TMT members (Walentowitz, et. al., 2010:2). The CIO is first and foremost a business leader and must participate as a real general management peer (Pyburn, 1983:12), displaying such characteristics as a diplomat, visionary, leader, strategic thinker, relationship builder, and reader of markets (Peppard, 2011:36) in addition to the tactics used for influencing TMT members (Enns and McDonagh, 2012:3). Organisations are a reflection of its senior managers (Menz, 2012:49) and this echoes upper echelons theory that states that 'organisational outcomes, strategic choices and performance levels are partially predicted by managerial background characteristics' (Hambrick and Mason, 1984:193). One of the CIOs multiple and ambiguous roles is that of an IT evangelist, 'selling' the value of IT within the organisation (Peppard, 2011:35) but it has been found that strategic alignment is also influenced by shared understanding between IT and the business, and indeed

the IS 'savviness' of all functional TMT members (Peppard, 2010:81; Jentsch and Beimborn, 2014:1). The capabilities of the IT leadership team reporting to the CIO is also an important element. Without their expertise and high performance, the CIO lacks credibility (Peppard, 2011:40). Strategic alignment, 'applying IS in an appropriate and timely way, in harmony with business strategies, goals and needs' (Luftman, 2000:3) has been the primary concern of TMT members for the past number of decades and many scholars have given due focus to finding a resolution. The fact that strategy is a 'perennially unfinished project' (Iszatt-White, 2010:409), makes this quite the challenge. There has been a recognition that IS strategic planning can be used to influence business strategies (King and Zmud, 1981:304). It was concluded that IS strategy should emanate directly from business strategy (Henderson and West, 1979:46; Pyburn, 1983:3), and co-ordination of these plans were thought necessary to meet organisational goals (Lederer and Mendelow, 1989:5). However, there was no guidance in the literature on how this was to be achieved (Pyburn, 1983:3), and the value of IS strategic planning was not empirically validated until Henderson and Sifonis (1988:187) found that the strategic process must provide internal consistency between business and IS, a link confirmed by further empirical studies during that period (Tavakolian, 1989:314; Zviran, 1990:67). At the start of the nineties, it was recognised that IS strategies need to be developed in the same process, simultaneously with business strategies (Goldsmith, 1991:67).

According to the strategic alignment model, the concept is based on two fundamental assumptions, economic performance which directly relates to the strategic fit of external positioning and internal arrangements, and that strategic fit is inherently dynamic, and reaching dynamic capability depends on the organisations ability to 'exploit IS functionality on a continuous basis'. Strategic alignment is therefore 'not an event, but a dynamic process of continuous adaptation and change' and consists of four dominant alignment perspectives (Henderson and Venkatraman, 1993:472-477). The first two arise when business strategy is the driver, *strategy execution* whereby the TMT has responsibility for strategy formulation and the CIO has an implementation role, and *technology transformation* where the CIO has the role of architect to the TMTs' technology vision. The last two perspectives have IS strategy as the enabler in which the TMT is the business visionary to the CIOs' catalyst role of developing emerging IS capabilities, and finally, service level which is concerned with building a world-class IS service organisation with the CIO enacting an executive leadership role as the TMT prioritises the allocation of resources. Success depends on the development of a mechanism of knowledge integration across the TMT (Wagner and Weitzel, 2006:570; Balhareth, et. al., 2012:4. Reynolds and Yetton (2013:2:4) said that there is little guidance on how to build and sustain alignment and called for a 'deeper understanding of dynamics, taking into account the cross-sectional linkages within an organisation and the temporal nature of strategic decision making', whilst Pelletier and Raymond (2014:1:2) suggest that a reconciliation between strategic formulation and implementation is still needed.

One significant challenge in Business-IS strategic alignment is that an information system is 'not an external object, but a product of ongoing human action, design, and appropriation, which, *over time*, becomes imbricated, embedded, entangled and intertwined', (Wilson, et. al., 2013:3) subject to social negotiation and sensemaking, 'materialising through anchoring and objectification' (Dulipovici and Robey, 2013:107). There is a process of user improvisation and adjustment, due to perception and understanding of technology features that demonstrates that strategic plans are 'resources for situated action that do not in any strong sense determine their course' (Iszatt-White, 2010:409; Dulipovici and Robey, 2013:104). A first stage of adjustment is decoupling, whereby organisational members form personal views and interpretations of IS strategies based on their own local context. According to their situational needs, users then reframe the technology, and when the adjusted practices become repackaged and stable, these are then recognised as strategic in relation to the formal strategy (Wilson,

et. al., 2013:2). The nature of IS within the process of strategic alignment is therefore unpredictable. However, the dominant assumption within strategic alignment literature is that the IS 'artefact' is a stable and unproblematic entity, but in practice is an 'organism', 'an idea that drastically changes the traditional notion of IS alignment' (Benbya and McKelvey, 2006:286).

Strategic response to supply chain disruption:

Phases such as planning, preparedness, mitigation, detection, response and recovery (Kovács and Spens, 2007:101) necessitate different supply chain management practices (Heaslip and Barber, 2014:61) as organisations urgently mobilise to reduce the 'gap of pain'. These events are largely un-plannable but a preparation phase incorporates five supply chain elements of: implementing a disaster management framework, establishing logistic operations and process management, human resource management, knowledge management and preparing financial resources (Heaslip and Barber, 2014:63). The immediate response phase is determined by the nature of the event but should involve structured command and control systems coupled with appropriate asset capabilities. The reconstruction phase aims to bring the disaster under control and return all systems to a normal or better state (Heaslip and Barber, 2014:68). Gattorna (2015:350), guided by the doctoral research of Kate Hughes, describes a prequel phase of '*hedge and deploy*' by prepositioning supplies at strategic global locations before any catastrophic event', the adoption of a fully flexible supply chain during survival phase, an agile supply chain operating in an emergency response phase 'in the face of extreme disruption' and re-establishing organisations during the rebuilding and restoration phase. It can therefore be concluded that the response to disruption is a phased and dynamic process. However, being responsive to supply chain disruptions requires strategies that are closely aligned to corporate strategy (Roh, et. al, 2014:200). Multi-dimensional integrations, including socio-technical collaboration with strategic suppliers and customers, and techno-process integration such as advanced manufacturing technologies, all 'toward time-based outcomes' represent the most important characteristics of a responsive supply chain strategy (Roh, et. al, 2014:207).

Research Problem and Research Approach:

The traditional role of supply chain management is that of strategic execution, and the prevailing age of accelerating forces such as globalisation, climate change and technology *demand a more responsive and agile approach* through reducing the gap of pain (Heaslip and Barber, 2014) between corporate (business) and supply chain strategic goals. This paper aims to both increase our understanding of supply chain managers' engagement in the process of dynamic business - supply chain strategic alignment, within the context of supply chain disruption and contribute to the broadening of supply chain management to an integrated perspective across the top management team rather than a uni-dimensional and dichotomous view through exploring the research question of *how supply chain managers engage in the process of dynamic business-supply chain strategic alignment*. These aims are expanded to include specific objectives:

- Determine how supply chain managers operationally identify, predict, cope and recover from supply chain disruptions
- Identify which phases in the supply chain disruption process require engagement with the TMT to implement strategic solutions aligned to business goals
- Consequently, determine whether a categorisation of supply chain strategy exists, such as a tier consisting of strategies that can be implemented autonomously by the supply chain division, and a tier(s) that requires 'negotiation' across the TMT prior to implementation

- Determine how supply chain managers engage with the TMT in the process of aligning business and supply chain strategies, thereby identifying key enablers and inhibitors
- Develop a process model that establishes the phases of supply chain manager engagement in dynamic business - supply chain strategic alignment
- Test, refine and validate developing theories in a real case 'laboratory' setting, thereby demonstrating the value creation potential of dynamic business-supply chain strategic alignment

The initial approach to the research problem has been an exploration of strategic alignment issues that organisations face. The author is in the early stages of a doctoral programme and as the main body of research progresses, the data will inform the author to develop a survey instrument to be sent to a larger sample of Irish organisations to determine how supply chain managers strategically align to business goals in response to disruption. This will later be supported by grounded theory methodology. Thus, an in-depth pilot case study was carried out of the IDF and the logistics challenges faced as part of their participation in the Nordic Battle Group, a global strategic response to the threat of disruption. The choice of a military study was one of opportunistic access and the literature has shown how the domains of humanitarian, military and corporate are interconnected in this age of globalisation. Yossi Sheffi of MIT, a leading expert in supply chain risk analysis, also borrowed from the military to observe that, how a government responds to crises is the main cause of disruption rather than the actual attack or event, such as closing borders, shutting down air traffic, or evacuating areas (Sheffi, 2001:3). In the aftermath of the 9-11 tragedy, trucks loaded with components bound for U.S. manufacturing plants such as Ford, were delayed at the Mexican and Canadian borders, while steering sensors for Toyota were held at Frankfurt airport. Sheffi also identified that the military response to disruption aligns to the corporate domain, particularly in terms of the preparation phase and the strategic use of redundancy. Interestingly, crises are closely linked to the accelerated forces in much the same way that the elements of computing power move forward as a group. Consider Syria, the 'geopolitical superstorm of the age of accelerations' and how a catastrophic drought known as jafaf gave rise to the Islamic State of Iraq and the Levant, whose cause grew exponentially through a global reach that was powered by technology (Friedman, 2016:22:258:262).

A memorandum of understanding signed by the IDF Deputy Chief of Staff mandated the HQ Director of Logistics to have the capability to set up a theatre of operation anywhere in the world within a seventy-two hour notice period from its base in Collins Barracks, Cork. To develop this capability, an expeditionary logistics concept was initiated to integrate with the Swedish armed forces and set up within a green field site in Skillingaryd on a four-month deployment. This pilot study was an examination of how the Logistics Branch operationalised a strategic intent, both a governmental and TMT directive, to overcome significant challenges leading up to and during deployment and is contextualised through historical reference in Appendix One. Several in-depth semi-structured interviews were held with key personnel at Collins Barracks, including detailed analysis of confidential strategy documents and explicit discussions on the steps taken to overcome challenges across each stage of the mission. This satisfied the purpose of the study which was to validate the phased response to SC disruption as found in the academic domain of SCM and to demonstrate that addressing the research problem through the lens of business-IS alignment literature appropriately sets the scene for a new strand of business-SC alignment research. Both of these elements will inform the next phase of research with the expected contribution being a process model that enables increased responsiveness to supply chain disruption in TMT-directed strategic environments.

Case Study: Nordic Battle Group: *ad omnia paratus - prepared for anything*

The IDF operational rotation of the NBG spanned eighteen months, with training taking place between Jan-Dec 2014 (planning and preparation), before a six-month seventy two-hour on-call period from Jan-Jun 2015 (response and recovery), proceeded by the German BG who stood to for the next six months, emanated by the British BG in 2016, and so forth. *This was consistent with the phases identified within the literature such as planning, preparedness, mitigation, detection, hedge and deploy, response, survival, rebuilding and restoration and recovery (Kovács and Spens, 2007:101; Gattorna 2015:350).* The IDF logistics concept for the NBG derived from the Commanding Officer who issued a *'commanders intent of operation'* that outlined the purpose, method and end state of the mission. Finalising the method was subject to constant, and at times innovative, group training and integration, known also as training, tactical and procedures. This provided autonomy to the Logistics Branch to adjust the strategy to situational needs. *The literature identifies that within the definition sub-process of strategic formulation, TMT members perform the role of ratification, articulating strategic intent (Floyd and Lane, 2000:156).* The degree of required adjustment posed challenges within a broad categorisation of *constraints, restrictions and freedoms* and *necessitated different supply chain management practices as the IDF urgently mobilised to reduce the 'gap of pain'(Heaslip and Barber, 2014:61):* The IDF MOU adopted an all-arms approach that facilitated cross-organisational support to the NBG, such as knowledge and equipment sharing. A CS-41 document (Appendix Two) outlined the available resources to meet the mission objectives, together with the empowerment, through TMT support, to internally re-distribute equipment as needed. *Supply, sustain and maintain* were the tenets applied to developing a self-sufficient unit of excellence using a front load policy that meant positioning all personnel and equipment in Sweden at the start of the operation. Militaries such as Sweden used a push policy, whereby strategic air support was used to sustain units as needed. Future deployment would necessitate integration with the Swedish push policy as there are limitations to front loading. The aim was to conduct operations, regardless of environment from 30 to 120 days, characterised by a high level of *flexibility, modularity and endurance*.

The CS-41 provisioned the use of Host Nation and 3PL Support to Operations. Despite the availability of an after action review from NBG 2011, challenges arose during the mission readiness exercise which commenced in June 2014, giving clearance to build all systems. *This validated the literature in that strategic alignment is 'not an external object, but a product of ongoing human action, design, and appropriation, which, over time, becomes imbricated, embedded, entangled and intertwined', (Wilson, et. al., 2013:3).* For example, in advance of the exercise in August 2014, the IDF attended a coordination conference in Sweden and discovered that an MOU signed between the two governments did not legislate for electricity maintenance. The IDF cannot have more than 850 troops overseas at any one time, and additional electricians etc. were not provisioned. One solution was to secure site generators for the exercise but the challenge was that these were all deployed on other missions, and had to be transported in pairs, each one in a 20FT Container, necessitating an unplanned additional sealift with an engineering detachment. Instead, an improvisation was made to transport smaller generators and lighting systems within the allocated 19 containers on the manifest. Another problem concerned HP 508 tents which were not fit for purpose and this resulted in damage. Note: visualise substantial marquees housing a large contingent of troops, kitchen, dining hall, sleeping quarters, etc., hence their criticality. Whilst the tents were erected through power from vehicles, there were three topside struts that needed to be secured manually and the troops could not reach these without potential injury. A-frame ladders were added to the manifest and these were placed to the rear of the tent racking systems during transportation to Sweden. These systems did not initially offer optimisation of container space, for which an outsourced vendor solution was sought. The successful vendor invested time and resources into designing a bespoke racking system with significantly improved utilisation. The additional engineering cost of this was offset by tangible benefits that are outlined in Appendix Three. Other

adjustments to the manifest were the inclusion of tent repair kits and clip flooring to prevent damage. The tents were not soldier-proof and needed specialist assembly. Generators for the mission were also found to be temperamental but this was resolved through specialist training. The IDF were burning 60 litres of day per day per heating system, twice as much as the Swedes, who used built-in thermostats and lagging systems, which not only reduced fuel usage, but also evenly distributed heat throughout the tents. The CS-41 also did not provide for cooks and it was recognised that the field kitchen should be part of certification training in Ireland. Both the provision of a pot wash facility and the leasing of local sanitation equipment were also identified. In addition, technicians needed to be co-located with the field kitchen in order to maintain the VAMs. The Tactical Operations Center enabled situational awareness, range of operation and capabilities when delivering orders, and an increase in data transfer rate. However, the satellite communications link was intermittent, additional equipment was needed, such as laptops and phones, and training in all CIS systems was essential. Movement of vehicles was a challenge. Bulk collection was arranged for all armoured vehicles, which resulted in significant time and labour savings. By contrast, the collection of infantry light tactical vehicles was not as co-ordinated due to other mission needs and this caused minor delays, and the training of drivers and fitters to enable qualifications in fuel pod operation, and vehicle maintenance was needed. In the absence of military aircraft, a 3PL Ocean Freight solution loaded equipment at Ringaskiddy Port bound for Halmstad Port in Sweden. The loading concept of choice was RO-RO (8-hour operation) but LO-LO (20-hour operation) was the procured system due to 3PL availability and sailing schedules. This would have required two drivers moving four containers at a time from Halmstad to the brigade assembly point 141km away in Skillingaryd. However, the IDF negotiated with the Swedish Forces and secured their assistance to move thirteen of the Irish containers. Another challenge was that these movements necessitated weapons declarations and thereby the availability of specialist weapons inspectors at specific points along the route to Sweden, all adding to the transit time. Finally, parking and storage space was needed for 20 containers and the Mowag and LTAV fleet.

Conclusions:

The Logistics Branch of the IDF successfully re-framed and aligned *business* strategy to operational readiness as part of Ireland's rotation of the Nordic Battle Group. It was demonstrated how a senior management directive (strategy) underwent an extensive period of preparation, shaping and re-framing to align with situational needs, while simultaneously maximising stakeholder value and ensuring actions taken were to the benefit of future rotations and missions. However this preparation phase took many months to complete (gap of pain) due to the fact that strategy was directed by a TMT that did not engage with the Logistics Branch during strategic formulation. In this age of global accelerations, strategic response to supply chain disruptions must align business and supply chain goals in order to significantly reduce this gap of pain. Returning to the specific objectives of this research:

- Determine how SC managers operationally identify, predict, cope and recover from SC disruptions: *The disruptive event remained hypothetical but there were measured periods of preparation and deployment (response) followed by a recovery phase involving an after action review. This was consistent with the literature and the duration of preparation (gap of pain) can be a useful metric to demonstrate an organisations agility and responsiveness to disruption*
- Identify which phases in the SC disruption process require engagement with the TMT to implement strategic solutions aligned to business goals: *This study demonstrated a TMT-directed approach and the minimal alignment resulted in an elongated gap of pain*
- Consequently, determine whether a categorisation of SC strategy exists, such as a tier consisting of strategies that can be implemented autonomously by the supply chain division, and a tier(s)

that requires 'negotiation' across the TMT prior to implementation: *Although directed, the Logistics Branch had the autonomy to reshape the TMT strategy within the boundaries of the IDF core competencies*

- Determine how SC managers engage with the TMT in the process of aligning business and SC strategies, thereby identifying key enablers and inhibitors: *The after action review was a tool to influence future strategy, the result of which is as yet unknown*

The remaining objectives of developing a process model and testing emerging theories will be addressed as this research progresses. The two contributions of this paper are the use of literature from another academic domain to assist with the research problem and the identification that the greater the degree of TMT-directed strategic enforcement, the greater the gap of pain in response to supply chain disruption.

Appendix One:

Nordic Battle Group: Historical Context

The Nordic location of Finlandia Hall in Helsinki during the summer of 1975 appropriately sets the scene for Ireland's contribution to the pursuit of global security. Attended by then Taoiseach, Liam Cosgrave, the Conference on Security and Co-operation in Europe resulted in the signing of the non-binding Helsinki Accords aimed at reducing tensions between the Communist bloc and the West. European Union members subsequently signed the Helsinki Headline Goal 1999 in accordance with the Common Security and Defence Policy, which created a Helsinki Force Catalogue to enable the completion of so-called Petersburg Tasks (Petersburg Declaration 1992). These included humanitarian and rescue, peacekeeping and crisis management tasks. Primarily, it was considered that it took too long to raise a United Nations reactionary force to deal with global disruptions and crises, and from this, an EU Battlegroup was established, now comprising 18 sub-groups of small, independent, self-sufficient, rapid-response units capable of deployment in a theatre of operation.

One such unit is the Nordic Battle Group headquartered in Enköping, Sweden, which has been active since 2008 and has a force of 2500 troops. NBG members include Sweden, Finland, Norway (despite non-EU membership), Republic of Ireland, Estonia, Latvia and Lithuania. This is not a permanent unit, rather it is mobilised on a rotational basis. A modular organisation with a mechanised infantry battalion is at the core of the unit, but since 2011, a framework exists for the integration of additional resources ranging from artillery, air defence, and intelligence, to additional logistical support. Republic of Ireland, with the second largest troop count behind Sweden, is the eyes and ears of the Battlegroup, providing an ISTAR component: intelligence, surveillance, target acquisition and reconnaissance. However, another vital Irish element has been the afore-mentioned logistical support, the execution of which has met with and overcome many challenges, both strategic and tactical.



Appendix Two:

Nordic Battle Group: CS-41 Provisions

- 51 personnel that included 4 officers, medical and signals (communication) detachments, 3 engineers, 3 ordnance to maintain equipment such as weapons (valued at €1.6m) and catering systems, transportation which included 2 DAF 6x6 trucks, each with 2 drivers

- 19 Containers (660 CBM and 164,400 Kgs, with a combined value of €3.8m), carried tents on 2 units, 3000 pack rations within a 20' Reefer, capable of sustaining the brigade for 20 days in a remote environment as a form of redundancy, dry goods which complimented the Irish policy of purchasing fresh produce from the local community, fuel pod, ammunition, pyrotechnics, which needed to be in a separate container and thereby not completely utilised, weapons systems, together with dangerous goods certificates, and generators

- Due to the front load policy and for security reasons, the Irish moved ammunition, baggage, a fuel pod, generators, weapons and communications to the brigade assembly point in Skillingaryd, Sweden, in advance of the exercise. This included a C2 Container housing the Tactical Operations Center (TOC) which became the epicenter of the site from which all other elements developed



Appendix Three:

Nordic Battle Group: Concomitant benefits from additional engineering spend

- Additional space to take an armoured vehicle, thereby increasing troop safety
- One less soft-skin truck meaning one less driver, enabling one additional specialist to support the maintenance of the site resulting in less protection needed from a security perspective
- One less container on a ship or aircraft, meaning less weight, resulting in greater fuel efficiency, and by default, incremental cost savings on subsequent DF missions
- Maximum return for the tax payer by co-coordinating procurement, engineering and operations



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Managing cost-to-serve in omnichannel retail logistics

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Abstract

Purpose: This paper aims to identify how clothing, footwear and accessories retailers and brands can manage or reduce the total cost-to-serve in their omnichannel supply chains through recognizing the key cost areas and levers at each stage of the value chain, and recognising the effects of data capturing and product identification standards on their supply chain costs.

Research Approach: Multiple case studies of six apparel companies are conducted, by using multiple sources of data including interviews, documents and focus groups. The interviews were conducted with the logistics and supply chain managers in clothing, footwear and accessories retailers and brand owners. The cases were synthesised through within-case and cross-case analysis.

Findings and Originality: A detailed cost-to-serve framework has been developed, which addresses the main cost drivers of omnichannel retail logistics. The framework underlines the effects of network complexity and market volatility on omnichannel logistics performance. It also formalises the role of information flow visibility in managing the omnichannels.

Research Impact: The paper contributes to the research in the areas of omnichannel logistics, cost management, and information management.

Practical Impact: The developed framework of this paper, which has been validated by empirical data and expert reviews, provides an applicable decision support platform for managers. The framework also employs empirical evidences to show the ways through which logistics data standards can lead to controlling costs in clothing omnichannel retail.

Keywords: *omnichanel, retail logistics, cost-to-serve, apparel, logistics data standards*

Introduction

Today, manufacturers, wholesalers, retailers and consumers have various options to manage material and information flows across the product supply chain. Those options are generally known as channels, and act as mechanisms for communication and product/service delivery (Saghiri et al., 2017). Multi-channel networks such as home delivery, click & collect, catalogue shopping, mobile shopping and tele-shopping form a diverse range of conventional and modern purchase, supply and delivery choices for both customer and seller. The use of multi-channel to meet consumer demand has become the new norm in many industries, where more efficient means of reaching a larger and wider range of customers are considered (Zhang et al., 2010). Achieving reliable, consistent and seamless flows of material and information in multiple channels needs a thorough network to link and coordinate processes, technologies, and people throughout all different channels for each product. Such a network is coined as omni-channel (Piotrowicz and Cuthbertson, 2014). Omni-channel aims to provide a unified view of the product and maintain the brand value irrespective of the channel (Liebmann, 2013). Accordingly, it tries to expand the range of services for customers, increase total sales, reduce supply chain costs, improve customer trust, and build synergies throughout the supply (Tate et al. 2007).

Notwithstanding the recent studies, the academic literature of omni-channel is still nascent. Recent pressures toward digitalisation and online/mobile presence have demanded further research to explore various challenges and enablers of omni-channel. Frazer and Stiehler (2014) have positioned omni-channel within the digital environment.

To fill some parts of those gaps, this study explores the issues related to managing cost-to-serve in omni-channel networks. It also recommends data capture and sharing mechanisms to overcome omni-channel data management challenges. This paper pursues qualitative approach based on six case studies of leading UK companies clothing, footwear and accessories.

Literature review

In order to ensure the whole logistics system acquire a single view of products in terms of technical data, stock availability, location, despatch timing and delivery information, different elements of an omni-channel should be fully integrated. Zhang et al. (2010) explore the synergies achieved through integration across channels including: sharing market information and decisions, leveraging resources and physical assets, cross-channel promotions, cross channel customer interaction, and wider product and price comparisons. Overall, we have identified seven types of integration, which materialise omni-channel, as follows:

- Integrated market information which refers to linking and synchronising the sources, channels and interfaces of market data and promotions (Småros et al., 2003). This includes market trends, demand size, customer taste, customer behaviour, and similar products demand data. Integration in market and promotion information support demand visibility, and availability of demand data of different channels helps the omni-channel system to move or stock products more effectively.
- Integrated product information, where providers, organisers, and distributors of product information (i.e. the product's technical, physical, component, or ingredient data), should work collaboratively with shared product information resources to make sure the same information about the product is distributed to all members of the omni-channel system as well as the customer (Musa et al., 2014).
- Integrated transaction which involve payment instruments such as cash, cheques, cards coupons, gift cards, postal orders, and electronic transfer, and linking them with authorisation mechanisms like PIN number, verification code, and signature (Carton et al., 2012). It may also imply a secure accessibility to customers' transaction data via various channels (i.e. availability of payment data of individual customers to the relevant parts of the omni-channel system).

- Integrated pricing which synchronises the products' prices across channels and make changes in them (e.g. discounts) visible for customers and other members of the omni-channel system (Oh et al., 2012).
- Integrated order fulfilment which involves many activities, carried out through various channels and by different parties and tries to enhance traceability, tractability, and changeability of product, customer, and their relevant orders. It also included the inventory status and location information, which should be accessible and retrievable across the omni-channel system.
- Integrated customer service which implies the same or compatible service standards delivered by all members of the omni-channel. Hence, all service providers should be aware of and communicate the customer expectation and service standards properly (Das and Chowdhury, 2012).

Integrated reverse logistics which implies the link among different stages of reverse logistics and different channels involved in it. So, information around the return point(s), stock keeping point(s), and product(s) reverse flow should be retrievable, traceable, and changeable (Oh et al., 2012).

Achieving those integrations, as the core of omni-channel, is not obviously straightforward for many businesses. Accordingly, this paper tries to address the challenges in achieving omni-channel integration types (listed above) and the data management mechanisms needed to make it happen.

Methodology

Research into omni-channel networks is emerging, and this situation calls for exploratory research leading to elaboration of the phenomenon. This research adopted an inductive, multiple case study research design (Eisenhardt 1989; Yin 2014), because it provides a strong base for building theory, making it a suitable research method in developing fields (Eisenhardt and Graebner, 2007; Yin, 2014).

Six major UK manufacturing and retailing companies in clothing, footwear and accessories sectors are studied. The unit of analysis (Yin, 2014) is the omni-channel network of the case companies. The cases are selected based on their significance in the UK market as leaders of their sectors. The list of studied companies is shown on Table 1.

Table 1-Case companies and their main omni-channel highlights

Company	sector	Type of company
Company A	Retail chain	Upmarket items
Company B	Manufacturer and retail chain	Footwear
Company C	Retail chain	Clothing
Company D	Online retailer	Fashion and beauty
Company E	Retail chain	Fashion and clothing
Company F	Fashion and clothing	Retailer

Data collection

The sources of data for the multiple case studies (Yin, 2014) include interviews, documentations and industry focus groups. Miles and Huberman's (1994) recommendations for creation of a case study database, sorting of data, coding, writing and reflecting on the remarks are followed. An inductive approach proposed by Kaufmann and Denk (2011) was used to develop a set of propositions from the evidence collected through the cases.

Interviews

Semi-structured interviews with supply chain and logistics managers of the companies were conducted, following a prepared protocol. The conversations were transcribed and then were coded leading to identification of the main themes in the qualitative data. The list of interviewees is shown on Table 2.

Table 2- The list of interviewees who participated in this research.

Company	Position	Type of interview
Company E	General Manager	Telephone
Company F	Supply Chain manager	Telephone
Company G	Stock Distribution Controller	Face-to-face
Company H	Head of Supply Chain Development	Face-to-face

Documentations

Documents, including company reports and the data supplied in format of Excel sheets by the companies, has been used for completing the dataset required for conducting the analysis and also to triangulate the data.

Focus groups

Three focus group meetings took place in order to understand the omni-channel networks of the companies and to realize the benefits of the DMSs for improving their performance. The attendants were experienced practitioners with more than 15 years of experience in consulting large UK companies to adopt data standards for managing their supply chain processes. The findings of the project were discussed through these sessions and feedback and required information were received from the participants, leading to gaining a better understanding of the supply chains of companies and the issues related to data management in their omni-channel networks.
The main source of data was the semi-structured interview, while documentation was used to support and triangulate the data (Yin, 2014) collected through interviews.

Findings

Challenge of cost to serve

As UK retailers have embraced globalisation and omnichannel retailing, there has been an increased uptake of supply chain standards from apparel, footwear and accessories retailers and brands. This has been demonstrated through the growth in membership of GS1 UK, the growing number of organisations including UK Department Stores and online retailers that stipulate GS1 standards as a requirement of trade as well as the growth of standardised supply chain technologies.

At a foundational level, GS1 standards are used to uniquely identify products, locations and assets within the supply chain. As a global means of identification, GS1 identifiers ensure that businesses can use 1 way of labelling their products to trade with various partners all over the world. Beyond identification, GS1 standards are used to automate the capture and sharing of supply chain information which helps businesses streamline supply chain processes and improve communication.

The technologies relevant for the apparel market that are used to identify, capture and share information include;

- barcoding through Global Trade Item Numbers (GTIN)
- Radio Frequency Identification (RFID)
- Electronic Data Integration (EDI) which is used to share transactional data

Impact of standardisation on the challenges and levers

- Standardisation reduces complexity through the establishment of a common business language and global ways of working. In reducing network complexity, GS1 standards can

play a role by supporting systems integration, making it easier to work with 3rd parties and future proofing investment in infrastructure.

- Standardisation gives retailers the data and tools to react to market changes with flexibility and agility enabling them to manage market volatility. Specifically, GS1 standards can help reduce volatility caused by peak sale activity and supplier performance.
- By creating a common language and the standards by which to share information, standardisation enables visibility of both internal and external activities along the chain. Through greater visibility retailers can improve their data quality, better manage their inventory and use this information ensure their service promise is sustainable.

The cost areas which data standards are affecting include PO placement, warehousing, payments, store inventory management, and home delivery.

Conclusion

The apparel retail market is a fast moving and competitive environment. The complexity of the product (i.e. variety offered to the customer size, fit, colour) drives specific challenges for online channels and for the management of inventory to ensure maximum full price sales across channels and the greatest returns on inventory.

Understanding CTS is now critical to success of CFA retailers as margins are increasingly under pressure and CFA is particularly sensitive to changes in delivery channel, customer demand and competitor activity. Requirement for organisations to reflect carefully on cost to serve and consider how future changes will influence operational costs across the end to end value chain including suppliers and 3rd partners.

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The case for macrologistics

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ABSTRACT

Purpose

The primary objective of this paper is to further the development of the emerging field of macrologistics by proposing a definition and a quantification construct for macrologistics. The secondary objective is to illustrate the feasibility of this approach through the application of South Africa's established macrologistics models to address national-level logistics challenges.

Design

The definition of macrologistics is developed through a literature survey. The instrumentation of macrologistics, i.e. the development of a quantification construct, is based on a freight demand model which provides commodity-level, spatially-disaggregated freight-flow data, followed by a related component-level logistics costs model with four endogenous logistics costs elements (transport, storage, inventory carrying costs, and management and administration costs). The important quantitative contribution is that the measurement is bottom-up and disaggregated. The detailed nature of this instrumentation allows for a wide array of macrologistics applications which are illustrated in the results.

Findings and value

The formalisation of the emerging field of macrologistics is advanced by the development of a definition of and quantification construct for macrologistics. The outputs of South Africa's freight flow and logistics costs models show that the country's macrologistics challenges persist because they are not receiving macrologistics management attention. The research provides a measureable approach to macrologistics costs that can benefit society on a macro level, not only as far as policy is concerned, but also to support a wide array of applications by enabling freight logistics solution development that is in line with the national freight logistics context.

Research limitations

This type of research is often challenged by the absence of bottom-up, spatially-disaggregated commodity-level data. The ability to develop this data cost-effectively will allow the theory of macrologistics to advance.

Practical implications

The development of South Africa's freight logistics models provides an important contribution to the quantification of macrologistics costs in national economies and provides impetus for the elevation of logistics to the macroeconomic realm.

Keywords: Macrologistics, logistics costs, evidence-based policy, gravity modelling, South Africa

INTRODUCTION

Management sciences as an academic discipline emerged towards the end of the 19th century following the unprecedented shifts in the production structure of the economy brought about by the Industrial Revolution (Pindur et al., 1995). Gaining traction in the 1970s, logistics is therefore a very recent discipline in management sciences (Taylor, 1973). Initially, a discernible portion of the theory of logistics included what we would now call macrologistics perspectives, but this never developed into a formal subject field, distinct from firm-level logistics. In addition, many of the recent academic and management texts in the logistics discipline still pay little attention to the various perspectives of macrologistics. These perspectives include a rising number of themes that can no longer be addressed within the classical logistics and supply chain disciplines. The macrologistics themes relate to areas such as sustainability, humanitarian logistics, trade facilitation and the interfaces with macroeconomic policy and infrastructure investments (ATKearny, 2017).

Providing an efficient national freight logistics platform within the context of the national economy is crucial to address these themes and to, ultimately, increase national wellbeing (Havenga, 2010). Skowrońska (2012: 1) contended that macrologistics 'may be one of the most important factors in the development of the global economy'. More than three decades ago, Kojima (1982) reflected on the importance of incorporating the impact of *inter alia* transport costs and input-output interactions in macroeconomic theory. Liu et al. (2006) referred to the dynamic correlation between macroeconomic development and logistics development at the scale required to both support and enable economic growth. Banomyong et al. (2015: 23) recently lamented the 'very limited' research on 'logistics systems on a macro level'. Their objective is to synthesize existing frameworks to evaluate national-level logistics performance. Yet, even at a company level, strategic attention to logistics as a source of competitive advantage is a relatively new phenomenon, following on from a focus on product quality during the 1980s and customer service in the 1990s. It is therefore not surprising that the macroeconomic shift towards strategic logistics management is still in its infancy.

The overarching imperatives for advancing the discipline is to facilitate an enabling macrologistics policy environment and cohesive large-scale infrastructure investments to ensure the intelligent management of limited resources through cost optimisation, operational efficiency and economic viability of infrastructure investments (Müller et al., 2012). A prerequisite for facilitating this is a more in-depth understanding of the freight transport market through access to reliable, disaggregated freight-flow information (Lyk-Jensen 2011). The reason for this is that the backbone of all high-performing systems is management information (Fredendall and Hill, 2001). This holds true irrespective of whether the performance of businesses, industries or entire economies is at stake.

The primary objective of this paper is to further the development of the emerging field of macrologistics by proposing a definition and a quantification construct for macrologistics. The secondary objective is to illustrate the feasibility of this approach through the application of South Africa's established macrologistics models to address national-level logistics challenges. The literature survey culminates in a definition for macrologistics. The methodology section presents a quantification construct for macrologistics through the description of South Africa's established macrologistics models. The results section discusses the outputs from the models in a macrologistics context, followed by an overview of specific macro- and meso-level applications of these models to improve the macrologistics performance. The concluding remarks summarise the outputs.

LITERATURE SURVEY

On a micro-economic level, the definition of logistics is well established. Logistics is an integrative and systemic support function, applying trade-offs to determine optimal cost levels in the provision of the transport and storage of goods to address the time and place discrepancy between supply and demand for the purpose of conforming to customer requirements (Lummus et al., 2001). The integrative and systemic nature of the discipline relies on the development of activity-based cost data to establish the impact of activities on one another, in order to determine the lowest cost of logistics configurations (Rutner and Langley, 2000). The supply chain focus adds the trade-offs between logistics costs and the costs of purchasing, production and marketing, to enable the lowest total cost of ownership (Ellram and Siferd, 1998). This is important as a cost increase in one supply chain activity, such as increased bulk buying, can increase logistics costs (e.g. through higher inventory carrying costs), but due to bulk discounts, the total cost of ownership is reduced. Similarly, this holds true for a national economy – the ability to conduct national-level trade-offs between all input costs could lead to a lower total cost for the national economy (Hardin, 1968).

However, within macroeconomics, transport costs are typically relegated to the realm of administered costs, i.e. not considered as a distinguishing factor amongst economies, and therefore not measured (Hesse and Rodrigue, 2004). At the same time, macroeconomists do consider inventory as an important construct in the macro economy. Almost three decades ago, Ramey (1989), in an important discussion of macroeconomic inventory, touched on the role of logistics, however without specific reference to the concept. She realised that where macroeconomists had treated inventories as a buffer stock, it should have been seen as a production factor, i.e. the 'stock of inventories provides a flow of services to the firm'. She illustrated that, on a macroeconomic level, 60% of the decline in inventory investment during a recession is attributable to unanticipated shifts in demand, i.e. there is significant room for improvement in managing this production factor.

Burger (2008) postulated three causes of the great moderation in South Africa's macroeconomic cycle since the mid-1980s, i.e. improved monetary policy, an efficient financial sector, and improved inventory management. He observed that the latter played a less significant role in South Africa's economic cycles than in that of the USA. Similar to Ramey (1989), he touched on logistics principles without mentioning the discipline explicitly, arguably because of logisticians' absence in the economic discourse. Du Plessis and Kotze (2010) also related the decline in macroeconomic volatility since the late 1980s to *inter alia* improved private sector inventory management. Public sector infrastructure and logistics policy however also influence inventory, yet both the macroeconomics and logistics disciplines are silent on this topic.

The term "macrologistics" is unfortunately also used incorrectly. What macrologistics tries to achieve was established at the birth of the discipline, both by logisticians of the time and by macroeconomists venturing in the fields of transport and inventory production factors. Yet the stagnation in further theoretical development of the discipline led to near deviant descriptions such as Stein and Voehl's (1998: 7) use of the term to describe logistics as a driver within a business to change organisational processes. This is clearly not what was intended when the micro and macro perspectives of logistics were developed initially.

The maturation of the logistics discipline has brought about attempts to rectify these matters, for instance comparing logistics efficiency factors amongst nations through the World Bank's (2016) Logistics Performance Index. Recent research highlights the attempts to improve the quantification of national logistics costs.

Weng and Du (2015) urge cost comparisons based on those portions of GDP that have direct relations with logistics activity, i.e. the transportable economy (agriculture, mining and manufacturing). They demonstrate that some of the savings that the USA achieved over time in logistics costs as a percentage of GDP were merely due to the higher growth in the services sector compared to that of transportable GDP. Their results also demonstrate that, while moving in a narrow band, the USA's logistics costs as a percentage of transportable GDP has been consistently higher than that of China during the time period of their analysis (1998-2011). The Australian Logistics Council (2014) and Rantasila and Ojala (2015) cautioned that national accounts only capture outsourced activities, i.e. not in-house logistics services. Gleissner and Femerling (2013) described macrologistics based on its components, namely the traffic system, transport and warehousing. They expanded the view to what they call 'societal logistics' where the human element is included.

Liu et al. (2006) (in their concern for the demands on logistics due to China's fast growth) attempted to find links between macroeconomic development and logistics. Their problem is, however, whereas the GDP time-series (for analysing macro-economic trends) is readily available, the only time series available for logistics was traffic turnover volume. They merely assume that transport and other logistics functions such as storing and packing will be correlated. Through this work they want to influence logistics policy-making, but the departure premise negates the critical systemic interaction between logistics components and cost effects.

Banomyong et al. (2008) provided an important extension to the macrologistics discussion through the addition of the institutional or policy perspective. Skowrońska (2013) also accentuated the policy and infrastructure dimensions of macrologistics and expanded the view towards standardisation of services and technologies, and the strengthening of trade and industry. Memedovic et al. (2008) referred to logistics functions in global value chains in terms of improved competitiveness of geographical locations. They argue that logistics is reliant on intermodal facilities, skills, a complex production network and adequate infrastructure which can make the combination of flows more competitive. This view mirrors Taylor's (1973) definition of three decades ago that 'extending the concept of materials flow to a geographical region or area would appear to be a logical progression'. This logical progression of the discipline never advanced to the definition and tools required to optimise trade-offs between factors that influence these freight flows on a macro level.

However, none of these studies achieve a level of disaggregation of macrologistics cost measurement to the same extent as the activity-based cost measurement that is required on a company level, i.e. at the level of detail required to determine the actual effect of policies and infrastructure choices, or any other macrologistics tradeoffs that decision-makers require. The importance of measurement systems to aid macrologistics challenges has been recognised, but the complete instrumentation is lacking. Within specific fields, such as for logistics carbonisation, many "trans"-company studies aid in quantification, such as for decarbonisation (McKinnon, 2016) and carbon footprint forecasting (Piecyk and McKinnon, 2010) in the fields of sustainability. Other macrologistics challenges include issues with trade, sustainability and humanitarian logistics that require policy and infrastructure decisions, but the macrologistics tools to influence decision-making are lacking. Skowrońska (2008) for instance, described issues around society (including accidents), the environment (emissions) and space (incorrect location of centres and routes), but does not propose how macrologistics might influence behaviour to address these issues.

The definition of macrologistics proposed next is informed by these principles. It is defined within the context of macroeconomic management and concludes with a quantification construct. The objective of macroeconomic management should be to engineer the lowest total cost of ownership to the national economy through cost trade-offs between macroeconomic production factors and input costs (including economic, social and environmental costs). Macrologistics is defined as a branch of economics dealing with the policies, performance, structure and behaviour of the nation's logistics system to support the trade of goods to the benefit of the economy as a whole. The contribution of macrologistics to macroeconomic management is the quantification of commodity-level, spatially-disaggregated freight-flow models, and related component-level logistics costs models to determine lowest cost of logistics configurations. For the purposes of this paper, the latter is referred to as the instrumentation of macrologistics.

In the next section, the problem statement is summarised.

PROBLEM STATEMENT

The macroeconomic role of logistics is not recognized, and it is therefore not developed as an integrated body of knowledge that can add macroeconomic value. In addition, a quantification construct for macrologistics is currently not embedded within the macroeconomic measurement system. This hampers the ability of the logistics discipline to support public and private sector planning, policy development and investment strategies on a macroeconomic level to achieve economic, social and environmental advantages.

THE INSTRUMENTATION OF MACROLOGISTICS

The key driver of the instrumentation of macrologistics is **sufficient disaggregation and costing of the national transportable economy** on a spatial and commodity level to enable detailed analysis on all the core components of the national freight system.

Supply and demand per commodity on a geographical basis

The modelling of supply (production and imports) and demand (intermediate demand, final demand, exports and inventory investments) on a geographical basis per commodity is based on the input-output table of the economy. Supply and demand interaction is translated into modal share through gravity modelling for 83 commodities in 372 geographical areas (356 magisterial districts, eight inland border posts, seven ocean ports and one airport), culminating in a 30-year forecast at 5-year intervals for three scenarios. In gravity modelling, a distance-decay function describes the attraction value of freight between origins and destinations over a certain distance. The decay parameter determines the slope of the distance-decay function (de Jong and Van der Vaart, 2010).

Once freight flows have been modelled, they are aggregated to facilitate analysis and recommendations. Primary flows refer to ring-fenced logistics systems that are by nature mode-monopolistic (rail export lines, pipelines and conveyor belts), for which are typically known. The competitive surface freight transport market refers to corridor, metropolitan and rural freight flows (Havenga, 2013). Results are calibrated with industry research and correlated with known freight flows.

The models are hybrids, utilising actual and modelled data, thereby allowing for a more comprehensive and accurate analysis of the system under investigation (Islam, 2007). The modelling of total supply and demand addresses a concern of Lyk-Jensen (2011) that freight traffic forecasting typically does not adequately incorporate international trade flows. Correlation with the national input-output table ensures that traffic volumes are not over- or under-reported (Liu et al., 2006).

Calculating logistics costs

South Africa's logistics cost model measures logistics costs for disaggregated freight flows as received from the freight-flow model (Havenga, 2010). Four cost components are calculated. Inland transport costs are calculated as a mode-dependent (rail, road, pipeline) cost per tonne-km. Using actual tariff data for rail and pipelines and a highly detailed road tariff model, the cost per tonne-km is unique for each commodity travelling on each origin-destination pair. The different cost elements of road transport are determined by vehicle type; vehicle types, in turn, are determined by the commodity type, typology and route of travel. The commodity's 'preferred' vehicle type will change with changes in each of these variables. Once the vehicle type and volume are known, the cost elements can be assigned. The core drivers of transport costs, i.e. weight in tonnes and distance travelled, form the basis of the approach. Inventory carrying costs take into account the repo rate (the central bank's interest rate) and the average time each commodity is kept in storage. This cost per tonne is unique for each commodity but is independent of origin-destination pairs. Warehousing costs include all costs associated with keeping a commodity in storage. This includes rental costs, equipment costs, direct labour costs and insurance. It is calculated per tonne taking into account the average time in storage and the cost per tonne for storage for a specific commodity. The storage cost depends on the packaging type and density of the product. This cost per tonne is unique for each commodity but is independent of origin-destination pairs. Management and administration costs is a cost per tonne which takes into account the cost of indirect labour, administration and other indirect costs.

An externality cost extension to the logistics costs model was developed to quantify all non-charged costs, which include emissions, accidents, congestion, policing and noise pollution (Havenga, 2015).

However, the ultimate goal is to understand the drivers behind these cost elements and the relationship between them on a flow level. This will be showcased firstly, through describing the overarching outputs of the model, followed by specific applications of the models to address the challenges identified with the aid of the model outputs.

SOUTH AFRICA'S MACROLOGISTICS STATUS

South Africa is still one of only three countries who consistently measure and publish logistics costs on a national level, the other two being the USA and Finland (Rantasila and Ojala, 2015). South Africa's logistics costs totaled R429bn in 2014 and equated to 11.2% of GDP, compared to North America's 8.6% and Europe's 9.2% in 2014 (Armstrong and Associates Inc., 2016). Logistics amount to 51.5% of transportable GDP. Transport costs are the dominant contributor towards logistics costs, amounting to 57% of the total in 2014, (compared to the estimated global average of 39% (Rodrigue et al., 2009)), followed by inventory carrying costs (15.2%), warehousing (14.6%) and management & administration costs (13%).

Demand for land freight transport reached 848 million tonnes in 2014. The primary economy (agriculture and mining) was responsible for 76% of total volume but only contributed 44% to the transportable GDP (i.e. in value terms). In contrast, the secondary (manufacturing) sector made up the remaining 24% of volume, but added 56% value to the transportable economy. Manufactured commodities are highly densified along the country's two key general freight corridors, namely Gauteng-Cape Town and Gauteng-Durban. The 848 million tonnes land freight flows in 2014 translated into 379 billion tonne-km. Tonne-km increased by 46%, and tonnes by 17% between 2010 and 2014. If the dedicated ring-fenced transport systems (i.e. the rail export lines, pipelines and conveyer belts) are removed, 272 billion tonne-km (or 72% of total flows) remain that is classified as general freight, of which approximately half is long-distance, corridor freight. Road freight comprises 80% of this long-distance corridor freight and contributed 83% to total transport costs in 2014.Transport externalities add an additional 18% to already high transport costs; the contribution of non-road modes to these externality costs is negligible. Dense, long-distance flows are ideal candidates for intermodal solutions, which will, in addition to reducing direct logistics costs, also reduce externalities (refer to the section on the applications or our models).

The instrumentation of macrologistics has enabled South Africa to determine that:

- The country's logistics costs, as percentage of GDP is higher than that of key trading partners (Armstrong and Associates Inc., 2016);
- The contribution of transport costs to total logistics costs is significant; and
- The contribution of road transport to general freight transport costs, and the resulting environmental impact, is not sustainable.

These challenges persist because they are not receiving macrologistics management attention.

THE INSTRUMENTATION OF MACROLOGISTICS: APPLICATIONS

Our macrologistics instrumentation has already enabled specific macrologistics application successes.

1. More than half of South Africa's potential intermodal freight moves on the country's two most-dense freight corridors. Building three intermodal terminals to connect the three major industrial hubs – Gauteng, Durban and Cape Town – could enable modal shift to rail, increasing rail densities and thereby reducing logistics costs (including externalities) for the identified intermodal freight flows on these two corridors by two thirds (Havenga et al., 2012). Policy implementation challenges are hampering successes in this regard.
2. Transport externalities add an additional 18% to already high transport costs. Our scenarios indicate that increased returns to rail density due to a modal shift could result in a lower total national freight bill, despite the internalisation of all externality costs (Havenga, 2015; Havenga and Simpson, 2016).
3. Research outputs illustrate the advantages of supply chain coordination and the elimination of trade barriers. Reducing delays at South Africa's two major inland border posts can reduce the costs related to these delays by 55% due to reduced buffer stock required at the destination site, reduced

costs of carrying inventory, and reduced vehicle utilisation losses (Havenga et al., 2013). Havenga et al. (2016) showed that, for international trade, trade documentation costs and induced transport costs due to truck and ship standing times are approximately equal to direct port charges. These costs are at least in part avoidable and can be addressed through improved port efficiencies and collaboration between the ports, industry, and the South African Revenue Services.

4. The freight-flow model was a key input to inform Transnet's infrastructure investments in rail, ports and pipelines this century, estimated at R500bn up to 2027 (Transnet, 2015; Njobeni, 2016).
5. Detailed spatial data analysis points to opportunities for a revival of rail branch lines, which will reduce transport costs and externality charges in rural areas, and increase equitable access to the core transport network. The research also expounds the single-network characteristic of South Africa's railroad, based on density requirements relative to the size of the network (Simpson and Havenga, 2010).
6. In 2016 we had the opportunity (funded by the World Bank) to expand our macrologistics instrumentation to India. The results have already informed two major infrastructure investments. Firstly, the development of a freight village and extended gate for Kolkata port at Balaghar, as part of an integrated corridor design on the Delhi-Kolkata corridor, one of the densest freight corridors in the world. This will decongest cities and highways through the redirection of freight and serves as a case study to inform integrated corridor design. Initial indications are that logistics costs on the corridor can be halved. (Simpson et al., 2016). Secondly, in Varanasi, our results illustrated that a freight terminal currently being established could capture 39 million tons of intermodal freight rather than a meager one million tons (Dash, 2017).

CONCLUDING REMARKS

The primary objective of this paper was to further the development of the emerging field of macrologistics by proposing a definition and a quantification construct for macrologistics. The secondary objective was to illustrate the feasibility of this approach through the application of South Africa's established macrologistics models to national-level logistics challenges.

Macrologistics is defined as a branch of economics dealing with the policies, performance, structure and behaviour of the nation's logistics system to support the trade of goods to the benefit of the economy as a whole. The contribution of macrologistics to macroeconomic management is the quantification of commodity-level, spatially-disaggregated freight-flow models, and related component-level logistics costs models to determine lowest cost of logistics configurations. For the purposes of this paper, the latter is referred to as the instrumentation of macrologistics.

I hope that the work presented in this paper can initiate the macroeconomic formalisation of logistics costs. Our modelling results show that South Africa's macrologistics challenges persist because they are not receiving macrologistics management attention. In support of this, the instrumentation construct has already delivered important inputs to national economic challenges, both in South Africa and other developing economies.

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Supply Chain resilience

Strategic choices in creating resilient supply networks

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Introduction

Defining the right supply chain strategy for your product requires a contingency based approach – i.e. one size does not fit all (Fisher, 1997, Christopher and Towill, 2001). Under 'normal' operating conditions supply chain management requires due consideration of the customer expectations with respect to responsiveness, total cycle time, total cost, degree of customisation and potential risks associated with product delivery. But what may work for 'normal' conditions may have different implications when it comes to how a supply chain performs when a disturbance occurs, e.g. when there is considerable volatility in the market place or there are sudden abrupt drops in supply.

The concept of supply chain resilience recently came to the fore as a means to act against the potential catastrophic failures that may occur due to a disturbance. Resilience itself is the "ability to recover from or adjust easily to misfortune or change" (Merriam-Webster Online Dictionary 2014) and is usually associated with human psychology and the ability of an individual in dealing with hardship or misfortune (Stewart et al., 1997). In a supply chain context there has been a number of definitions including "the ability of a [supply chain] system to return to its original state or move to a new, more desirable state after being disturbed" (Christopher and Peck 2004) or "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at desired levels of connectedness and control over structure and function" (Ponomarov and Holcomb 2009).

Although various definitions exist, the requisite capabilities to achieve resilience are not well understood from a practical or theoretical basis. More recently, Purvis et al. (2016) proposed a supply chain framework highlighting the necessary 'ingredients' to achieve resilience. Specific management paradigms addressed include robustness, agility, leanness and flexibility (RALF) that, when exploited in different phases through a 'sense-respond-recover' process following a disturbance, allows a supply chain to be resilient to both demand and supply side uncertainty.

As Purvis et al. (2016) advocated the RALF model based on a review of the existing literature they illustrated its utility with examples of its successful application from a single case in the drinks sector both to surges in demand and downturns in the economic cycle. The latter included the case of a supplier going into receivership. Our aim is to further test the RALF model to ascertain its potential exploitation in assessing the likelihood of resilience of a suite of supply networks in the clothing and apparel sector. We focus on capabilities required to deal with volatility in the marketplace and propose future research to enhance our understanding of supply chain resilience.

The RALF model

Purvis et al. (2016) propose the model of Figure 1 to explain the resilient behaviour of the Innocent Ltd. supply chain to external disturbances. The RALF model was originally intuitively developed in a practical setting but was developed and enhanced by Purvis et al. (2016) by building on the literature on supply chain resilience. Hence, they advanced the causal relationships between different existing operations management paradigms that underpin supply chain resilience. Here we give a brief overview of the salient features of the model.

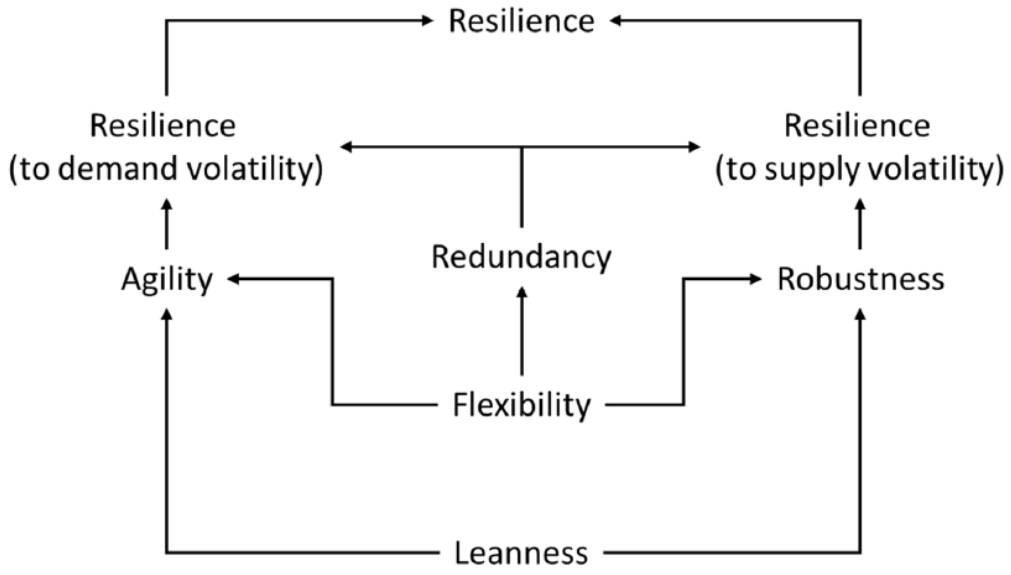


Figure 1: The antecedents of supply chain resilience (Adapted from Purvis et al. 2016)

While resilience could easily be attained at considerable cost through redundancy, for example through the build-up of high levels of just-in-case inventory, with all the prevailing obsolescence costs that would entail, building in a degree of leanness in the supply chain aims to the minimisation of waste, in terms of resources, efforts and time (Sheffi, 2005). Nevertheless, a lean supply chain may still lead to a robust supply chain by building strategic 'value add' stock to maintain optimum service delivery, while at the same time ensuring efficient processes (Bhattacharya et al., 2013). Lean thinking is also a central tenet for robustness (Christopher and Rutherford, 2004), as lean accommodates some variance in volume requirements within specified tolerances (Naylor et al., 1999).

Leanness, in the form of developing efficient and effective processes, is also seen as an underpinning prerequisite for agility (Narasimhan et al., 2006). Similarly, so is flexibility, in the form of coping with changes in customer needs (Wadhwa and Rao, 2003). While flexibility is a capability to mitigate against both supply and demand uncertainty, it is on the demand side that certain flexibility types, such as mix or volume flexibility (Naylor et al., 1999) enables agility to be attained. Other forms of flexibility, such as rigid flexibility, determines the scope and scale of events a supply chain can deal with (Stevenson and Spring, 2007).

Sheffi and Rice (2005) suggest that 'cost effective' redundancy is hard to achieve, as redundancy in many ways contradicts the principles of lean, such as just-in-time systems and eliminating waste, but flexibility, in the form of rapid reconfiguration of resources, is an enabler of redundancy. Purvis et al. (2014) highlights that redundancy may be achieved by flexibility in having available capacity in specific nodes within the supply network and / or a capability to switch between suppliers and/or service providers.

Hence, we find that supply chain resilience is made up of two parts; that to demand uncertainty, primarily achieved via agility (where agile firms are extremely market oriented, continuously sensing and responding and recovering to opportunities afforded by changes in customer requirements (Sambamurthy et al. Grover 2003)) and redundancy, and that to supply side uncertainty, again from redundancy but also robustness (where a firm has "the ability… to resist change without adapting its initial stable configuration" (Wieland and Wallenburg 2012); that is, the firm is able to resist or adjust to shocks (Wallace and Choi, 2011)).

All of the prevailing suggests that there are inherent 'ingredients' that establish the resilience of a supply chain. What is less obvious is the 'recipe', that is, the mix of the various capabilities that is required to achieve a level of resilience. There may also be a requirement to consider the trade-offs that exist within the 'mix', for example, the degree of efficiency required, achieved through leanness, versus the level of redundancy, agility or robustness. While Purvis et al. (2016) have presented a drinks sector case that demonstrates the interplay of the different capabilities, we here extend the testing of the RALF model via a qualitative study of two supply networks in the clothing retail sector.

Research approach

We adopt a deductive approach to our research as we are further exploring an existing model of supply chain resilience, namely RALF. In line with Purvis et al. (2014), the UK retail clothing sector, which involves both local and global supply chains consisting of garment producers, textile manufacturers, textile finishers and printers, trim manufacturers, logistics providers and intermediaries. It is one of the most concentrated in the world, with specialist clothing retailers accounting for 68% of market share, with independent specialists only having a 14% share. Hence, the sector is heavily dominated by substantive clothing multiples. Data also suggest that the sector is relatively resilient to economic downturns in comparison to other sectors. Whilst year-on-year sales volumes and values fell in the aftermath of the financial crises of 2008 for non-food retail, those for Textile, Clothing, Footwear and Leather retail grew during this period (Office for National Statistics, 2013)."

We used a purposive sampling strategy for case study selection. We approached the top 10 leading UK specialist clothing multiples in terms of market share. Of these, two agreed to participate in the research. They offer a range of products, in line with Fisher's (1997) supply chain categorisation – from functional, low fashion content items with long life cycles and predictable demand to high fashion items with a shelf life of up to 6 weeks and a very volatile demand.

The research was designed primarily to understand the sourcing strategies of the retailers but the data capture led us to reflect on the resilience capabilities of their supply networks consisting of different supply chain types. We undertook 12 semi-structured interviews yielding 200 pages and 30 hours' worth of transcripts. We also interrogated existing public domain and archival data, as well as undertaking site visits and facilitating a workshop. We ultimately defined four different operating supply chains in their networks and determined their RALF characteristics.

Findings

Table 1 provides a summary of the four supply chain types identified from the cases. Supply chain 1 is for long shelf life, low fashion content items, supply chains 2 and 3 are for medium shelf life products and supply chain 4 supports short shelf-life, high fashion items. Based on the RALF model of Figure 1, we highlight the specific attributes that define the interplay between customer requirements in terms of supply chain responsiveness, vendor and sourcing flexibility underpinning agility, leanness and its foundational support for agility and robustness, and redundancy as typified by excess capacity, lead-time slack or stock within the network.

	Vendor flexibility		*Sourcing Flexibility*	*Customer sensitivity (responsive)*	*Redundancy*	*Robustness*
	Mix Flexibility	*Volume Flexibility*				
Supply chain 1	Low (max 5 SKUs/range)	Low (+/-10%)	Low	Low (12-18 months)	Little available in terms of vendor capacity nor sourcing options	May be able to cope with small fluctuations in volume.
	Lean		**Lean**			
Supply chain 2	High (5-30 SKUs/range)	High (-100%; +300%)	Low	Medium (6 months)	Highly capital intensive capacity availability.	Low ability to deploy alternative suppliers
	Agile		**Lean**			
Supply chain 3	High (5-30 SKUs/range)	Low (+/-5%)	High	Medium (6 months)	Exploits inventory for postponement and use of intermediaries to source suppliers and book capacity.	Use of inventory and flexible supply base to deal with change in market requirements.
	Lean		**Agile**			
Supply chain 4	High (5-30 SKUs/range)	High (-100%; +25%)	High	High (3-6 weeks)	Additional capacity available due to ability to employ staff at short notice.	Flexible supply base.
	Agile		**Agile**			

Table 1: Identifying RALF attributes to the four supply chains (extending Purvis et al. 2014).

Supply chain 1

The products in this supply chain, such as basic socks and vests, may be classified as 'functional' with long life-cycles in the range of 12 to 18 months, high volumes and a low number of SKUs per range. Sourcing is global from low labour cost countries with high physical delivery lead-times. But demand is relatively stable and easy to forecast due to small variations, hence the need for resilience to demand volatility is limited. Due to the relative stable environment the retailer has developed long-term partnerships with its suppliers.

Supply chain 2

A local UK supply chain (UK based apparel and textile suppliers) exists for a relatively complex, high-fashion knitwear product. The production line is capital intensive with a relative high risk of obsolescence due to a typically 6-month life cycle after which lines are discontinued and prices are 'marked down'. A long-term partnership exists between the retailer and knitwear supplier, with joint product development and high frequency, low volume orders and deliveries. The UK supplier has available capacity to ramp production up and down and accommodate a high number of SKUs per range. The retailer is highly sensitive to demand changes and readily avails such information to its supplier.

Supply chain 3

A global supply network has been established for a range of relatively 'low cost' mid-fashion items. With the UK's textile manufacturing base at an all-time low, the design and manufacture of fairly intricate products relies on sourcing from multiple suppliers, with low labour costs, with different technical capabilities from a large and complex global network. That said, the level of technology is very low and there is a high labour content in manufacturing. To mitigate against the retailer themselves having to manage the network there is a reliance on intermediaries to procure and administer the supply base. The retailer will preposition raw materials inventory and book capacity to exploit once market design needs are determined. Lead-times are long, due to the use of surface land and sea transport in order to, again, minimise costs.

Supply chain 4

This supply chain caters for high-fashion garments, with life-cycles of 3-6 weeks. Demand forecasting is extremely difficult to undertake and hence the supply chain has to be extremely agile to changing market needs. While UK suppliers may have been ideal, due to the lack of a competency base in the UK, including low availability of fabrics, high labour costs and limited capacity, the retailer has created a supply base in Eastern Europe and North Africa, hence relatively 'near shoring' in comparison to supply chains 1 and 3. Fabrics are bought-to-stock while design and manufacture are undertaken on a make-to-order basis. Small batch sizes and frequent deliveries aim to minimise obsolescence costs. Intermediaries are also used in this supply chain so as to allow suppliers, with high capacity availability due to relatively low labour costs, to bid for business at short notice.

Discussion and conclusions

Bearing in mind that the supply chains researched were not necessarily designed with resilience in mind, we have determined the extent to which the RALF capabilities are prevalent in each of the four. We must also recall that this paper is predominantly interested in the demand side uncertainties that the four supply chains may be able to cope with but elements to the supply side are also evidenced. Hence, we are able to give a narrative of the resilience characteristics that are evident. We find that two extreme scenarios exist.

Supply chain 1 is a lean supply chain with little if any of the other three RALF elements indicated. This supply chain may be extremely vulnerable to supply-side disturbances, with long lead-times and little spare capacity or inventory in the system. In contrast, the data available for supply chain 4 suggests that it is highly resilient to external shocks, exhibiting a number of the RALF model traits with a strong emphasis on agility. Supply chains 2 and 3 may be classified as 'intermediary', showing potential resilience to disturbances.

Our results suggest that elements of the RALF ingredients are definitely evident in the supply chains we have studied. The early indications are, as with Purvis et al. (2016), that a potential 'recipe' exists for each of the supply chains identified. The exact 'mix' remains unknown. Therefore, our research enhances the theoretical explanation of the role of various paradigms that yield resilience, by empirically testing the RALF framework in a new sector with multiple supply chains within two case networks.

The research suggests that the continuing successful operations of such supply chains is possible despite external and internal disturbances although one-size does not fit all. In certain supply chains, although potentially vulnerable to supply-side disturbances, given the functionality of the product and the lack of sensitivity required for customisation, there is no need to develop resilience to demand volatility, with the associated costs that it entails. Our research does suggest that a high degree of resilience is attainable through robustness, agility, leanness and flexibility but a trade-off between them is apparent. Potential future research could explore the trade-off considerations via multi-criteria decision making (MCDM). Candidate techniques include the analytic hierarchy process (AHP) and multi-attribute utility theory (MAUT) among others.

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Supply Chain Resilience Capabilities and Dynamic Capabilities: A Conceptual Framework

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Introduction

Researchers and practitioners studying supply chain disruptions invoke the concept of resilience as a mechanism to prepare, respond and recover from disruptive events (e.g. Pettit et al., 2013; Sheffi, 2015). Hence, building supply chain resilience (SCRES) capabilities is perceived a strategic capability that enables firms to maintain business continuity and competitiveness (Seville et al., 2015). Research on SCRES capabilities, however, remains fragmented, with the disparity in the identification of the core capabilities and a lack of clarity on the relationships between capabilities and other SCRES constructs such as elements and practices (Ponomarov and Holcomb, 2009; Ali et al., 2017). The inconsistencies surrounding SCRES capabilities in the literature suggests further theoretical explanations are required to advance future empirical research. Similarly, scholars in the strategic management literature argue in times of uncertainty, and rapidly changing business environment firms need to build dynamic capabilities to sense threats, seize opportunities and reconfigure resources to achieve competitive advantage (Teece et al., 1997; Teece, 2007). Dynamic capabilities help firms to create, extend, and modify its operational capabilities to match the environment (Helfat et al., 2007). The two concepts can, therefore, be promising when applied together in a turbulent environment. Despite the similarities and potential value of both concepts, dynamic capabilities theory has only scarcely been applied in SCRES studies.

The purpose of this study is twofold: first, to discuss the synergies between SCRES capabilities and dynamic capabilities by identifying a set of five high-level dynamic SCRES capabilities derived from a systematic literature review (SLR) by Ali et al. (2017). Second, to develop a conceptual framework of a firm SCRES that integrates these dynamic SCRES capabilities as a formative measure, which in turn influences operational performance and reduces disruption risks. This conceptual study contributes to current study in SCRES by grounding a set of SCRES capabilities in dynamic capabilities theory, thus addressing a current gap in SCRES research, which lack theoretical underpinning in most models. It also contributes to managerial practices by presenting a measurable model of dynamic SCRES capabilities, which can help managers to make sound decisions regarding resources and investments on resilience. By assessing each of these dynamic capabilities, managers get a measure of their firm SCRES, can evaluate their weaknesses and strengths, and the effectiveness of the managerial and organisational processes that support these capabilities.

Literature Review

Supply Chain Resilience Capabilities

Building SCRES capabilities are considered one of the fundamental attributes of supply chains to effectively cope and adapt to disruptive events. Indeed, current research on SCRES capabilities has highlighted several operational capabilities such as collaboration, visibility, agility, flexibility, and robustness to name a few; which builds resilience and leads to improved performance and competitive advantage (e.g. Jüttner and Maklan, 2011; Scholten and Schilder, 2015). However, the published research on SCRES capabilities remains fragmented, with the disparity in the identification of the core capabilities and uncertainty on the relationships between the capabilities and other SCRES constructs such as elements and practices (Ponomarov and Holcomb, 2009; Ali et al., 2017).

For example, terminologies such as elements, sub-elements, dimensions, competencies have all been used to describe SCRES capabilities. There is a lack of clarity on what are core SCRES capabilities and associated managerial and organisational processes that support them. Further theoretical explanation is warranted to advance the theory and ascertain the value of SCRES capabilities (Ali et al., 2017). Despite an increasing number of publications in SCRES studies, few attempts have been made to address these issues.

To date, perhaps the most holistic framework of SCRES capabilities is provided by Ali et al. (2017). Based on an SLR, they induced five core SCRES capabilities following the analysis of 59 definitions. These five SCRES capabilities are the ability to anticipate, adapt, respond, recover and learn. Furthermore, these capabilities are linked to the different phases of resilience, risk management strategies, SCRES elements and managerial practices, thus providing an integrative view on the relationships between SCRES capabilities and other constructs that support to build these capabilities. This study adopts these capabilities to address the link between SCRES capabilities and dynamic capabilities. The following sections discuss the dynamic capabilities literature followed by the linkages between dynamic capabilities and SCRES capabilities.

Dynamic Capabilities Theory

The dynamic capabilities theory was developed in the 1990s to inform managers on how to integrate, build, and reconfigure competencies/capabilities to cope with the rapidly changing business environment (Teece et al., 1997). In conditions of change and volatile environment, firms must develop dynamic capabilities to create, extend, and modify how they make their living (Helfat et al., 2007). Dynamic capabilities describe how a firm's ability to innovate, adapt to change and create change that is favourable to their customers and unfavourable to competitors (Teece et al., 2016). Moreover, it presents a theory of the firm and firm-level competitive advantage in conditions characterised by deep uncertainty (Teece, 2014) and offers a promising way to explain how organisation adapt to such conditions (O'Reilly and Tushman, 2008). Thus, they become a source of sustained competitive advantage (Eisenhardt and Martin, 2000).

In a dynamic environment, the firm uses its dynamic capabilities and associated managerial and organisational processes or routines to alter its initial position and path (Zollo and Winter, 2002; Helfat et al., 2007). As such, dynamic capabilities are built rather than bought in the market (Makadok, 2001). The dynamic capabilities theory, however, is still in its infancy and developing; the studies are mainly conceptual and focused on issues such as the definition of the concept (Wang and Ahmed, 2007; Di Stefano et al., 2010). Some debates pertain to the nature of dynamic capabilities, concerns about their effects and consequences (Cepeda and Vera, 2007; Easterby-Smith et al., 2009). Hence, dynamic capabilities are labelled as an abstract concept or an elusive "black box" (Pavlou and El Sawy, 2011).

In summary, dynamic capabilities theory is a nascent theoretical lens that has attracted much attention in the strategic management literature. While the debate continues how dynamic capabilities manifest themselves in practice (Birkinshaw et al., 2016), the consensus is emerging about the key characteristics of the theory regarding the following four areas (Cepeda and Vera, 2007). First, dynamic capabilities are higher level capabilities, which are organisational process and routines rooted in knowledge gathering and sharing (Cepeda and Vera, 2007; Easterby-Smith et al., 2009). Second, the input of dynamic capabilities is the initial configuration of resources and operational routines (Eisenhardt and Martin, 2000; Cepeda and Vera, 2007). Third, dynamic capabilities involve transformation, renewal, and adaptation of resources and operational routines (Cepeda and Vera, 2007; Wang and Ahmed, 2007). Finally, the output of dynamic capabilities is a new configuration of resources and operational routines (Cepeda and Vera, 2007; Pavlou and El Sawy, 2011).

SCRES Capabilities as Dynamic Capabilities: Theoretical Framework

A key debate in dynamic capabilities literature is the distinction between dynamic and operational (ordinary) capability. A capability, whether operational or dynamic, is the ability to perform a task or activity (Helfat et al., 2007). Capabilities are a collection of routines, and a routine is a 'behavior that is learned, highly patterned, repetitious, or quasi-repetitious, founded in part in tacit knowledge' (Winter, 2003, p. 991). Although both capabilities are a collection of routines, dynamic and operational capabilities, differ in their purpose and intended outcomes, and the line between them is inevitably blurry (Helfat and Winter, 2011). Operational capabilities enable a firm to make a living in the present and are about doing things right (Teece, 2014). They help a firm to perform an activity on an on-going basis using the same techniques to support existing products and services to serve its customers; hence it maintains the *status quo* (Helfat and Winter, 2011). A dynamic capability enables a firm to change how it currently makes its living (Teece et al., 1997; Eisenhardt and Martin, 2000; Zollo and Winter, 2002). It includes the capacity with which a firm can identify the need or opportunity for change, formulate a response and implement a course of action (Helfat et al., 2007). There are as a result of managerial and organisational processes that ensure learning, integration, reconfiguration and transformation as market changes (Helfat et al., 2007; O'Reilly & Tushman, 2008).

Unlike dynamic capabilities literature, there is an ambiguity in the distinction between high-level SCRES capabilities and operational capabilities in SCRES research. Researchers in SCRES studies have discussed SCRES capabilities at different levels of analysis. For example, some authors discuss capabilities at a strategic higher-level operating along the lines of the resilience phases of readiness, responsiveness and recovery (e.g. Chowdhury and Quaddus, 2016). These are also sometimes referred to as proactive and reactive capabilities (e.g. Dabhilkar et al., 2016). While some discuss them at operational lower-level daily managerial practices needed to maintain resilience. For example, visibility, collaboration, flexibility, agility, and so on (e.g. Jüttner and Maklan, 2011). As such, the literature is inconsistent in its classification of these capabilities, and it becomes difficult to decipher core SCRES capabilities. However, more recent work by Ali et al. (2017) has distinguished the relationships and interactions between five core SCRES capabilities and other related constructs such as elements and managerial practices to bring conceptual clarity. Thus, providing a foundation for this study and future empirical studies. Indeed, it is these five SCRES capabilities that we seek to engage further and develop conceptually: the ability to anticipate, adapt, respond, recover and learn.

In line with dynamic capabilities literature, the five SCRES capabilities are conceptualised as dynamic capabilities that encompass how firms survive, grow, and thrive in uncertain and challenging environments (Teece, 2014). These five capabilities are to referred to as dynamic SCRES capabilities in this study for several reasons. First, they meet the criteria of being higher-level capabilities supported by organisational processes and routines, which are referred to like elements, sub-elements, competencies or managerial practices in SCRES literature. Second, the input of dynamic SCRES capabilities is the initial configuration of resources and operational routines (e.g. flexibility and sharing information). Third, dynamic SCRES capabilities involve anticipation, transformation, renewal, and adaptation of resources and operational routines in times of adversity (Wang and Ahmed, 2007). Finally, the output of dynamic SCRES capabilities is a new configuration of resources and operational routines (Cepeda and Vera, 2007; Pavlou and El Sawy, 2011), which enables a firm to survive, thrive and grow in adversity (Pettit et al., 2013). In this study, dynamic SCRES capabilities are defined as those high-level activities that enable a firm to anticipate, adapt, respond, recover and learn from disturbances to sustain competitive advantage. Competitive advantage in this sense is attained through operational performance and reduced disruption risks, as shown in Figure 1 below.

A Firm Dynamic SCRES Capabilities: Conceptual Framework

Ability to Anticipate: Sensing Capability

In a rapidly changing business environment, firms are constantly in a state of alert seeking information and new knowledge to create opportunities. Sensing opportunities is related to a scanning, creation, learning, and interpretive activities both internally and externally to a firm (Teece, 2007). Firms must constantly scan, search and explore markets to identify and shape opportunities and threats. Sensing capability is congruent with the ability to anticipate, which is one of the core SCRES capability. The ability to anticipate is supported by five essential elements such as situation awareness, robustness, knowledge management, security and visibility, which can gauge a firm's level of SCRES readiness (Ali et al., 2017). These elements can be linked to managerial and organisational processes or routines in the dynamic capabilities literature. For example, situation awareness relates to sensing and interpreting events (Teece, 2007) to identify potential problems, robustness refers to configuring resources (Helfat et al., 2007), knowledge management relates to learning (Zollo and Winter, 2002) and security refers to the scanning and searching (O'Reilly and Tushman, 2008). Finally, visibility can relate to seeking information to sense and shape opportunities (Teece, 2007). Hence, the following proposition is proposed:

Proposition 1: A firm's ability to anticipate disruptions increases its dynamic sensing capability, which in turn increases a firm's SCRES.

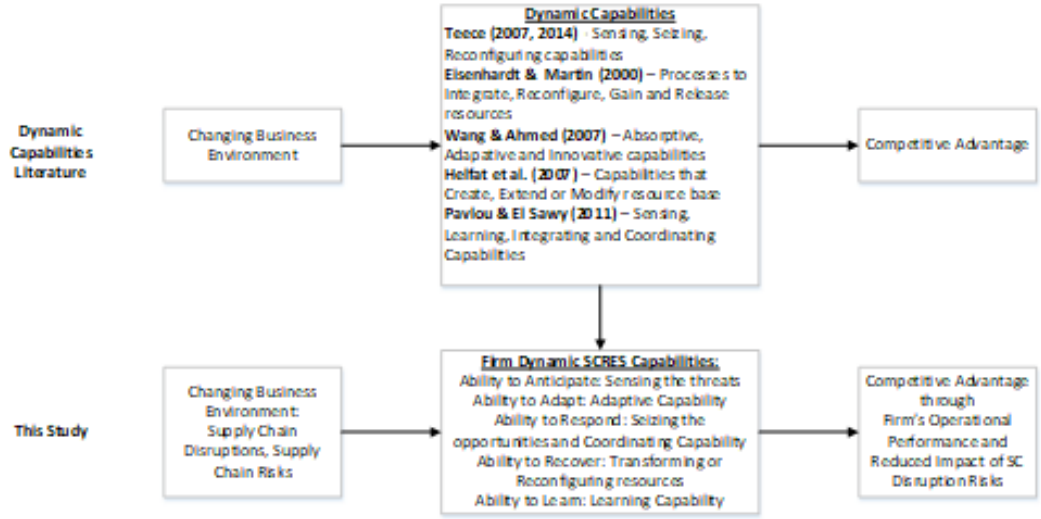


Figure 1: Proposed Theoretical Framework

Ability to Adapt: Adaptive Capability

After sensing threats and opportunities, firms engage in the seizing process, which involves the ability to make timely decisions to develop new chances (Teece, 2007). Firms that have high levels of adaptive capability display dynamic capabilities (Teece et al., 1997). The adaptive capability is consistent with the ability to adapt, which is a core SCRES capability. The ability to adapt during disruptions by managing and adjusting critical supply chain resources enables a firm to absorb and cope with disturbances (Ali et al., 2017). In the context of SCRES, two essential organisational processes and associated managerial practices are identified: building flexibility and redundancy. Increasing flexibility provides a firm with the ability to adapt to changes quickly by reorganising dedicated capacity (Rice and Caniato, 2003). Flexible supply via multiple suppliers and flexible manufacturing are some of the examples of managerial practices related to building flexibility, which forms part of the dynamic capabilities that alter a firm's position. Similarly, building redundancies in

the shape of excess capacity to respond to disruptions improves the ability to adapt to sudden changes through the strategic use of inventory or storage facilities. Thus, the following proposition is formulated:

Proposition 2: A firm's ability to adapt during disruptions increases its dynamic adaptive capability, which in turn increases a firm's SCRES.

Ability to Respond: Coordinating Capability

Firms that can demonstrate timely responsiveness and management capability to coordinate and deploy internal and external competencies effectively are competitive in the global market (Teece et al., 1997). Coordinating capability is similar with the ability to respond, which is a core SCRES capability. The ability to respond in a timely and efficient manner during disruptions lessen the impact of a disruptive event to ensure a desirable outcome (Ali et al., 2017). In the context of SCRES, two essential elements and associated managerial practices are identified: collaboration and agility. Collaboration is the ability of supply chain partners to respond to supply chain disruptions through collaborative planning and information sharing to effectively coordinate the response (Christopher and Peck, 2004). While agility is the capacity to respond rapidly to changes through synchronised shared information among partners to improve response time to variations in both risk mitigation and market response (Braunscheidel and Suresh, 2009). Hence, the following proposition is put forth:

Proposition 3: A firm's ability to respond to disruptions increases its dynamic coordinating capability, which in turn increases a firm's SCRES.

Ability to Recover: Reconfiguring Capability

Reconfiguring operational capabilities and deploying new ones to address the aftermath of a disruptive event is a critical goal of dynamic capabilities. A key to sustained growth is the ability to recombine and to reconfigure assets and organisational structure as change happens (Teece, 2007). Reconfiguration of resources is vital to evaluate the level of SCRES recovery in the aftermath of an event. Hence, reconfiguring capability is congruent with the ability to recover, which is a core SCRES capability. In the context of SCRES, two essential organisational processes and corresponding managerial practices are identified: contingency planning and market position. Evaluating supply chain contingency plans that can be activated in the post-disruption phase enhances a firm's ability to recover, and hence its restoration plans (Ali et al., 2017). Reconfiguring and mobilising resources are essential for developing effective contingency plans (Pettit et al., 2013; Ambulkar et al., 2015). Also, having a strong market position results in high margins that allow investments in SCRES (Sheffi and Rice, 2005). The following proposition is therefore proposed:

Proposition 4: A firm's ability to recover from disruptions increases its dynamic reconfiguring capability, which in turn increases a firm's SCRES.

Ability to Learn: Learning Capability

Learning is at the heart and development of dynamic capabilities. Learning as a dynamic capability allows tasks to be performed more efficaciously, often as a result of experimentation and reflection on failure and success (Ambrosini et al., 2009). Hence, organisational learning is a source of dynamic capabilities, which are shaped by co-evolution of learning mechanisms (Eisenhardt and Martin, 2000; Zollo and Winter, 2002). Similarly, post-disruption knowledge management enhances a firm's ability to learn through a pattern that generates and modifies its operating routines in pursuit of improved effectiveness (Zollo and Winter, 2002). Therefore, learning capability is consistent with the ability to learn, which is a core SCRES capability. In the context of SCRES, two organisational processes and associated managerial practices were identified that characterised learning in the aftermath of the event: Post-disruption knowledge management and building social capital (Ali et al., 2017). Firms that possess resilient supply chains cultivate their ability to learn through education and training,

and post-disruption feedback (Rice and Caniato, 2003; Blackhurst et al., 2011). Likewise, building social capital among supply chain partners and other entities (e.g. communities and government) strengthens the ability to learn (Johnson et al., 2013). Hence, the following proposition is developed:
Proposition 5: A firm's ability to learn from disruptions increases its dynamic learning capability, which in turn increases a firm's SCRES.

The Effects of a Firm's SCRES

The Effects on Operational Performance

Firms that possess resilient supply chains are perceived to absorb disruptions and restore their functions quicker that enables them to maintain business continuity and competitiveness (Sheffi, 2015). Thus, a firm's SCRES enhances a firm's operational performances such as customer satisfaction, on-time delivery, flexibility and responsiveness (Pettit et al., 2013), which enables them to react quicker than their competitors. Therefore, the following proposition is posited:
Proposition 6: A firm's SCRES has a positive effect on its operational performance, which can be a source of competitive advantage.

The Effects on Supply Chain Disruption Risks

SCRES enables firms to anticipate, adapt, respond, recover and learn promptly from unpredictable events (Ponomarov and Holcomb, 2009; Ali et al., 2017). SCRES enables firms to return to its original state or move to new, more desirable state through adaptation (Christopher and Peck, 2004), bounce back from disruption (Sheffi and Rice, 2005), thrive and grow in the face of adversity (Pettit et al., 2013). Hence, the following proposition is formulated:
Proposition 7: A firm's SCRES has a negative effect on its supply chain disruption risks, which can be a source of competitive advantage.

The propositions on a firm's dynamic SCRES capabilities and their effects are depicted in a conceptual framework as shown in Figure 2 below.

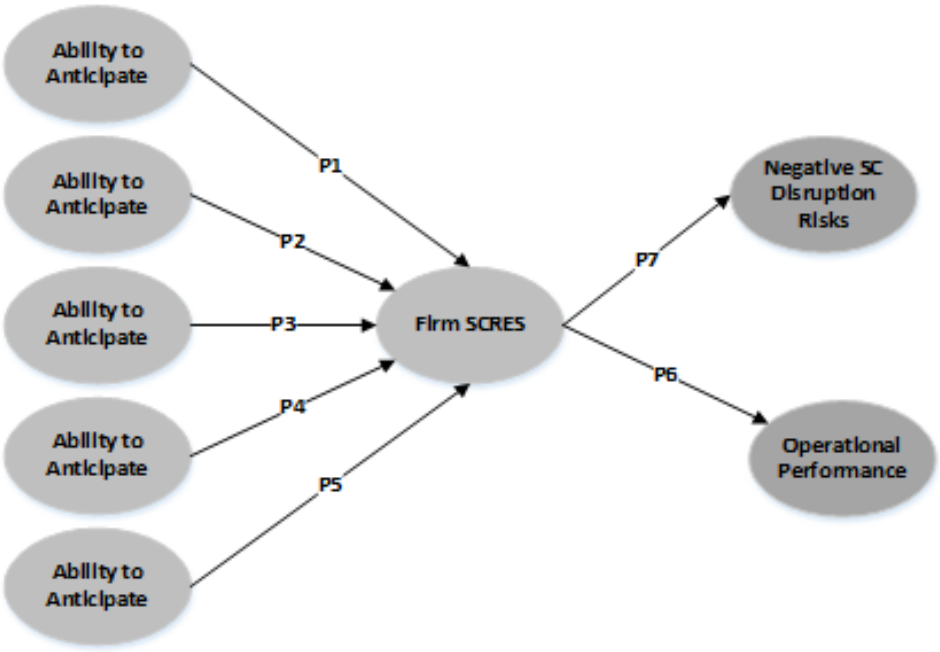


Figure 2: A Firm's SCRES Conceptual Framework

Conclusion and Implications

There are calls to extend research on dynamic capabilities to domains and industries beyond high-tech industry (Easterby-Smith et al., 2009). This paper has answered this call by conceptually linking the synergies between two growing areas in SCM domain and strategic management. Both fields are emerging and share the same environmental dynamism in which they operate and how they can become a source of competitive advantage. This study proposes a set of five dynamic SCRES capabilities that support a firm's SCRES, which in turn influence operational performance and reduces the impact of disruption risks. The dynamic SCRES capabilities rely on managerial and organisational processes to anticipate, adapt, respond, recover and learn from disturbances and changing business environment. These capabilities enable firms to build sensing, adaptive, coordinating, reconfiguring and learning capabilities to alter their resource base. This study has theoretical, research and managerial implications.

The theoretical contribution of this study is that it brings two streams of literature together by highlighting their similarities and extending the application of dynamic capabilities theory beyond the realm of strategic management. It also addresses a current gap in SCRES studies, which lack appropriate theoretical lens to meet the dynamics of SCRES phenomenon. The research implications of this study lie in the classification of high-level SCRES capabilities as dynamic capabilities. While previous studies have addressed SCRES and dynamic capabilities theory together, these studies have mainly focused on supply chain functions such as supply resilience (Dabhilkar et al., 2016), or operational capabilities such as flexibility and agility (Lee and Rha, 2016) as dynamic capabilities. This paper has conceptually linked SCRES and dynamic capabilities as a higher-level capability as intended in strategic management by taking a holistic view of SCRES capabilities that cover the three phases of resilience: pre-disruptions, during disruptions and post-disruptions. Thus, lays the foundation for future studies to analyse these high-level dynamic capabilities in different applications and contexts. The managerial implications are that the five dynamic SCRES capabilities cover the various phases of resilience and thus provide a mechanism to cope with disruptions and changes from varied sources. Also, the conceptual framework presents a measurable model of a firm's dynamic SCRES capabilities, which can help managers to make sound decisions regarding resources and investments on resilience. By assessing each of these dynamic capabilities, managers get a measure of their firm SCRES, can evaluate their weaknesses and strengths, and the effectiveness of the managerial and organisational processes that support these capabilities.

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How to improve supply chain resilience through supply chain design and technology

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Introduction

In the last few decades, supply chain networks have been subjected to an increasing number of complex and unpredictable events. Apart from environmental issues and natural disasters that disrupt the day-to-day sourcing and delivery agenda, supply chain networks are now also subjected to fast-changing economic, political, and trading policies. In addition, the emergence of vast innovations in artificial intelligent and autonomous technologies, such as flying drones, self-driving trucks and smart warehousing, in the last few years have added even more disruptions to the supply chain. These technologies have opened new ways in how products can be produced, sourced, stored and delivered. Face with all these disruptions, some organisations handle better than others. A few manage to even turn these disruptions into opportunities, which help them to soar above their competitors. As quoted by PwC (2017), "90% of companies do not have visibility over their suppliers' plan and 75% experience at least one major supply chain disruption a year". Therefore, for any organisation to stay competitive or even survive, it will require a supply chain that is resilient to possible disruptions as mentioned above.

The concept of resilience applies to a variety of disciplines. Heckman *et al.*, (2015) has described resilience as the ability of the underlying system in order to adjust or maintain essential functions under stressful and harsh conditions. In terms of supply chain management, *Christopher et al.* (2004) has defined supply chain resilience as a supply chain's ability to return to its original or move to a new, more desirable state after being disturbed. As described by Christopher *et al.*, (2004), in order to improve or create a resilient supply chain, an organisation must employ four actions: 1) supply chain reengineering, 2) supply chain collaboration, 3) supply chain agility including visibility and velocity, and 4) supply chain risk culture creation. In the article, Christopher has highlighted the importance of supply chain knowledge and the transparency of supply chain strategy in creating a more resilient supply chain. The actions discussed above not only improve the strategy itself overtime, but also create a more collaborative environment for suppliers with better visibility and execution velocity. Without doubt, supply chain strategy is so crucial that it can determine an organisation's life and death when it faces challenges/disruptions.

In the book by Dittmann (2012), the author defines supply chain strategy as "a set of actions that creates the supply chain capabilities the firm will need in the future." In other words, supply chain strategy should not only focus on the current state but also consider the future state of the organisation. Supply chain strategy can be categorized into three; short term operational activities, moderate term tactical planning, and long term strategic plans. In an organisation, short term operational activities are probably the most frequently executed. Typically, these are plans that focus on specific assignments or objectives that need to be delivered on a daily or weekly time-frame, for example, production sequencing and vehicle routing. In moderate term tactical planning, its objective is to help organisations to utilize existing resources for specific functions, for example, production line utilization and prebuild inventory decision. These tactical plans are normally carried out once or twice in a year, in order to ensure that the utilization of existing resources meets expectation. Lastly, long term strategic plans aim to perform radical changes to the existing supply chain network so that an organisation can stay competitive in the market whilst being profitable. Since these kinds of strategies involve changes in supply chain functions (e.g. warehouse/supplier/factory selection and production facility determination), they are not executed every month or year, but maybe in a 3 to 5 years' time-frame.

The aforementioned strategies are not new to any organisation, but too often the decision makers in an organisation struggle to make sound decisions due to four reasons, namely: 1) bounded rationality, 2) a tendency to consider only external variables, 3) the stickiness and friction of information and knowledge, and 4) mental models (Chermack 2004). As a result, it is essential for any organisation to have a set of short, moderate and long term strategic plans, which are tailored with the flexibility to play with different "WHAT-IF" scenarios. Equipping with such capability makes the strategy more adaptable to any disruptions, providing different options for decision making. Moreover, these options must also cover important Key Performance Indicators (KPIs) of the organisation, such as cost to serve, expected profit/revenue and customer service level, which allow decision makers to easily compare between them and have a better alternative view to the future. Once these strategies are implemented, when disruption occurs, decisions makers can break out their own box, and play out different futures (Chermack 2002, Schwartz 1991, Van der Heijden 1997), this allows them to quickly and accurately understand the impacts on KPIs of different options. In addition, they will also be able to test future scenarios based on the decisions they made, and thus, having more insights about the future to better prepare for any future disruptions.

To realise all these benefits, it is vital for an organisation to invest in Supply Chain Design technologies. Not only do these technologies enhance the understanding of supply chain resilience, they also enable organisations to achieve economical savings. As reported from a survey conducted by University of Michigan (2015), organisations that have been using Supply Chain Design, manage to achieve between 6 and 12% in economic savings for different areas of their supply chain. This paper, therefore, focuses on how Supply Chain Design and technologies enable an organisation to unlock these potential benefits. In particular, emphasis has been placed on the moderate and long-term strategies, as they are the ones that cause the most impact to any supply chain network. In the next section, four pillars that set the foundation for improved supply chain resilience based on design and technology are discussed. Moreover, throughout the paper, practical examples are given based on data collected from Supply Chain Design software vendor, LLamasoft™.

Driving supply chain resilience through design and technology

PILLAR 1 – Integrated Technologies – "Better Supply Chain Design = Measurable Cost Savings"

To sustain a competitive advantage in the market, organisations seek to improve their supply chain resilience by reducing cost, improving service levels and mitigating any risk. To do this, an integrated Supply Chain Design technology along with data analytics platforms is a "must-have" capability for any organisation to keep up with the continuous changing environment. While the choice of technologies is important, the level of their integration is also key to drive a more sustainable supply chain. Together, these technologies offer a platform to work easily with a large amount of data, whilst reducing the risk of decision making based on one solution by considering multiple "what-if" scenarios. As a result, decision makers are provided with a full picture of all the options in consideration.

In Supply Chain Design, there are generally four main technologies: Network Optimisation, Inventory Optimisation, Transportation Optimisation and Simulation. Whilst each technology is good at answering a specific type of decision, the real added value comes when they are integrated and used simultaneously, Figure 1. This does not only mean additional savings in different functions of the supply chain, but more important, generating invaluable insights across the supply chain functions for better decision making. In a survey of 288 customers conducted by LLamasoft™ between 2015 and 2017, Figure 2, there was an obvious positive correlation between the average savings and the number of technologies adopted.

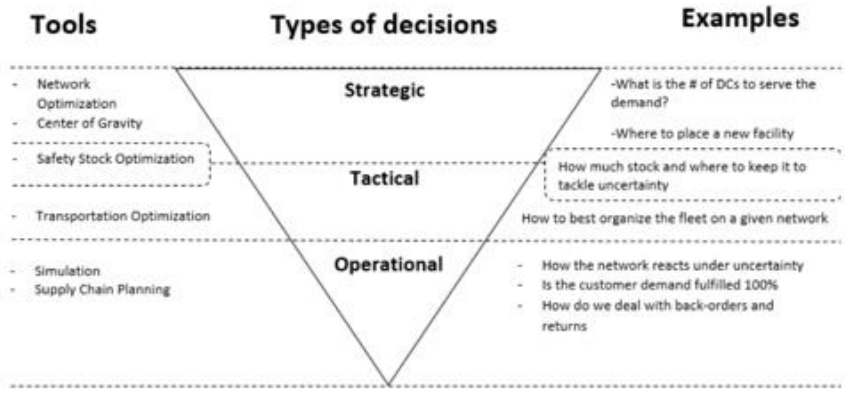


Figure 1: Examples of how Supply Chain Design tools can help in decision making



Figure 2: Average % savings with the number of technology being used

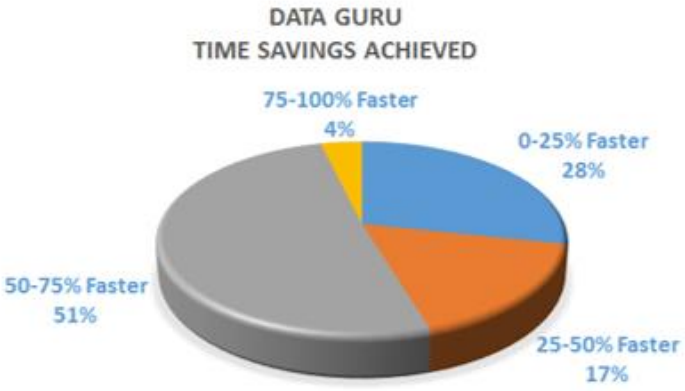


Figure 3: time saved by using DataGuru®

Aside from the Supply Chain Design tools mentioned above, Noha Tahomy (2017) from Gartner has highlighted in one of her latest reports that "analytics capabilities, where the user can independently conduct data discovery and visualization, have become increasingly vital for them to build flexible reports and dashboards based on business requirements". Moreover, in this data driven era, the ability to mine data in a repeatable manner to generate insights and continuously feed "new" data into the four building blocks to "innovate" the supply chain has become an essential ingredient needed in the improvement of supply chain resilience.

From the same customer survey conducted by LLamasoft™ between 2015 and 2017 on 288 customers (Figure 3), it is very clear as to how important the use and integration of Data Analytics tools is. The majority of Data Guru (LLamasoft™'s data analytics tool) users - 54% of them, indicated that data mining and manipulation process was reduced by at least half compared to the pre-implementation stage of the tool.

A recent report from the LLamasoft™ support help desk on the count of DataGuru® tickets, (Figure 4), it reveals that the number of tickets for the visual data analytical tool, have increased over 16-fold in less than 2 years. This significant change highlights the fact that organisations have realised the need for a data analytical tool to drive Supply Chain Design faster, more frequently and more accurately.

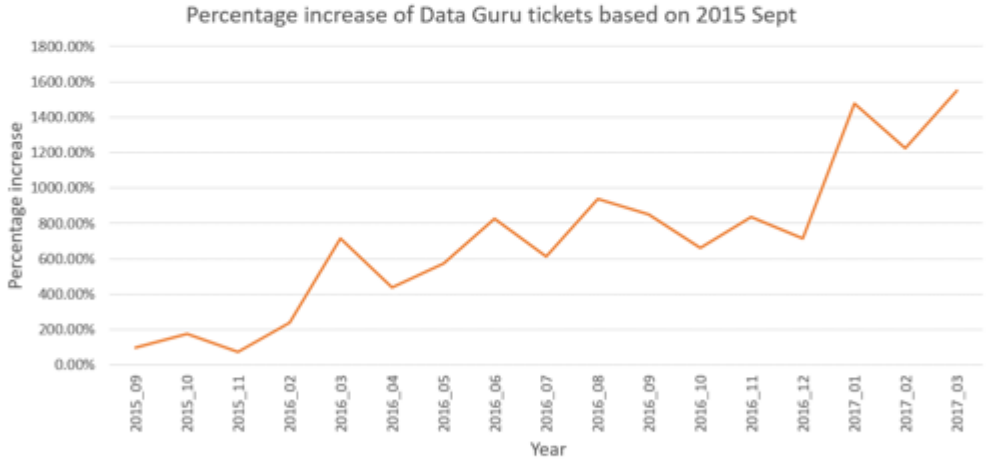


Figure 4. Percentage increase of tickets for data analytical tool between 2015 and 2017.

From the line graph (Figure 4), it is evident that there has been a rapid adoption of the DataGuru® product. It is therefore apparent that integration of data analytics tool alongside Supply Chain Design tools is becoming a norm for any organization that is seeking improvement in supply chain resilience.

PILLAR 2 – Talented Personnel: "CoEs are the way to go"

Integrating the right technology and tools is the first step towards improving supply chain resilience, but this does not guarantee success on its own. Too often, the people aspect has been forgotten or under-valued, which can potentially lead to failure of the initial investment. Considering the amount of capital that needs to be invested in technologies, making assumptions that savings will automatically occur just by implementing the tools without having the right level of talent is risky. Consequently, prior to any investment in technology, an organisation should measure the maturity of their human capital, as this can shape the way it designs its supply chain resilience.

This pillar focuses on the people who are using and implementing these Supply Chain Design tools. Companies must find the right talent, who will be "effective in problem solving and who will have analytical skills to implement the new tools and processes" (UOM 2015). Moreover, talented personnel who also have additional experience in the industry are going to be priceless assets for the organisation. Therefore, companies should seek the right mix of people - that have both analytical skills and a certain level of experience to ensure the successful integration of technology and business processes.

Searching for the perfect talent is always an expensive venture and most of the time, the right talent is unavailable. It is, therefore, important for any organisation to look out for candidates who have shown great potential in skills and knowledge. Companies should equip these new hires by investing in them through training, as well as providing them with the right level of on hands coaching. Generally, that the more an organisation invests in its people via coaching and training, the more mature they become, and the more savings they can potentially bring. As a practical example, if you look at the LLamasoft™ professional services team (the supply chain consulting division of the organisation), there has been a clear upward trend in the training and coaching services requested by its customers over the years. This increase is a result of two- trends: an increase in staffing in the customers' supply chain department, and a more advanced Supply Chain Design strategy – for example, a customer adopting other technologies such as Inventory Optimisation and Simulation in addition to the entry technology - network optimization. Recently, LLamasoft™ has also begun to see more customized training requests – highlighting the growth of our customers' interest in supply chain design.

After any formal coaching and training for any technologies mentioned here, product users should also have access to a world-class product support service so that any issues or problems they run into when using these tools can be addressed as fast as possible. As reported by the support team of LLamasoft™, the average response to a support request is 1.5 hrs, with a ticket resolution time of 1.5 days. Such a speedy service allows product users in organisation to focus on their project deliverables, as they have total confidence of getting backing from the technology provider.

Combining well-integrated technology, talented people and excellent support service, results in what has been referred to as a "Centre of Excellence" (CoE) (UOM 2015). Based on the research done at the University of Michigan in 2015, CoEs with people that have industry experience were over 25% more efficient with time and cost savings measures. In the same report, the authors also indicated that "over 70 percent of survey respondents said that having a CoE helped the business save at least 10 million dollars" (Figure 5). This is a tremendous amount of savings and as such, a CoE positions the business to become more resilient to disruption and more sustainable in a competitive market.

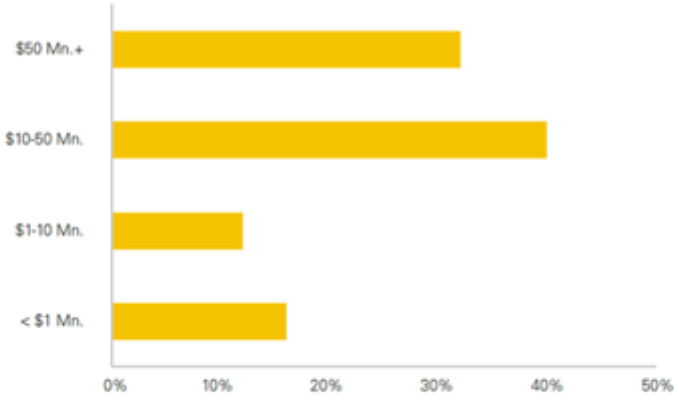


Figure 5. Total savings in US dollars after an organisation implemented a CoE.

PILLAR 3 – Community Engagement – "Be part of Supply Chain Design communities"

So far, the first two pillars have been focusing on the basic requirements for a better supply chain resilience. Pillar 3 is about external engagement and how the community outside of the organisation is going to be beneficial to the user as well as the organisation as a whole.

As we are living in a time filled with rapid changes and uncertainties, it can become risky or even dangerous if Supply Chain Design is practiced under closed-door without any intention to

communicate with a larger community. Being so reluctant to share practices and knowledge to the outside world can potentially lead to group silo thinking confined within the four walls. This is certainly something that each organisation must try to avoid as it can have a significantly undesirable impact on the decision-making process. Instead of keeping knowledge private and working in a silo, organisations must learn to share their knowledge, and keep their eyes and minds open for new trends and creative ideas for supply chain approaches and practices. Being extrovert leads to better knowledge learning, which, in turn, leads to business processes' improvement and potentially more innovations.

To realise the benefits above, organisations should seriously think about and encourage employees to be part of a community that shares the same value and passion of supply chain excellence. One example for such a community is the SummerCon, LLamasoft™'s major customer annual event, in which hundreds of supply chain practitioners and executives from different industries and sectors are gathered for networking and knowledge sharing. Being part of this community means that "Supply chain teams have more access to tools and insights into data than ever before, enabling them to cut through the clutter and drive a competitive edge".

As LLamasoft™ has reported, a large number of companies have already identified that the investment on engaging their supply chain organisation into a community does not only broaden their view, but also brings in unexpected benefits such as alternative modelling approaches and better design process. It has been reported by LLamasoft™ that the registration rate to SummerCon has been increasing for the past number of years. More specifically, the number of registered companies for 2017 has increased by almost 41% compared to that in 2015. This highlights the positive outcome from a supply chain community, Figure 6.



Figure 6, number of companies registered in LLamasoft™ SummerCon.

Considering that all those registered companies are multimillion, if not billion, dollar businesses, the positive trend in the participation in SummerCon indicates that organisations have already realised the benefits of engaging and sharing their insights to a broader community in Supply Chain Design.

PILLAR 4 – Supply Chain Collaboration – "Collaborate effectively through the cloud"

The speed of collaborating both internally and externally is one of the key area to gain advantage over competitors. To achieve this, apart from the basic building blocks of technology, people and community, the choice of technology that supports such a collaborative approach is also critical. Referring to the market, this kind of technology is termed as a SaaS (Software as a service)-based Supply Chain Design platform. SaaS is a cloud based application, it aims to connect Supply Chain Modelers, planners and stakeholders onto one platform, enabling Enterprise-Scale Analysis,

collaboration & knowledge management. With this approach, the level of information sharing and the user's connectivity are enhanced, speeding up the design process significantly. Most important of all, in the context of Supply Chain Design, SaaS-based solutions encourage the expansion of supply chain capabilities in an organisation, of which "planners can run their own what-if scenarios using existing models to accelerate consensus, decision-making and implementation of supply chain improvements" (LLamasoft™ Case Study 2017).

A SaaS-based Supply Chain Design platform is also catered with the ability to set different levels of authorization and access to a supply chain model. This provides organisations with the opportunity to find the best structure and processes' flow to fit and align with human resources effectively. This alignment can further enhance areas such as the overall decision-making process, better management control and greater time efficiency.

In the same survey conducted by LLamasoft™, 69% of the respondents indicated that SupplyChainGuru.com (a SaaS tool) has improved their work time efficiency by up to 25%, while 23% of respondents have achieved time savings of as high as 75%, Figure 7.



Figure 7: Time saved by using LLamasoft™ SaaS-based solution, SupplyChainGuru.com

Another practical example reported in a LLamasoft™ Case Study (2017), shows that a $3.5B semiconductor supplier has gained tremendous benefit after adopting the SaaS tool. The "production decisions that once took the organisation 2-3 weeks, now can be made in 1-3 days with more confidence than ever before. Faster-decision making combined with better coordination across the supply chain gives the organisation the flexibility and agility they need to continue to be a leader in their market".

Conclusion

To improve supply chain resilience, an organisation should invest into four areas. First, it should invest into a Supply Chain Design platform that has integrated all five technologies: network optimization, inventory optimization, transportation optimization, simulation and data analytics. If budget is a concern and/or only one technology is of interest, at least choose a platform that has the capability to expand to include all four technologies in the future. Secondly, organisations should invest in their people for proper training and coaching from the software vendor. These coaching and training services should not be a one-off request, but on-going if more advanced use of the tool is required. In addition, personnel should also be given the best support service from the technology provider. Thirdly, supply chain design practitioners should be encouraged to participate a larger community of Supply Chain Design. This includes conferences, webinars and other online communities. And lastly, organisations should not work as silos, they should reach out and

collaborate externally with planners and suppliers with the use of SaaS-based technology to help them work in a more collaborative manner.

To sum up, the four pillars are the foundation to improve supply chain resilience. Organisations must invest and get more mature in each of the pillars. By doing so, they will find themselves reacting to supply chain disruptions faster whilst making better decisions. While the payback for the investment may not be immediate, from a maturity survey of 20 customers, LLamasoft™ has reported, on a scale of 1 to 5 maturity, that the more mature an organisation is, the faster the payback period, and the more return of investment one can expect.

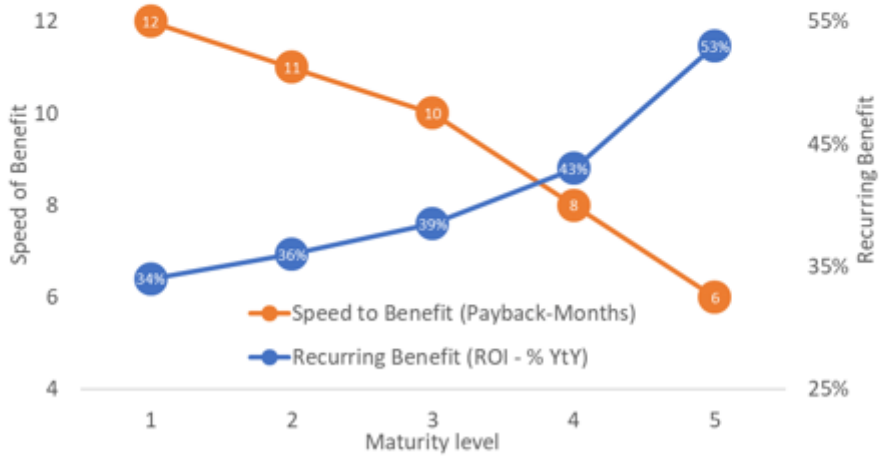


Figure 8: Benefit for getting more mature in Supply Chain Design

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Supply Chain Risk Modelling

Risk assessment and analysis of healthcare system using probability-impact matrix

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1. Introduction

Currently, in most countries, the major challenge within the health sector is to achieve a high quality healthcare service with limited available capacities (HIROC, 2014). Although healthcare expenditure has steadily increased over recent years, healthcare services are mostly characterised by bad quality aspects (Dumbravă and Iacob, 2013). This is often related to the enormous risk impact on performance. Therefore, these organisations are keen to identify and analyse a set of risks that can have the potential to disrupt their operations and consequently put patient safety at high-level of concern. In this context, some research efforts have focused on measuring patient experience with the quality of care given by the hospital. Beattie et al. (2015) presented a systematic review to measure the patient experience of hospital quality. They accounted for 11 different international measures for this care. However, they ignored measuring patient satisfaction which was not dismissed in the research of Roy et al. (2005) who considered determination a prevalence characteristic and physician awareness of test results which were received after discharge of the patient from the hospital. This is considered as one of the most vital points of the patient safety problem. Recent research presented by Safaeipour and Amer (2017) introduced a conceptual model that can be used as a systematic and integrated method for weighing the related measures of patient satisfaction. Additionally, the proposed method is used as an evaluation tool when considering the competence of the hospital as well as a performance ranking tool based on some key indicators. Patient complaints have opened dedicated research on satisfaction levels and this is now considered to be one of the most important aspects of the healthcare sector. Clearly, receiving complaints is considered to be a high alert for increased risk management episodes and consequently deserves early corrective action (Cydulka. et al., 2011). To date, no previous research has specifically focused on these risk types when relating to quality of service. This paper aims to present a tool for assessment and analysis of these risks within the healthcare system and the probability-impact matrix is the proposed tool used to prioritise and develop an effective strategy to address these risk effects.

The remainder of this paper is structured as follows: Section 2 gives a description of the research method and findings of the survey questionnaires. Section 3 presents the development of a healthcare risk matrix. Section 4 discusses the outcomes of the risk-matrix and finally, in Section 5, the conclusions of the paper are presented.

2. Methods

2.1 Risks and survey instrument

Risk mangers work proactively and reactively to address risks using various practices. However, managers should conduct effective and innovative risk assessment and analysis strategies. Healthcare organisation services present different risks when related to staff and patients and are required involve both parties when disciplinary action is necessary to tackle a problem. Within this context and based on the proposal of Donabedian (1988), this project considers two main types of risk; i) Risk to the patient, and ii) Risk to the organisation and staff and involves certain items which were used to measure these risks.
The empirical part of the research work starts with reporting the results of a questionnaire survey, which was conducted to identify whole risk factors related to the operation within a healthcare organisation. The constructed matrix resulted from a combination of probability where severity was used for estimating the likely risks. The considered case study in this research relates to the Australian hospital system.

2.2 Data collection and quality service measures

To address the research aims, questionnaires were used to consider patient satisfaction at three hospitals in South Australia. This included two stages of data collection using qualitative and quantitative questionnaires: i) a questionnaire for collecting patient data, and ii) a questionnaire to gather the response from patients about their satisfaction regarding the hospital service.

2.2.1 Questionnaire 1: the study population and the sample

The study population consisted of 70 random patients across three Australian hospitals emergency and outpatient departments. Received valid responses were 50. Details about patient gender, age, qualification and recent time visits are presented in charts as presented in Figure 1.

2.2.2 Questionnaire 2: part 1- quality service

The second questionnaire was qualitative and asked patients to give their impression on hospital service. Although the healthcare industry's approach is to put patient care at the center of its concerns, it presents various problems that are considered global and multidisciplinary in nature. Since the aim is to improve patient satisfaction and shopping for healthcare has become like shopping for cars, tourism or other services by searching the worldwide network, the healthcare provider must look to new ways and methods when engaging with prospective patients. Quality service metrics, patient reviews and price comparisons are the issues that impact the selection of a healthcare organization. Quality service metrics are used in this project to assess the healthcare delivery and fall within the patient experience. However, using multiple measures is important, as no single measure can give a whole or complete view of provided and received quality of care. These measures include waiting time to see a doctor within 15 minutes of the appointment time, recommendation of the hospital to a friend or family member and the overall satisfaction of received services from the hospital. The graphical representation of patient assessment to the quality of service at the hospitals with respect to the mentioned measures is presented in Figure 2.

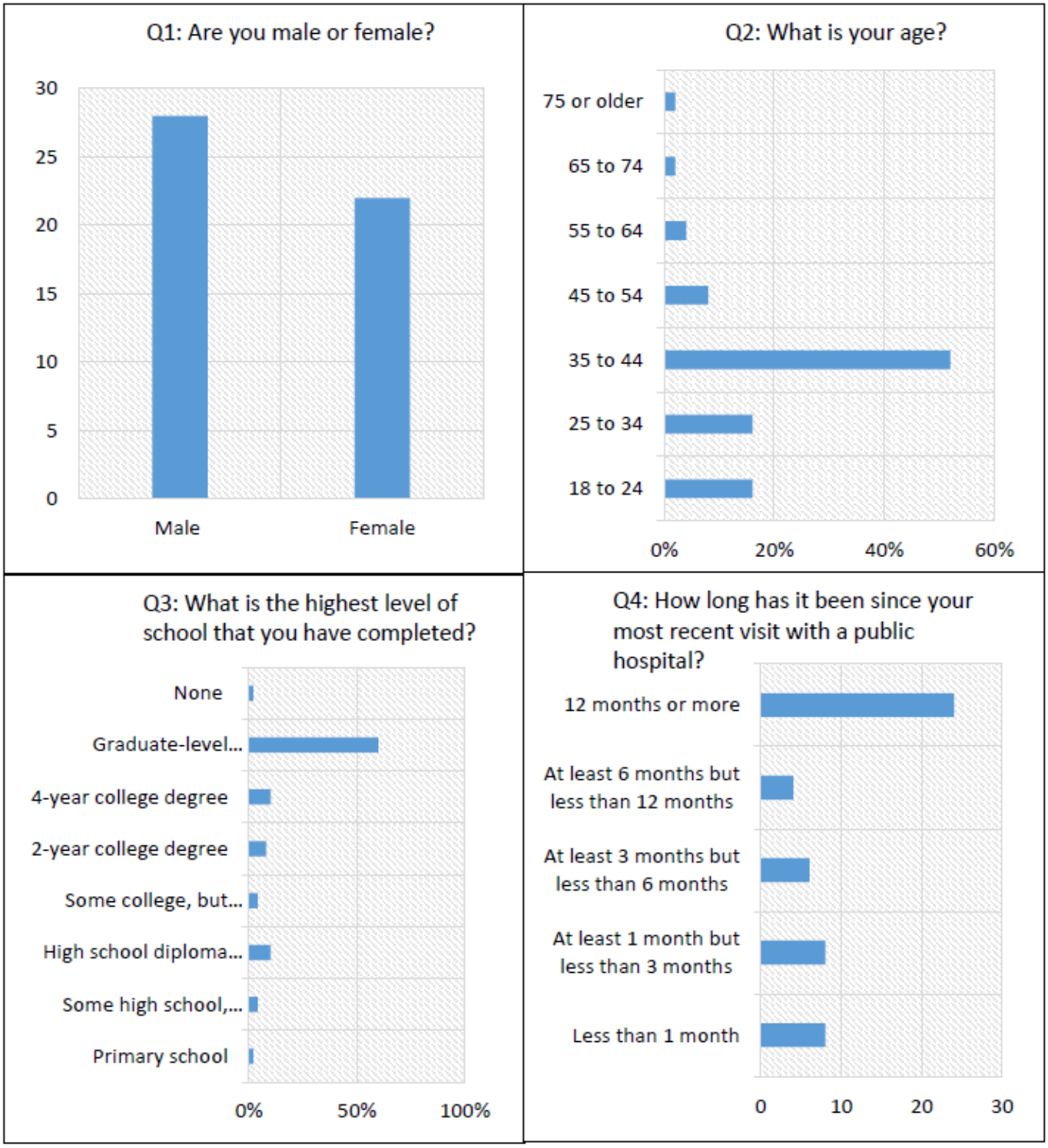


Figure 1: Questionnaire considered questions and patient responses

2.2.3 Questionnaire 2: part 2 - risk comparison

To determine which of the aforementioned risk factors and their ranking are most important, typically requires comparing the risks in respect of their importance to the individual patient. The patient chooses their response on a scale which compares the types of risks given in pairs and judges which one of each risk is important. Consider these risk comparisons, now ranked in a list and presented as a pair-wise comparison matrix in Table 1. Obviously, PR1 is the most important risk in this situation.

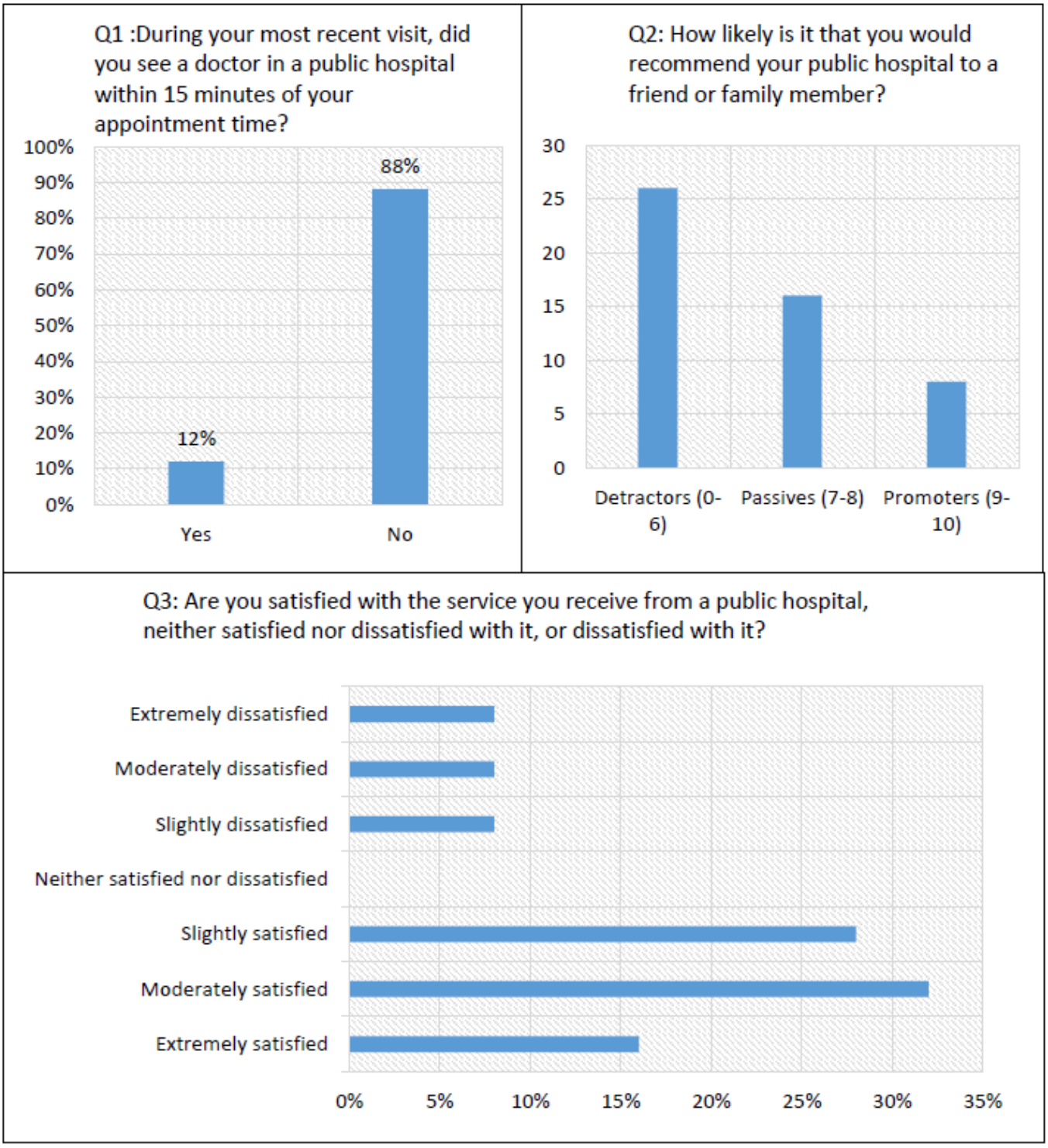


Figure 2: Graphical representation of the patient's assessments to the quality service at the three public Australian hospitals

3. Development of a healthcare risk matrix

Based on the conducted questionnaire using a sample of patients at three Australian hospitals and the outcome risk ranking presented in Table 1, the probability of occurrence and impact of each risk type is presented in Table 2. The rating given for human impact should be considered when the hazard has/is:

1. Unlikely to cause injury, illness or death to staff or patients.
2. Low probability of injury, illness or death to staff or patients.
3. Medium probability of injury, illness or death to staff or patients.
4. High probability of injury or illness to staff or patients with low probability of death.
5. High probability of death to staff or patients.

	PR1	PR2	OSR1	OSR2	OSR3	Total Scores	Ranking
PR1		5.40	5.68	4.25	4.83	20.16	1
PR2			3.82	3.45	4.18	11.45	2
OSR1				3.65	3.83	7.49	3
OSR2						4.92	4
OSR3						0.00	5

Table 1: Pair-wise matrix of risks based on the comparison

	Code	Risk factor	Probability	Impact
Risk to the patient	PR1	Waiting Time for Emergency Department Care	5	5
	PR2	Waiting Time for Elective Surgery	4	4
Risk to the organisation and staff involved	OSR1	Cost per NWAW	3	3
	OSR2	Staphylococcus Aureus Bacteraemia in Public Hospitals	2	2
	OSR3	Accreditation of Hospitals and Beds	1	1

Table 2: The constructed risk matrix

Table 3 is a conclusion of averages in probability terms and impact amongst the two stages of classified healthcare risks.

Risk Type	Probability	Impact
The Patient	4.5	4.5
The Organisation and Staff Involved	2	2

Table 3: Probability and impact averages in the undertaken Australian hospitals

To formulate the risk consequences, a formula presented by Dani (2009) and other researchers is used for this purpose:

$$C_i + P_i x I_i$$

Where P_i represents the probability of the risk occurrence and I_i is the expected impact. Figure 3 shows the results of combing risk impact rating and risk probability.

Probability	Score	Impact				
		Negligible	Minor	Moderate	Major	Extreme
		1	2	3	4	5
Rare	1	1	2	3	4	5
Unlikely	2	2	4	6	8	10
Possible	3	3	6	9	12	15
Likely	4	4	8	12	16	20
Almost certain	5	5	10	15	20	25

High Moderate Low

Figure 3: Risk rates at the sampled Australian hospitals

This risk matrix presents the identification of healthcare risks at the three Australian hospitals, where the questionnaires conducted. It starts with the probability increasing from the top to down, and for the impact, it moves toward the left corner (grey zone) and the greater is the HCRF consequence (Figure 4).

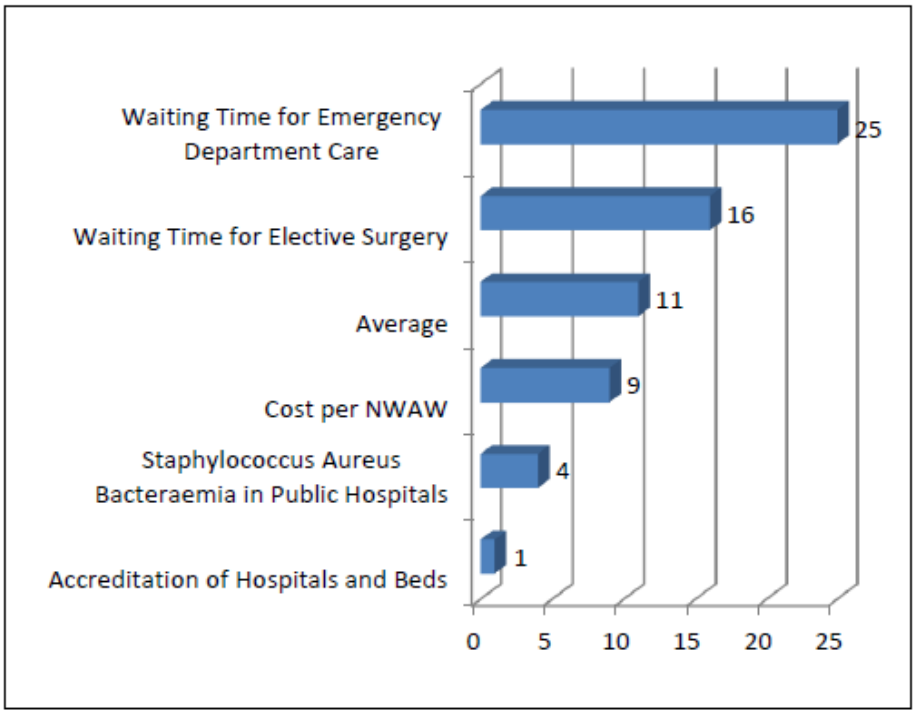


Figure 4: HCRFs by level of consequence

As Figure 4 shows, there are significant differences between HCRFs, waiting time for emergency department care (PR1) is considered the biggest risk factor and waiting time for elective surgery (PR2) is the most likely risk factor. Whilst cost per NWAW (OSR1), staphylococcus aureus bacteraemia in public hospitals (OSR2), accreditation of hospitals and beds (OSR3) are seen as having the least probability and impact risk. Clearly, these results are matched with our previous analyses of HCRF probability – impact matrix. A discussion will be conducted to address these remarks in the forthcoming section.

4. Discussion

As previously stated, it is a very difficult paradigm to measure quantitatively the quality of healthcare delivery. Moreover, it was thought that to measure it was an impossible task. Based on the proposal of Donabedian (1988), the three available types of measurement for quality of healthcare delivery are qualitative measures and include a namely structure of the healthcare organization, caring process and outcome of the patient. However, the quality measures based on organization structure and process are doubly not be able to reflect the patient satisfaction which consider as an meaningful and essential tool to address limitations and also to develop an efficient action plan to improve quality of healthcare organization(Brook et al., 2000). In this research, because of its ability to appropriately address quality of healthcare delivery, different risk factors may influence quality of healthcare are evaluated. The proposed matrix identified all the risks and opportunities that may affect operational performance of the healthcare organisation. Higher probability and severity have high numerical values cause high-risk index. Thus, a high detection levels should be scaled in terms of reducing the risk index and consequently highlights the need to implement a mitigation procedure.

The results indicate that despite an adequate delivery of healthcare, high risk situations can still occur at these selected Australian hospitals. Undoubtedly, these risks can have potentially harmful effects on patients. Actually, the amount of time which the patient spends in waiting is an important index for assessing patient satisfaction and consequently the quality of healthcare delivery. Here, in this research, waiting time for both; emergency department care and elective surgery are seen as high-risk factors affecting the utilisation of healthcare services as well as causing patient stress. This barrier can be overcome when obtaining the required care and resolved by increasing the number of the healthcare providers' staff. The healthcare risks matrix reveals that the risk of waiting times for emergency department care and for elective surgery causes the maximum fear. Whilst the risk related to cost per national weighted activity unit (NWAU) is considered a medium risk.

Risk factors refer to infection from staphylococcus aureus bacteraemia, and accreditation of hospitals and beds may result in significant illnesses and can necessitate additional diagnostic and therapeutic interventions and consequently generate added costs and are found within the lowest of important risks, based on the questionnaires conducted in this research. This is attributed to the low death rate of hospitalised patients at Australian hospitals.

5. Conclusion

Nowadays, there is no doubt that the healthcare delivery process is considered as one of the key factor when measuring the quality of life. Rather, it is considered as the "weakest link" in the index of hospital quality. There is not a single measure that can define and analyse the overall different risk factors related to healthcare quality and delivery that can exist in hospitals. Therefore, defining and analysing several risk factors are advised in order to avoid or to manage potentially risky situations. The common method to this end is completely subjective and based on physician or patient questionnaires. The aim of the empirical investigation into HCRF's presented in this research was to contribute to the explosive growth of research now focused on quality performance of healthcare organisations. It prioritises several risk factors associated with patient care and the organisation and staff involved. Based on two parts of the questionnaire the risk matrix was developed to analyse selected risk factors. The probability-impact risk matrix which was used to calculate and determine the consequence in the case of an event was considered to be a risk. The matrix was pursued and highlighted for the ease of position on a certain level of risk considered. The main conclusion which can be drawn from this research is that the population of South Australia might enjoy all the benefits of affluence and a modern healthcare system but they also run a significant risk as patients.

This presented research can be valuable for managers as well as researchers that are engaged in the investigation of healthcare system risk and analysis tools. In addition, this paper pointed out critical risk factors that should be kept in mind, within the healthcare industry. The proposed risk assessment tool is intended as a guide to assist in priority settings within the establishment of a comprehensive emergency plan. Finally, a remark has to be made on the objectivity of responses given by the respondents. Therefore, a larger sample could be interesting to lessen the subjective perception effect of values assigned to risk dimensions on the analysis output of the research.

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The role of supply chain guru in modelling of sourcing strategies for sub-tier risk management

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1. Introduction

Supply Chain Risk Management (SCRM) is the joint approach of the business entities constituting a supply chain to identify, evaluate and mitigate any internal or external events that might disrupt any part of the supply chain (Ho et al. 2015). Therefore, identifying risks coming from the entire supply chain ecosystem (parts of the supply chain, third-party logistics and other entities such as governments or NGOs etc, Viswanadham and Samvedi, 2013) is given importance and different cathgorisations of risk can be found in in literature. Samvedi, Jain, and Chan (2013) categorised the risks into supply (arising from downstream sides), demand (arising from forecasting errors or external factors), process (arising from the product flow), and environmental (external risks). Although different authors propose different risks categories such as C. Tang (2006) - operational and disruption, Tang and Musa (2011) - material, financial, and information flow, or Chopra and Sodhi (2004a) - disruptions, delays, failure, inaccurate forecast etc., they would agree on the fact that risk is something the supply chain structure should account for. In other words, the supply chain design in respect to risk management come to be vital and despite the battled to death cost efficiency, new topics such as improvement of resilience and robustness or reduction of vulnerability is becoming curtail. The balance of 'reduced cost' versus 'reduced risk' remains down to the art of management excellence (Chopra and Sodhi 2004a). The paper is presenting the ways of achieving such balance by examining multiply scenarios of a sub-tier risk management. An analytical tool of supply cost optimisation software, the Supply Chain Guru (SCG), is used to evaluate the impact of disruptions coming from different levels of sub-tier suppliers focuses on supply chain performance.

1.2 Preliminary Concepts

Supply chain vulnerability, negatively correlated with supply chain performance, can be defined as the susceptibility of the supply chain against disruptions affecting its operations (Wagner and Neshat 2012). Vulnerability assessment includes the identification of potential disruptions (random events or even intentional disruptions), their likelihood, and their potential negative consequences on supply chain operations and performance (Sheffi and Rice Jr. 2005). Supply chain resilience, on the other hand, is the capability to recover form that disruptive events which can be increased by anticipation, confrontation and mitigation of the potential event (Ponis and Koronis 2012). Therefore, building a resilient enterprise should be an integral part of the company's culture and a strategic approach spread across the business entities and the stakeholders of the supply chain (Sheffi and Rice Jr. 2005).

Due to supply chain visibility the managers take decisions that would result in positive long-lasting performance effects (Talluri et al. 2013). Such decisions that a firm is taking to prepare for a potential disruption in its supply chain are called mitigation strategies and are aimed to increase supply chain robustness and resistance to uncertainties and hazard event. While most of the relevant literature focuses on a mitigation strategies based on single location (Goh, Lim, and Meng 2007) or a single product (Melo, Nickel, and Saldanha-da-Gama 2009) models, this analysis is based on multiple locations and multiply products and with product components (bills of materials) addressing the gap.

1.2 Sub-tier Risk Management

Sub-tier risk management is a sub-category of supply risk management. Sub-tier risks emanate from business entities that do not belong to the firm and are not necessary directly linked to it. These risks are particularly difficult to cope with due to limited information flow between the sub-tier (second-level or above), direct suppliers and the firm itself. Limited visibility can cause not only a risk of disruptions but also a poor alignment between the supply-side operations and/or the firm's policies. In particular, lack of visibility and collaboration between the firm and its suppliers prevent supply chains from both, recovering quickly from potential disruptions (resilience) and coping with shortages in components and products (robustness) (C. Tang 2006). Although the literature has extensively focused on sourcing strategies related to the firm itself or its immediate suppliers, yet still a handful work devoted to risk management strategies refers to the second-level and above sub-tier suppliers for, and that for a single period models only.

An example of those few multi sub-tier setting can by a single-period analytical model of Ang, Iancu, and Swinney (2014). It address the matter of optimal sourcing with a network consisting of a single manufacturer and two tiers of suppliers. The tier 2 of supplier's overlap as well as emergency supplier's scenarios are examined. Those concepts were also given an importance in this paper and the results of such strategies are examined.

1.3 Gap identification

The research examines the impact of sub-tier risks on supply chain performance and introduces a framework to validate the sourcing strategies increasing the supply chain's robustness against sub-tier supply uncertainty. The risk mitigations for the second-level and above sub-tier suppliers for the multi-period models are evaluated.

The objective of this research is not to entirely eliminate risks from the supply chain and lead to a risk optimal model, but rather to lead to a cost-optimal supply chain configuration by simultaneously taking into consideration multiple risks and potential disruptions. The software used for model building and risk-cost balancing is Supply Chain Guru, a supply chain simulation and optimisation software, which is a leading supply chain design and analysis software on a global scale (Supply Chain 24/7 2016). It enables the global leaders of different industries to model and optimise their supply chain network for strategical and tactical decision making. Although widely used by practitioners, yet still a handful number of academic researchers have employed the SCG software. Therefore, one of the objective of this work, is to bridge the gap between industry and academia as well as bring the best industrial practice into the university circles. On the other hand, the SCG Software has not been broadly explore in the risk management field just yet. Consequently, this work, could open a new perspective to practitioners of such application of SCG. Problem formulation

2. Problem Formulation

The research is conducted based on realistic supply chain network data and structure. The comparison between the studied sourcing strategies is based on the variance in costs and time to serve. The service hours refer only to transportation time of the products and they are not related to the production time or the time required for preparation, queuing, processing, receiving and inspection of goods. These times were not included in the model because they wouldn't contribute to answering the research question more accurately. The excellence of modeling is the ability to adjust the model accuracy to model purposes. Decreasing the lead times and therefore time to serve, is a measurement of the supply chain robustness in this searcher. The cost evaluation enables to see the additional cost of each change improving the network robustness. Therefore solution can recommended based on cost-risk trade-offs.

The analysis is based on a multi-echelon supply chain model consisting of three levels of sub-tier suppliers and operating under a 12-month multi-period horizon. As illustrated on Figure 1 the modelled supply chain consists of three sub-tier suppliers which deliver to manufacturers and then distribution centers. The customers are allowed to receive products from all distribution centers, so the sourcing is dynamic across the entire supply chain. Different scenarios are developed to illustrate the various sourcing options (single_, double-, and triple-sourcing) of suppliers and manufacturing centers and, in some cases, supplier disruptions affecting the flow of products, modeled by exclusion of one of the suppliers in one of periods.

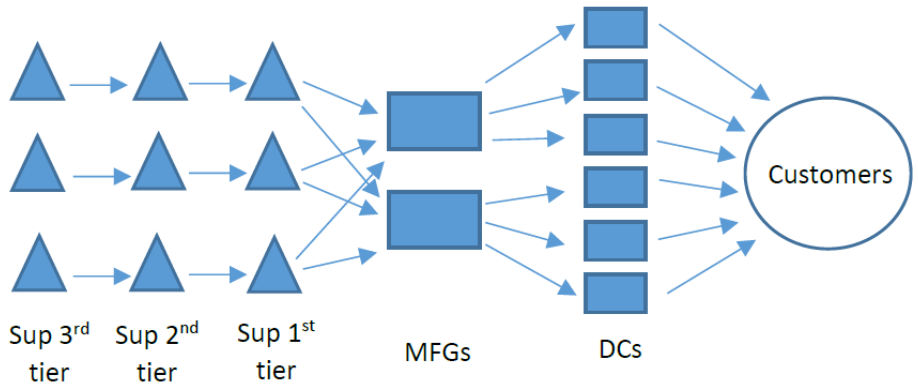


Figure 1: Network Structure

The addition of backup suppliers examines how the emergency supply improves the resilience of the supply chain. An initial (As-Is) scenario represents the current structure and policies of the end-to-end supply and is used as a comparison basis against the other scenarios developed.

3. Research work

The model consists of nine (9) main suppliers split into three (3) sub-tiers, two (2) manufacturing centers, six (6) distribution centers with different finite capacities, and seventy-three (73) customers based in various European cities. The four final products ordered by customers are manufactured in the company's two manufacturing centers and each product uses two to four out of six different components. These components are being delivered to the manufacturing centers from the suppliers belonging to the first tier only and they are produced by suppliers belonging to the third tier. Also, three (3) emergency suppliers, which manufacture the six product components, are built in the model, which are included or excluded depending on the considered scenario. The appropriate costs are assigned to products and components. Each facility has its defined capacity. There are no safety stocks allowed during the optimisation of scenarios in order to make the supply chain more vulnerable to supply disruptions and observe a bigger impact of the different sourcing policies. The additional costs such as fixed operating, distance-quantity based transportation cost and inventory carrying costs are modelled. The emergency sourcing cost is doubled comparing to standard sourcing cost. Three different transportation assets are modelled to introduce different motion speeds. Each mode is used with the certain probability split which introduce variation to lead times in the model.

Scenario 1 is represents an As-Is scenario, where no interruption occurs and no emergency supplier is involved. There is always a prior assigned single sourcing allowed between different tiers, as the arrows illustrate on Figure 1. Scenario 2 is based on As-Is scenario, but it differs by adding an emergency suppliers. If model is built correctly Scenario 2 should generate the same results as scenario 1 as no emergency supplier should be used when no disturbance occurs. The only purpose of this scenario is to verify the correctness of the model built. Scenario 3 - Scenario 5 are based on original set-up of As-Is scenario with emergency suppliers and disruption occurring in Tier 1 in each of the supplier (one scenario for each Tier 1 supplier disruption respectively).

Scenarios 6 - Scenario 10 take out the inter-tier fixed single sourcing constraints and enable to see what happens when there is a free flow of products allowed. In reality when dedicated relation with just one supplier exists, it usually means more favorable lot-size pricing. Therefore, enabling the free flows, it is introduced an additional sourcing cost, a cost penalty (+30% in scenario 7, and +50% in scenario 8). Scenarios 9 and 10 are built on Scenarios 7 and 8 respectively with disturbance occurring in one of the suppliers.

Scenarios 11 -24 examine double sourcing in different set-ups and configurations. The additional constraint of minimum order quantity is introduced, to avoid the situation of model forcing an artificial flow of just one unit to satisfy the constraints. Those scenarios are considered to have higher sourcing costs, since the company wouldn't have exclusive suppliers and wouldn't be able to benefit to the same degree from economies of scale. Therefore the sourcing penalty of 20% of sourcing costs is added for those scenarios. Scenario 11 and Scenario 12 are based on double-sourcing for manufacturers (MFGs) only and +20% sourcing costs increase and disruption of one of the suppliers (different ones for each of those scenarios). Scenario 13 is Double-sourcing for MFGs and tier 1 suppliers and +20% sourcing costs increase, and Scenario 14 adds the disturbance in one of the suppliers on top of Scenario 13 set-up. Scenario 15 - Scenario 24 can be described respectively: double-sourcing for all suppliers and MFGs; double-sourcing for all suppliers and MFGs and +10% sourcing costs; double-sourcing for all suppliers and MFGs and +20% sourcing costs; double-sourcing for all suppliers and MFGs, +20% sourcing costs and disruption Tier1_Supplier1; double-sourcing for all suppliers and MFGs, +20% sourcing costs and disruption Tier1_ Supplier2; double-sourcing for all suppliers and MFGs, +20% sourcing costs and disruption Tier1_ Supplier3; double-sourcing for all suppliers and MFGs, +20% sourcing costs and disruption Tier2_ Supplier1; double-sourcing for all suppliers and MFGs, +20% sourcing costs and disruption Tier2_ Supplier2, double-sourcing for all suppliers and MFGs, +20% sourcing costs and disruption Tier2_ Supplier3, double-sourcing for all suppliers and MFGs, +20% +sourcing costs and disruption Tier3_ Supplier1. In all of the cases the two sources are choose by the model.

The flowing scenarios, Scenario 25 - Scenario 28 use the pre-defined double sourcing (specific suppliers only), with additional 20% sourcing cost increase in Scenario 25 and interruption for one of the suppliers of each Tier for scenarios Scenario 26 - Scenario 28. Scenario 29 is a triple sourcing, Scenario 30 Triple sourcing and + 30% sourcing penalty, and Scenario 31 and Scenario32 are based on Scenario 30 with disturbances happening in tier 1 and tier 2 respectively.

4. Results Analysis

Figure 2 presents the total service hours per scenario as well as the percentage change of total service hours compared to the initial supply chain configuration (Scenario 1). Figure 3 shows the respective total costs for each of the scenarios.

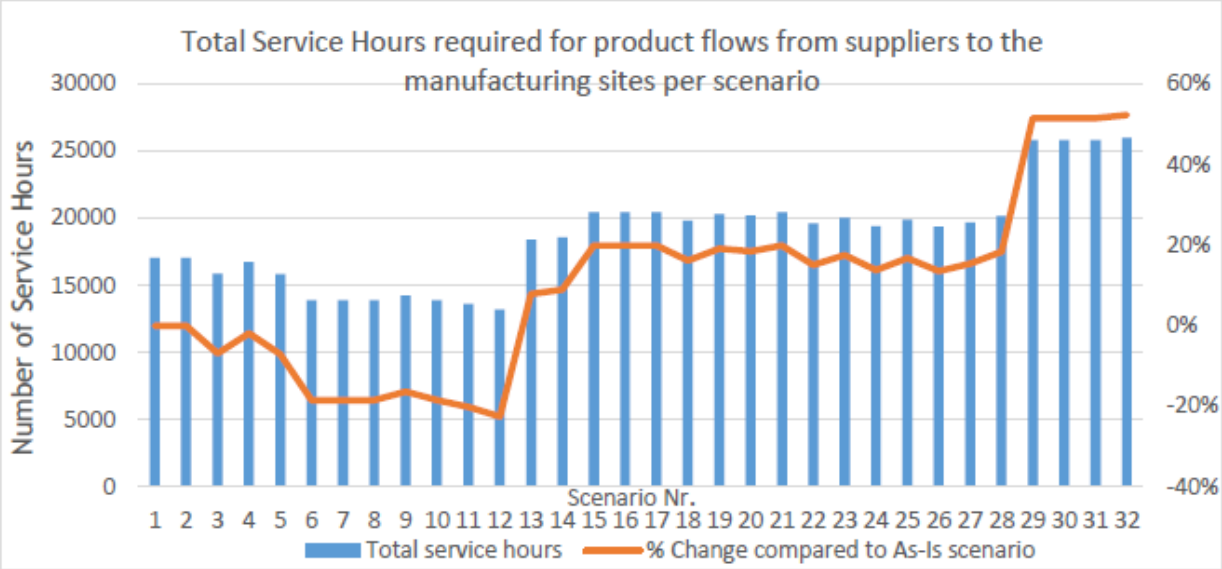


Figure 2: Service Hours

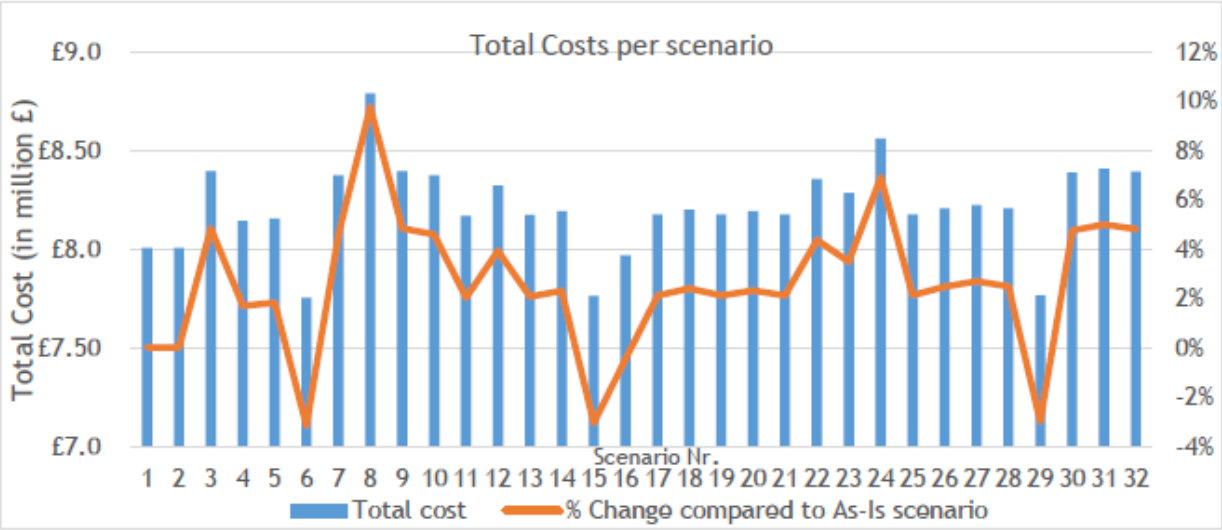


Figure 3: Total Cost

Scenario 1 represents As-Is scenario, where no interruption occurs and no emergency supplier is included in the model. All further scenarios are discusses against Scenario 1 in respect to service hours and cost difference. The emergency suppliers, although closer to the manufacturer then regular tier 1 supplier, are no expected to be use by the model unless necessary, due to higher cost.

Looking at the service hours as well as total costs of Scenario 2 in reference to As-Is scenario (Scenario 1) it can be observed that enabling emergency suppliers does not change service time (neither the cost). This shows that the model is set-up in a way that even if the emergency suppliers are enabled and their utilisation would reduce service hours, the model is not choosing to use them due to higher cost. This guarantee the cost-risk balance of the model. It can be seen that the emergency suppliers are used for the scenarios 3-5 when the disruption in one of the tier 1 suppliers occurs. Although is resulted in noticeable spike in costs (Figure 3), the model is choosing to use emergency suppliers due to lack of other possibility to satisfy the demand. The particular cost of Scenario 3 – Scenario 5 is dictated by the costing strategy of

each individual emergency supplier. This slightly reduces service time, where the emergency supplier are located closer to manufacturers (Scenario 3 and Scenario 5 – Figure 2)

The following scenario, Scenario 6, generates lower costs, as a reflection of unrestricted product flows between tiers. In this scenario no increase of sourcing costs is considered. This intermediate scenario, although not realistic (the sourcing cost should not be based on the same single sourcing lot size pricing), it enables to verify that the model acts according to expectations – unconstraint model chooses the cheapest and one of the quickest manner to satisfy the demand, which results in overall cost reduction (see Figure 3). As soon as the additional cost is added in Scenario 7 (+30% sourcing cost increase) and Scenario 8 (+50% sourcing cost increase), the spike in cost can be observe, although the service level stays unaffected due to choice of the same sourcing paths as in Scenario 6.

For Scenario 9 (original sourcing costs) and Scenario 10 (+30% sourcing cost increase), where the free inter-tier movement is allowed and the disruption occurs, it can be seen that the model can handle the sourcing without using the emergency suppliers. In case of disruption in tier 1 (Scenario 9), the costs and service time slightly increased due to less cost-optimal strategy chosen by the model, however in case of tier 2 disturbance (Scenario 10), the models choses the strategy which is equally cost and time efficient as in Scenario 7. Therefore, for a considered set-up (multi-sourcing), the network is robust enough to completely absorb the effect of tier 2 supplier interruption.

Scenario 11 and Scenario 12 where the double sourcing (for manufacturers only) is allowed and conditioned to minimal sourcing quantity, with +20% sourcing cost penalty result in cost changes reflecting the penalty reduction (form 30% to 20% of additional sourcing cost) and distribution costs associated with emergency supplier. In this case, the emergency supplier utulisation still turns out to be cost-efficient in respect to reduced service hours. Similar trend (however less drastic) can be observed for the respective scenarios of double sourcing allowed to manufacturer joined with tier 1 supplier (Scenario 13 and Scenario 14).

Moving towards scenarios with double sourcing of all tier suppliers (Scenario 15 - Scenario 24), there can be seen a clear raising trend in costs structure for Scenario 16 - Scenario 17, with additional 10% and 20% sourcing cost penalty respectively. Scenario 15, however, has similarly low cost to scenario 6 of unconstricts flows. It is the case due to the large flexibility of the model as well lack of the sourcing cost penalty (unrealistic case). The service hours remain unchanged for Scenario 15 – Scenario 17 thought, as apparently the addition cost of +10% and +20% in Scenario 16 and Scenario 17 respectively, does not affect the choice of sourcing strategy. For the Scenario 18 - Scenario 24, the slight fluctuations in service hours can be observed, coming from employment of emergency suppliers replacing different tier suppliers as well as how far the emergency supplier was located form the manufacturer. The further down in supply chain, the higher costs the destruction causes to the network for double sourcing network. Similar observations can be made for the Scenario 25 - Scenario 28, which use the pre-defined double sourcing (specific suppliers only), with additional 20% sourcing cost increase in Scenario 25 and additional interruption for one of the suppliers of each tier for Scenario 26 - Scenario 28. The service time depend on the closeness of the emergency supplier to the MFGs, and it stays in more or less similar lever for all four scenarios. The cost, on the other hand, does not even increase much from Scenario 25, where no emergency supplier intervention is needed. It means that the pre-fixed set up was already little cost efficient on its own.

Scenario 29 is a triple sourcing, Scenario 30 Triple sourcing + 30% sourcing cost increase, and Scenario 31 and 32 are based on Scenario 30 with disturbances happening in tier 1 and tier 2 respectively. They don't differ much from the unconstraint flow as a concept. For the same penalty cost then, it should be expected to get to similar costs as for unconstraint sourcing, and the sourcing time for the interrupted scenarios should be also as it was for unconstraint sourcing. It is indeed the case.

5. Results Discussion

The results indicate that majority of supplier disruption has a negative impact on the costs of the supply chain performance. The impact on lead-times depends on the potential sourcing from emergency suppliers as well as the distances between the business entities of the adjusted supply chain network. In the majority of the sourcing policies tested under individual supplier disruptions, tier 2 suppliers seem to be more critical than tier 1 suppliers for the continuity of supply chain operations without resorting to sourcing from emergency suppliers.

Comparing the different policies tested, single-sourcing is the most cost-efficient method when no supplier disruption occurs. Nevertheless, the costs and the implications on the supply chain performance in case of any supplier disruption are particularly harmful. On the contrary, triple-sourcing is a very resilient strategy against supply risks, but it is immensely expensive for the firm to incur its costs on a permanent basis.

Double-sourcing strategies result in slightly increased sourcing costs and longer service hours when no supplier disruptions occur but compensate with major improvements in sub-tier supply risk resilience and mitigation. The suppliers are significantly less critical compared to single-sourcing policy, so the supply chain vulnerability against a total product flow breakdown and the additional costs incurred in case of a supply disruption are significantly decreased. In addition, the supply chain performance is further improved when the double-sourcing policies are extended and implemented by sub-tier suppliers as well.It is noticed that if the supply chain could implement relevant double-sourcing policies, it would become resilient against risks and no supplier disruption could result in product flow break-down.

6. Conclusions

Supply Chain Risk Management is the combined effort of all the business entities forming a supply chain, which aims at evaluating and mitigating potential events that might disrupt any part of the supply chain. The topic of Risk Management can be widely find in the literature in respect to different aspect of risk and network formation. It usually, however, considers firm itself or its immediate suppliers in a single-period models. This work, though, is devoted to risk management strategies of the multi-tier suppliers for a multi-period models. It is based on multiple locations and multiply products with product components (bills of materials), which, again, found a handful interests in academia.

To conduct the research and evaluate different scenarios, the leading supply chain design software of Supply Chain Guru has been used. The research was conducted based on realistic supply chain network data and structure. The outcomes of this work are likely to be transferable to other case studies with similar supply chain designs.

The research implications are considered to be significant for researchers and practitioners as the results reveal the far-reaching positive effects that visibility over the firm's sub-tier suppliers could have on the efficient sub-tier risk management. A transparent supply network would enable supply chain managers to develop and implement cost-efficient double-sourcing policies that would increase the robustness degree

of their supply chain. Future research could use different analytical methods to investigate further the impact of sourcing policies on sub-tier risk management and extend the study to supply chain settings with more suppliers, sourcing echelons, and products. This however was not included in the current work due to the space limitations.

Bridging the gap between academic world and industry seems to be a main challenge of this research. The practitioners of Supply Chain Guru rarely realised the potential of the tool in topic of risk management, as its primary purpose is cost optimization in network design. Similarly, although widely used by practitioners in a wide range of operational research problems Supply Chain Guru, so far it gained little attention in academic world. This work, can potentially increase the awareness and initiate closing the gap between practice and academia in this respects. The collaboration between researchers and practitioners would also enable an empirical research with real data, which would possibly result in more robust results.

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Supply Chains in circular economy

From operational logistics performance to strategic relevance: adapting the packaging scorecard to circular economy challenges

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Introduction

This paper presents an important module of our international research programme proposing a packaging scorecard for closed-loop logistics systems in line with the emerging circular economy paradigm (Zhu, Geng & Lai, 2010). Packaging contributions to supply chain performance are commonly measured via dedicated scorecards elaborated by researchers (Olsmats and Dominic, 2003) or practitioners like Walmart in 2006. However, these tools focus on traditional supply chain performance dimensions and related metrics ("first dimension" of packaging scorecards), neglecting the environmental dimension and completely omitting the social one, in spite of external pressure increase such as the recent proposal for a directive of the European Parliament and the Council on packaging and packaging waste (2015/0276). By following the linear design of (traditional) supply chains, extant packaging scorecards also fail with regards to their "second dimension". Indeed, the range of assessors is incomplete for extant packaging scorecards reflecting forward or linear supply chain or network concepts rather than those of loops (Fabbe-Costes, Roussat & Colin, 2011; Fabbe-Costes & Roussat, 2014), as new reverse chain actors or physical nodes are missing.

Packaging performance, logistics and circular economy: state of the art

Frequent attempts to develop instruments for measuring company activities can be observed for almost three decades now. Amongst them, Kaplan and Norton's (1992; 1996a; 1996b) prospective *Balanced Scorecard* is one of the most notorious representatives. It has been tailored to various applications such as procurement (Procurement Executives' Association, 1996) or packaging and logistics (Johnsson, 1998). Beyond its simple measuring instrument capacities, Olsmats and Dominic (2003) recognized its potential of business strategy formulation and reorganization according to a holistic approach. Favouring this packaging approach and given the fact that supply chains become increasingly longer and complex, these authors proposed a tailored packaging tool, labelled "*Packaging Scorecard*" (Olsmats & Dominic, 2003). This scorecard is original, as it considers the different supply chain actors. It assesses the packaging role and functions at each actor's stage, in order to increase its performance. Their theoretical framework for a packaging scorecard is presented in Table 1 and, according to Olsmats and Dominic (2003), "summarizes functional criteria (marked X) that are typically the most significant ones for different actors along the supply chain and can serve as a base for the creation of the applied packaging scorecard". Ultimately, this packaging scorecard also strives for final customer satisfaction – common goal for all supply chain actors.

Pålsson and Hellström (2016) apply Olsmats and Dominic's (2003) packaging scorecard for 22 product category-specific cases, using three scorecards for each case, one per packaging level (primary, secondary, tertiary). Analyses are conducted for each supply chain actor or node (manufacturer, distribution center, retailer), divided into the whole packaging system ("system performance") and each packaging level. On the other hand, Pålsson and Hellström's (2016) analysis follows a linear conception of supply chain actors rather than the loop design related to the circular economy philosophy and, consecutively, considers less "assessors" and does not distinguish neither between product-centric and packaging centric loops.

Criteria	Supplier	Transportation distribution and wholesale	Retail	Consumer
Machinability	X			
Product protection	X	X	X	X
Flow information	X	X	X	
Volume and weight efficiency	X	X	X	
Right amount and size		X	X	X
Handleability		X	X	X
Other value-adding properties	X			X
Product information				X
Selling capability			X	X
Safety			X	
Reduced use of resources	X			
Minimal use of hazardous substance	X			X
Minimal amount of waste			X	X
Packaging costs	X			

Table 1. Criteria for the packaging scorecard. *Source:* Olsmats & Dominic (2003)

However, packaging scorecards are not the only representative when it comes to measuring performance of packaging and packaging design; other tools exist. This observation is particularly true for "sustainable" performance of packaging and packaging design. Recently, sustainability has indeed become a main issue for packaging and packaging logistics: specific concepts and approaches have been elaborated by researchers (Verghese & Lewis, 2007; Nilsson, Olsson & Wikström, 2011; Verghese, Lewis & Fitzpatrick, 2012; García-Arca, Prado-Prado & Gonzalez-Portela Garrido, 2014; Massaroni, Cozzolino & Wankowicz, 2014; Molina-Besch & Pålsson, 2016) and practitioners (Consumer Goods Forum, 2010; Ellen MacArthur Foundation, 2013; CNE, 2014; CNE, 2015), but operational tools are still scarce. Related to the concepts of sustainability and corporate social responsibility, circular economy describes an economic model that most often has been initiated by a political or governmental body and that strives for fostering the economic development of a considered territory (Lazzeri, Bonet-Fernandez & Domeizel, 2017), while preferring a closed-loop circulation of physical, water and energy flows as well as exchanges (see Figure 1). It is close to the "industrial ecology" concept (Park, Sarkis & Wu, 2010), imitating the operating principle of natural eco-systems that are characterized by autonomous organizational capacities and information feed-back mechanisms (Zhu, Sarkis & Lai, 2008). Above definition of circular economy confirms its high application potential within closed-loop logistics systems (Savaskan, Bhattacharya & van Wassenhove, 2004), justifying our preference for this concept amongst the multitude of other "green" or "sustainable" constructs.

The business stakeholders' association called Consumer Goods Forum (2010), for example, has identified very specific "indicators" for all three sustainable dimensions: environmental/ life cycle, economic and social. We observe several overlaps between these three categories (drawback), but also the high operationalization character, the potential inclusion of all three packaging types (primary, secondary and tertiary), the product-packaging "pair" logic (visible through the food waste-related indicators), and the need to focus on a specific product (family) category in order to yield meaningful metrics results (positive aspects). Similarly, Martin (2016) distinguishes, in a packaging purchase perspective, several levers and their "sustainable" impacts. Martin's (2016) positive sustainable impacts can be considered as packaging-induced performance, as they refer to reduced purchase costs, optimized transportation capacities, reduced financial contributions to green dot operators such as Eco-Emballages in France, and improved working conditions. Whereas Martin's (2016) levers refer to life-cycle-analysis–related design variables and marketing aspects, meeting expectations in both B2B and B2C settings. In academia, Svanes *et al.* (2010) compare extant "design tools", particularly with regards to the three dimensions of sustainability, even if the social one can be considered as absent in scientific literature so far - which surprisingly is also true for their own tool (Svanes *et al.*, 2010 did not consider Wever and Tempelman, 2009, who provide some modest contribution concerning the social dimension of sustainable packaging). In their contribution, Svanes *et al.* (2010) compare their own "*sustainable packaging design*" tool with Olsmats and Dominic's (2003) initial packaging scorecard, the Australian packaging evaluation tool PIQET, and Walmart's packaging scorecard as a business-side representative, created by the U.S. number one retailer allowing "suppliers to evaluate themselves relative to other suppliers, based on specific metrics" (Walmart, 2006).

All identified tools rely explicitly or implicitly on life cycle assessment (LCA) approaches: "Based on our experiences in the LCA of products and packaging, we have defined what sustainability means in this context and described the most important environmental effects caused by the products and packaging. However, the methodology cannot describe all environmental effects of all packaged products in the world. The user of the methodology will have to supplement if important issues have not been addressed. In addition to the sustainability issues raised by Waage (2007), this methodology covers many practical aspects that are important when designing packaging solutions. If a packaging solution does not appeal to the market or is logistically very impractical, it does not matter whether or not it is sustainable – it will not be used." (Svanes *et al.*, 2010). Saghir (2004) proposes a "packaging logistics analysis procedure" that enables to include in the performance analysis both the interplay of primary – secondary – tertiary packages (compatibility, neutrality, incompatibility) and the three basic packaging functions or requirements - logistics, marketing and environment. Complete and operational, it is however not exclusively dedicated to logistics functions of packaging (LFP), and related performance and does not yield the same accuracy level as packaging scorecards at the cross section LFP x considered actor, describing a "matrix" structure. Approaching packaging via its LFP[1] allows indeed a dedicated proceeding (Fulconis and Philipp, 2016): accordingly, packaging-related functional analysis or value analysis stresses upon logistics aspects rather than that of other concepts. Importantly, Pålsson and Hellström (2016) confirm the assignability/ conversion potential between the two constructs, namely packaging scorecard "criteria" (Olsmats and Dominic, 2003) and (logistics) "packaging function". To sum up, it is true that the interplay of the three concepts packaging performance/ logistics/ circular economy is not exclusively occupied by packaging scorecards; other tools exist as developed above. The advantages of the packaging scorecard according to Olsmats and Dominic (2003) can be summarized as follows vis-à-vis our research issue: (1) it stresses on logistics performance of packaging (compatible with our LFP concept as opposed to other functions of packaging, (2) it follows the overall design of a supply chain and its constitutive actors, (3) it strives for final customer satisfaction which is the ultimate goal of all supply chain actors and (4) it follows a more holistic vision of packaging's contribution to value creation.

However, and without devaluing their originality based upon a multi-actors' focus, the initiatives found so far are limited in number and mostly restricted to a linear supply chains' logic. The packaging scorecard proposed by Olsmats and Dominic (2003) indeed follows a simplistic segmentation of supply chains, considering only four categories: supplier (a), transportation distribution and wholesale (b), retail (c) and consumer (d). However, a circular conception of the economy requires the consideration of new actors, as mentioned above. Beyond the sole manufacturer/ distributor company unit, it indeed seems indispensable to include in our analysis the roles of the *reverse supply chain* actors, as

[1] Maintaining LFP as a main concept in our research provides an "anchor of stability", avoiding situations of inaccurate quasi-synonymous use of "functions" or "roles" (Jahre & Hatteland, 2004), "requirements" (Saghir, 2004; Rundh, 2005; García-Arca, Prado-Prado & Gonzalez-Portela Garrido, 2014) and "needs" (Molina-Besch & Pålsson, 2016). We observe the same tendency for the following notions: "design/ redesign" (García-Arca & Prado-Prado 2008), "development" (Simms & Trott 2010), "solution" (Hellström & Saghir 2007), "choice/selection" (Molina-Besch & Pålsson 2016) and "innovation" (Jahre & Hatteland 2004). Maintaining the concept of LFP is also compatible with the three elements of form, function and efficiency that are fundamental in product or packaging development (Lundström, 2009). "Form includes the shape and appearance, function includes the purpose and efficiency includes the performance and economy of the packaging" (Lundström, 2009).

well as those of the consumer (who wouldn't be any more the last and accessory link of the chain, but would become a full member within a closed-loop logistics chain), and those of eco-organisms, associations, researchers and, more generally, public authorities representing a stakeholder - if not the driver - of the transition towards the circular economy. In the same manner, we question the completeness of extant packaging scorecards with regards to their second dimension, i.e. their criteria or LFP elements, particularly within closed-loop systems characterizing the circular economy.

The present paper represents an important module of the authors' international research programme on those LFP susceptible to foster or hinder transition towards a circular economy (Fulconis & Philipp, 2016). It also covers the identification of those SCM-related competencies and skills to be mobilized or developed to increase LFP components' performance, while fostering transition towards circular economy (Fulconis & Philipp, 2017). At this stage, we have identified the packaging scorecard tool as most appropriate tool for generic LFP assessment, and pre-tested our adapted version "in a circular economy perspective" via eight packaging experts/ executives (Fulconis & Philipp, 2016). In addition to its methodological improvements, first findings suggest to distinguish between packages involved in a given product supply loop and the distinct packaging-centric loops for which the packaging itself is the considered "product". Both loops include various packages on different levels (primary, secondary and tertiary packaging), but their structure, constitutive processes and composition of actors/ nodes generally are completely different, as illustrated in Figure 1. We also provide guidance on how to deal with performance criteria antagonisms, on both intra-category (e.g. referring to the sole economic dimension) and inter-categories levels (e.g. between the ecological and the economic dimension).

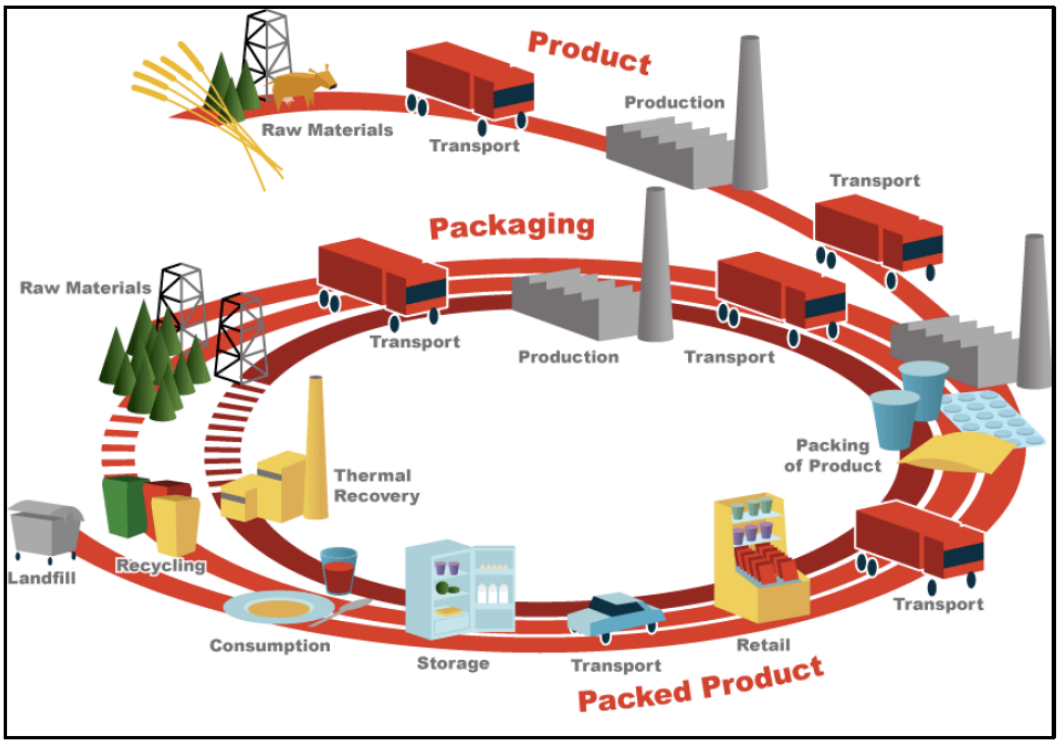


Figure 1. Circular economy system diagram
illustrating the distinction between product-centric loop and packaging-centric loop
Source: https://hermilocamacho.com/supply-chain-technology-could-be-the-key-for-a-fta-between-india-and-new-zealand/ (Accessed June 8, 2017)

Research objectives

Based upon our preliminary work developed above, the present research module can be characterized via the following four research objectives:

- RO1: complete the missing actors within the packaging scorecard.
- RO2: complete the missing LFP elements.
- RO3: measure the importance of the various LFP elements.
- RO4: identify the most adequate governance actors of the product-centric loop.

Methodology/data collection procedures and data analyses

Methodology available for the researcher usually reflects the maturity level of the considered discipline or field of study. Concerning our particular issue, Pålsson and Hellström (2016) observe that "packaging is strategically important and has a significant impact on supply chain performance, but surprisingly little research covers this area. The majority of the literature is descriptive or exploratory with a limited amount of theoretical contributions".

It seems necessary to focus on a specific product family, in order to yield meaningful results and to achieve a high operationalization level characterizing packaging contributions in research and practice, given the very heterogeneous nature of packages "in general". Indeed, both matrix dimensions of a packaging scorecard are concerned by the concentration on a particular product or product family. Indeed, interlocutors need to know for which product family they (1) evaluate the importance of LFP elements and for which product family they (2) identify chain or loop actors susceptible to assess LFP. This proceeding is in line with extant packaging logistics research contributions, mainly adopting the case study strategy (Jahre & Hatteland, 2004; Saghir, 2004; Lundström, 2009; García-Arca, Prado-Prado & Gonzalez-Portela Garrido, 2014; Pålsson & Hellström, 2016) and might be compared to marketing satisfaction surveys referring to a concrete product/ service customer experience and not to a "general" situation.

During the months of May and June 2017, we operated a first round of data collection via questionnaire (15 to 30 minutes per interlocutor: face to face or phone interviews), from a dozen company executives and business actors in France. In line with single case study requirements (Yin, 2013; Pålsson & Hellström, 2016), all interviewees belong to the health and beauty product-centric loop and are directly concerned by the involved packages, including point-of-sales advertising packages. In analogy to the model of Pålsson and Hellström (2016) "the respondents were selected based on their knowledge and awareness: they should have comprehensive insights into packaging performance within the organization and considerable knowledge of packaging on an operational level". Our respondents represent consecutive loop steps such as: cosmetics manufacturer, logistics services, retail, recycling industry, as well as associations specialized in supply chain innovation and environmental impacts management.

Results/findings and discussions

Results of our exploratory research presented in this paper include the empirical validation of the two parameters of our packaging scorecard, i.e. the actors' mapping and the performance criteria, yielding in a matrix tool "ready to use" on large scale, for both product-centric and packaging-centric loops. We followed Gardner and Cooper's (2003) guidelines for actors mapping concerning cyclic/ loop modalities for generic logistics channels as well as those of Pålsson and Hellström (2016) and Saghir (2004) for the specific context of packaging logistics.

Regarding perceived importance of each LFP element and following a circular economy perspective, two LFP elements out of 16 emerge from our first data analysis, namely "transportation" and "easy packaging sorting", closely followed by three others: "machinability", "storage" and "volume and weight efficiency". On the other hand, the three LFP elements "protection from waste", "product information" and "easy product sorting" appear less important amongst the 16 criteria targeting the product-packaging "pair" (CNE, 2015), even if their scores still are above average respectively.

Concerning the "other" packaging criteria or properties susceptible to add social, environmental or economic value, our results suggest to distinguish two groups. A first group is composed of properties considered as important by the respondents (average score superior to 3/5), namely "environmental consideration", "reduced use of resources", "minimal amount of waste", "minimal use of hazardous substances", "minimal amount of emissions", "actors protection/safety – security" and "selling capability". A second group consists of criteria considered as moderately important (average score equal or slightly inferior to 2/5), namely "easy product recycling", "easy packaging recycling" and "social norms".

The question "what actors of the health and beauty product-centric loop should be targeted by the packaging scorecard?" was answered in an almost unanimous manner. Indeed, six actors stand out from the others according to our results: recyclers, packaging suppliers, product manufacturers, pallet service providers, distribution centers/ logistics platforms and logistics service providers. On the other hand, e-retailers and local authorities are seldom mentioned by our interlocutors. Regarding our question about the most appropriate governance actors, potentially responsible for overall management of the product-centric loop and involved packages in line with the circular economy philosophy, our results suggest in essence: on the one hand, associative structures and eco-organisms, and, on the other, inter-companies co-operations (according to a vertical supply chain logic), whereas single companies are practically not mentioned. We included this question in order to provide a bridge between the operational and the strategic spheres of our packaging performance research issue.

Conclusions

Important module of the authors' international research programme at the interface packaging performance/ logistics/ circular economy, our loop-oriented packaging scorecard is now operational for wide-spread and in-depth use within several case studies reflecting different product categories. Focusing on logistics functions of packaging (LFP) and loops (as opposed to networks, chains or channels) has turned out to be a robust proceeding for this enterprise. Having empirically validated relevant LFP (first dimension of the packaging scorecard) and actors assessing the various packages involved within the health and beauty product-specific loop (second dimension), we now are able to "launch the next rocket stage" of our research programme, addressing complete mapping of product-centric loop processes, differentiated by packaging type (primary, secondary, tertiary).

Research-side, our contribution links together formerly fragmented fields of study, as circular economy, SCM and packaging logistics. It also further develops main concepts within the packaging logistics sub-discipline initiated by Scandinavian researchers (Olsmats & Dominic, 2003; Jahre & Hatteland, 2004; Hellström & Saghir, 2007), by amending them for circular economy challenges.

Business-side, proposing a packaging scorecard "ready to use" is a fresh approach to drive transition from a linear to a circular economy, still considered as a "mobilizing utopia" (Capron & Quairel, 2005). Indeed, relevant supply chain actors will be able to measure and improve logistics performance, on economic, ecological and social levels. Governance actors will receive a dedicated tool to plan, implement, monitor and assess packaging-related operations, in line with both business and public objectives, and according to the definition of circular economy.

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Supply chains in the circular economy – theoretical characterization of a circular supply chain archetype

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Introduction

Over the past few decades, sustainability issues concerning supply chain operations have gradually occupied a more prominent space within the wide spectrum of managerial topics addressed by academics, practitioners and policy makers (Carter and Liane Easton, 2011). The growing number of studies in this field has created a substantial body of literature in which four sustainability narratives of supply chains have emerged, namely: reverse logistics, green supply chains, sustainable supply chain management (SSCM) and more recently, closed-loop supply chains.

At a generic level of analysis, it is possible to associate these narratives with specific emphases, regarding the notion of 'circularity' in supply chain operations research. Govindan and Soleimani (2016) and Govindan, Soleimani and Kannan (2015), for example, point out that reverse logistics is usually associated with supply chains that enable products to flow back into corporate operations, minimising the flows to landfill waste. Green supply chain research is particularly associated with a strong emphasis on reducing environmental and ecological impacts of product/process design and development. Sustainable supply chain management (SSCM) engages broader corporate governance and management of social responsibility issues for supply chain operations. Finally, closed-loop supply chains are associated with ideas that simultaneously consider forward and reverse supply chain operations.

A problematic aspect concerning these four sustainability narratives of sustainable supply chains is a general lack of conceptual distinction and in particular, in relation to restorative and/or regenerative outcomes. They largely overlap in many of the phenomena they address, to the extent that scholars refer to them interchangeably and studies consider reverse, green and close-loop aspects synonymously under a wider SSCM perspective (Seuring and Müller, 2008; Carter and Rogers, 2008; Walker and Jones, 2012).

The transition to a Circular Economy predicated on business models facilitating reverse cycles, cascading of products, by-products and waste outputs, requires a refreshed appreciation to explore circular supply chain form(s) and their embedded circularities (Dervojeda et al., 2014). The increased complexity and expanded scope of circular supply chains and their role as enablers of business responses to the sustainability imperatives of the Circular Economy deserve a more comprehensive understanding (Batista, Bourlakis and Maull, 2016).

There is momentum for progressing theory by revisiting existing sustainable supply chain research in the light of Circular Economy ideal espoused on the global stage. Accordingly, this paper analyses extant literatures on sustainable supply chain by considering the main restorative processes underlying the 'circularity' features of business models in the Circular Economy. The following research questions are to be addressed:

> RQ1: What extant body of knowledge on sustainable supply chains contributes to our understanding of the circular supply chain phenomenon of interest as espoused by the notion of a Circular Economy?
>
> RQ2: What distinctive 'form(s)' of a circular supply chain enable restorative and regenerative processes in Circular Economy business ecosystems?

In response to the research questions, we conduct a content-based literature review (Gosling et al., 2016; Jia et al., 2014; Seuring and Gold, 2012) of sustainable supply chain research. We subsequently develop a conceptualisation of a circular supply chain archetypal form along with related propositions concerning fundamental aspects of circular supply chains.

Content-based systematic literature review

A content-based literature review comprised the main methodological approach of the study. This method relates to systematic literature review (Tranfield, Denyer and Smart, 2003) approaches involving a more orderly and consistent method to map, consolidate and identify gaps in an existing body of knowledge (Gosling et al., 2016; Jia et al., 2014; Seuring and Gold, 2012). The content-based approach allowed the capture of the main 'circularity' narratives emerging from extant sustainable supply chain research and body of knowledge.

We have adopted the qualitative approach to develop the content-based analysis. Seuring and Gold (2012) describe the main steps involved in this method, as follows: (1.) *Material collection*: Delimitation of the material and unit of analysis; (2.) *Descriptive analysis*: Initial descriptive analysis of the material; (3.) *Category selection*: Selection of the collected material according to specific analytic categories or dimensions; and (4.) *Material evaluation*: Theoretically-based analysis of the material according to the categories previously specified.

The selective approach was implemented with basis on the three search streams (A, B and C) shown in Table 1. Search stream A selected from research publications on sustainable supply chains perspectives comprising reverse, green, closed-loop and SSCM perspectives, including direct references to 'circular' and 'open loop' supply chains. Search stream B selected from research publications on core supply chain functional areas. These search streams were further combined with search stream C, which selected from publications on key restorative processes enabled by supply chains. Table 1 shows a detailed list of the search streams and related search strings adopted in the literature selection process. The papers were selected from two major academic source databases that provide access to full text publications: *EBSCO* and *PROQUEST*.

A. Sustainability perspectives of supply chains	B. Supply chain functional areas	C. Restorative processes
"reverse" "green" "closed loop" "sustainable" "circular" "open loop"	"supply chain*" "logistics" "transport*" "sourcing" "purchasing" "procurement"	"reuse" "repair*" "recondition*" "refurbish*" "remanufactur*" "recycl*" "cascad*"

Table 1: Search streams and related search strings (full/truncated)

After refinements and elimination of duplicates, we have finalised the selection phase with a total of 49 papers identified for final in-depth review.

Findings

We have analysed supply chain research papers in accordance with their sustainability narratives. In this respect, there is a substantial body of literature on reverse supply chains linking **reverse logistics** with sustainability issues. A fundamental 'circularity' notion of reverse logistics is its role to implement the movement of materials from consumers back to producers. Besides recycling, over the years, researchers have been considering reverse logistics perspectives related to other alternatives to disposal processes such as reuse, repairing, reconditioning and remanufacturing (Agrawal, Singh and Murtaza, 2015; Cannella, Bruccoleri and Framinan, 2016). This expanded scope of restorative processes associated with reverse logistics represents a shift from the predominant

focus on single products collected and recovered as a whole to wider reverse logistics perspectives that consider multiple products and related spare parts (Tahirov, Hasanov, and Jaber, 2016).

The expanded scope of reverse logistics perspectives led to different sustainability perceptions of supply chains, such as green, sustainable supply chain management (SSCM) and closed-loop views. The **green perspective** puts more emphasis on environmental issues concerning supply chains. By definition, green supply chains involve traditional supply chain management approaches with the additional 'green' component, which includes managerial practices such as green purchasing, green distribution, green manufacturing, eco-design, etc. which lead to improved environmental and economic performance (Green et al., 2012). Typical restorative processes such as recycling, repairing, remanufacturing, and so forth are studied from green supply chain viewpoints which usually involve broad perspectives of analysis (Mishra, Kumar and Chan, 2012; Dües, Tan and Lim, 2013).

Although the green supply chain narrative has considerable overlap with the **SSCM narrative** (Glover et al., 2014), it remains essentially narrower in scope and opportunity for innovation (Ahi and Searcy, 2013). While the former has a predominant focus on the environmental dimension of sustainability, the latter extends the environmental perspective to include social and economic perspectives that, together, allow more comprehensive triple bottom line approaches to supply chain management (Beske and Seuring, 2014).

Distinct from the broad narratives mentioned above, the **closed-loop narrative** is concerned with the appropriate logistics and supply chain structures to support forward and backward flows of products. The restorative flows of materials considered by this narrative overlaps significantly with the reverse perspectives above discussed; however, the reverse logistics and closed-loop perspectives of supply chains are fundamentally different in scope and opportunity for innovation. A primary notion is that while reverse logistics focuses on the reverse flows of materials from the point of consumption to the point of origin, closed-loop supply chains consider forward and reverse supply chains simultaneously (Govindan and Soleimani, 2016). In other words, closed-loop supply chain combines forward and reverse supply chains to cover entire product life cycles from cradle to grave.

Overall, although the literature analysis indicates academic research with direct references to 'circular' (or the idea of circularity) in supply chains, its characterisation still remains a marginal venture in the field of supply chain operations management. There is a lack of a conceptualisation of what constitutes a '**circular supply chain**' in the context of a Circular Economy ideal. Thus far, due to associations with restorative and regenerative processes, the reverse and closed-loop narratives offer useful contributions towards theoretical frames that link sustainable supply chain operations research with circular economy principles and praxis. By considering reverse and forward flows, the closed-loop supply chain narrative in particular offers a useful starting point to represent what might be construced as circular supply chain operations. However, the closed-loop narrative remains insufficient because it does not address wider post-production and stewardship operations espoused by the grand idealisation of a Circular Economy, such as for example the supply chain operations supporting waste flows and by-product synergies linking organisations from diverse sectors. We address this deficiency in the next section, where we introduce a conceptalisation of a circular supply chain archetype that integrates and builds upon core features of the four supply chain narratives discussed.

An important outcome reveals that the reverse, green, SSCM and closed loop narratives tend to focus on the flow of one main product only. This outcome provides a valuable insight regarding the characterisation of studies considering the sustainability of supply chains in the context of a Circular Economy. Due to the broad scope and stronger emphasis the Circular Economy posits on resource efficiency, the supply chains analysed from the Circular Economy perspective usually take into account a spectrum of restorative cycles involving not only the main products, but also the related by-products and useful waste. They also commonly consider the economic dimension of sustainability alongside with the environmental and the social dimensions. This augmented

complexity might help to explain the preference for mixed method approaches in circular supply chain studies, where predominant case study approaches are combined or complemented by quantitative analysis.

Fundamental aspects of a circular supply chain archetype

In response to our second research question, we introduce a conceptualisation of a circular supply chain archetype that takes into account the wide spectrum of restorative and regenerative flows advocated by the Circular Economy idealisation. To this end, we integrate the dominant features of the existing sustainable supply chain narratives (reverse, green, SSCM and closed-loop) to provide a more comprehensive understanding of a circular supply chain.

The 'closed-loop' narrative provides a helpful perspective to represent key circularity aspects of Circular Economy business models. However, we should be mindful that its propositions tend to emphasise reverse (closed-loop) flows, even though 'open-loop' flows are also part of the 'closed-loop' narrative. Our view is that embedding 'open-loop' flows into the broader conceptualisation of 'closed-loop' supply chain may appear counter intuitive, undermining understanding and the accurate representation of the circularity features of the supply chains supporting Circular Economy business models.

In addition, the closed-loop narrative tends to focus more on the flows of main products, to the detriment of by-products and useful waste flows. This is evident in the definition of closed-loop supply chain management provided by Guide and Van Wassenhove (2009), who point out that closed-loop supply chains support value creation systems derived from entire product life cycles and related returns. Following from this, we suggest that (1.) circular supply chains extend the boundaries of closed-loop supply chains by taking into account post-production stewardship to include forward feeding flows into alternative supply chains, and (2.) circular supply chains support sustainable value chain systems derived not only from products and their end of life returns, but also from associated by-product synergies, services and waste flows. From this we specify a **definition of circular supply chain**, as follows:

> *The coordinated forward and reverse supply chains via purposeful business ecosystem integration for value creation from products/services, by-products and useful waste flows through prolonged life cycles that improve the economic, social and environmental sustainability of organisations.*

Based on the definition above, we infer that circular supply chains entail the integration of the main original supply chain with additional restorative supply chains supporting the implementation of materials recovery processes. The original supply chain refers to the traditional forward supply chain supporting core production processes of organisations. The restorative supply chains refer to two restorative cycles: (1.) The reverse supply chains supporting closed-loop cycles of products (returns) and components back to the organisation in focus, and (2.) the forward open-loop cycles supporting cascading flows of materials to organisations outside the original supply chain (Dervojeda et al., 2014; Krikke, le Blanc and van de Velde, 2004; Tahirov, Hasanov and Jaber, 2016). This scenario is illustrated in Figure 1, which represents a generic archetype of a circular supply chain and the different types of material flows it involves. In the figure, the primary materials are the raw materials used in the core production process of an organisation. The recovered materials are the returned products, parts, components, as well as by-products and useful waste that can be used as inputs in further production processes. The secondary materials are materials such as used products, parts, components, by-products and useful waste that can be used in restorative processes for the production of secondary products (e.g. repaired, reconditioned, refurbished, remanufactured or recycled products).

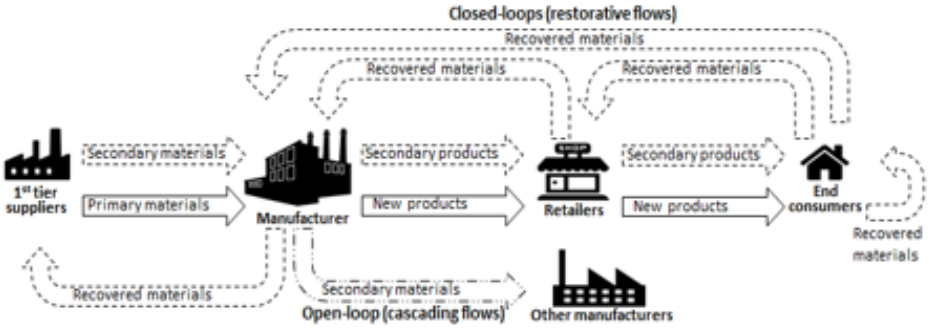


Figure 1: A circular supply chain archetype

The supply chain archetype above also points out typical product recovery loops in circular supply chains. A fundamental aspect to highlight here concerns the recovery loops that take place at different levels, and involve different actors, across the supply chain. For instance, the loops downstream, particularly the ones at 'end consumer' level, typically involve product reuse and product repair initiatives. By their turn, remanufacturing processes usually involve loops linking consumers downstream with manufacturers upstream.

These loop differentiations are important because they are claimed to have different levels of 'resource efficiency' in terms of their impact in the context of a circular economy (Stahel, 2010). That is, although all possible restorative loops enabled by circular supply chains are important, the 'inner loops', i.e. the ones downstream the supply chain, are claimed to be the ones that generate less environmental impact because they require less reprocessing of materials (Dervojeda et al., 2014; Stahel, 2010).

Circular supply chain is considered a collective term for the coordinated forward and reverse supply chains, as indicated in the definition of circular supply chain proposed. More specifically, a circular supply chain comprises a series of supply chain processes which are expected to improve the life span of products and enable core restorative and regenerative processes being implemented by business model innovations that aspire to circular economy ideas (Lovins and Braungart, 2014; World Economic Forum, 2014). To facilitate understanding, Figure 2 provides a logical, structured and holistic representation of the 'traditional-restorative / forward-reverse' supply chains that form in a circular supply chain.

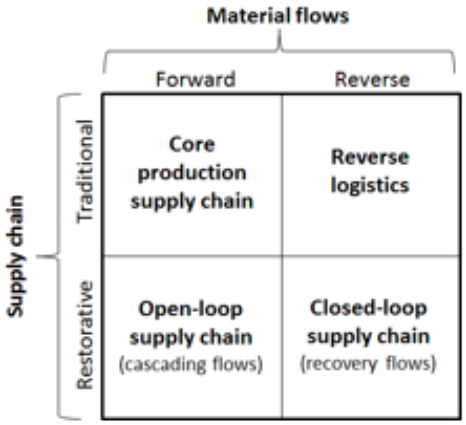


Figure 2: Circular supply chain views in terms of antecedent perspectives

We finalise our discussion by summarising the fundamental premises concerning a circular supply chain archetypal form in terms of sustainability, design and value chain composition.

- *Sustainability*: It expands the closed-loop perspective of supply chains by considering value creation chains derived not only from products and related end of life returns, but also from by-products and useful waste flows recovered from reverse or forward cascading chains. It involves triple bottom line approach to improve the economic, social and environmental sustainability of organisations.
- *Augmented design complexity*: It requires coordinated integration of the traditional supply chain with restorative supply chains supporting the implementation of restorative processes involving forward and reverse flows. Furthermore, it may involve several loops of recovery materials for a number of different restorative processes (e.g. reuse, repairing, reconditioning, refurbishing, remanufacturing, recycling and cascading).
- *Downstream design*: In terms of resource-efficiency, circular supply chains should be designed to favour restorative processes downstream.
- *Value chain composition*: It comprises traditional and restorative supply chains involving forward and reverse value chains of primary and secondary materials.

5. Conclusion

The conceptual aspects here developed have practical implications. For instance, we emphasise the importance of coordinated integration of distinct value chains (traditional and restorative/regenerative) comprising a circular supply chain. It is also important to stimulate restorative processes downstream. This is possible by designing products that facilitative reuse and repair processes close to end consumers. Product modularisation in this context becomes an essential strategy, which can be supported by the circular supply chain archetype characterised in this paper.

The Circular Economy advocates a certain 'resource efficiency' hierarchy for the restorative loops discussed in the paper, claiming that 'inner cycle' loops are more environmentally friendly (Dervojeda et al., 2014; Stahel, 2010). Although there is a coherent logic in this assertion, future validation studies are welcomed.

An in-depth discussion of the configurational challenges of circular supply chains and the network of actors engaged in different restorative business models is also an important area for further research. As Bocken et al. (2014) point out, sustainability value is not created by firms acting in isolation, but by a group of actors acting together through formal and informal arrangements. Circular Economy business models and their related circular supply chains comprise a wide set of stakeholders that require a broader value chain outlook that take into account the collaborative ties for developing the restorative and regenerative capabilities espoused by the Circular Economy.

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Sustainable supply Chains

Green agenda and sustainability in follow up and evaluation stage of purchasing of logistics services: Perspectives from the British shippers and forwarders

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Introduction

Traditionally, logistics decisions about purchasing logistics services have been driven by minimizing cost, maximizing profitability, and achieving customer service targets (Menon et al. 1998). As concepts the of sustainability and green agenda were added to business objectives there has been an increased interested from companies in reducing or even eliminating impact of their products and operations on the environment (Nidumolu et al. 2009). In recent years, companies are under an increasing pressure to look at their logistics operations as there are several ways they may be a threat to the environment: impairing air quality, source of noise and vibration, cause of accidents, and an important contributor to climate change (McKinnon et al. 2015). As a result, a number of ways to make logistics sustainable and green were proposed and applied within the field (Halldórsson and Kovács 2010; Dey et al. 2011). There is a strong evidence that popularity of the outsourcing strategy of logistics services, which allows companies (shippers) to focus on its core competencies, leads to an increased reliance on the third-party logistics service providers (3PL, forwarders) for sustainable and green initiatives (Min 2013; Colicchia et al. 2013). On the other hand, forwarders only deliver services that they were contracted for, leaving the decisions about purchasing green logistics services with a low environmental impact with shippers (Wolf and Seuring 2010). A survey of shippers and forwarders by Björklund and Forslund (2013) suggested that environmental performance measurement systems were sparsely used by shippers to evaluate forwarders' performance. This indicates that evaluation of performance of logistics services is predominantly based on traditional objectives (i.e. price, quality, on-time and in-full) (Lammgård and Andersson 2014). Within this context, this paper investigates the role that green agenda and sustainability plays in follow up and evaluation stage of purchasing of logistics services and it is based on empirical evidence from the British shippers and forwarders.

Following this introduction, the authors' literature review provides an overview of the process of purchasing logistics services and related environmental concerns. Then the rational of the current study is explained and the authors' specific objectives are set out. Next, the methodology employed by the authors is described. Then authors discuss the key messages from the research highlighting some of the main limitations and contributions of the paper.

Literature Review

Process of purchasing logistics services

Area of purchasing transport and logistics services is fairly under-researched with a limited number of articles available (Evangelista et al. 2013). A framework for purchasing 3PL services by SMEs was presented by Holter et al. (2008), which included such elements as: comparative bids; comparison of costs, services, and transit times; and supplier management. A more generalised process of purchasing, which can be applied to purchasing of logistics services was presented by Weele (2009) and it is summarised in Figure 1. This paper follows stages proposed in the Weele's framework and offers a brief explanation of each stage below.

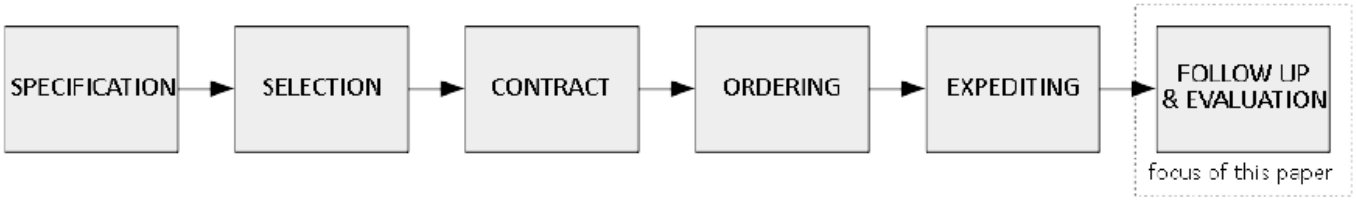


Figure 1: The purchasing process

Specification is the initial stage of the purchasing process in which order requirements in both functional and technical aspect are defined. At this stage shippers send out their request for proposal (RFP) to forwarders (3PLs), which may be pre-selected based on previous experiences, market surveys, and industry rankings (Qureshi et al. 2007). RFPs are highly standardised to allow for comparison between responses (Andersson and Norrman 2002). Supplier selection is interwoven with the specification process and includes "a preliminary selection of the most suitable suppliers by means of a tender and ranking procedure" (Selviaridis and Spring 2007). Supplier selection ends with negotiations, in which forwarder and shippers enter a dialogue on contractual details (Jané et al. 2006). According to Jané et al. (2006, p.27) logistics contracts focus mainly on technical, economic or operative aspects – "The parties' main concern... is the negotiation of the price and the performance levels that the 3PL provider must achieve while rendering the services." Logistics contracts have a relatively short duration, which leads to uncertainty on the side of the forwarders and may stifle innovation (Kacioui-Maurin et al. 2015). Ordering and expediting stages happen after the contract has been agreed and purchase orders for transportation or services are placed. Forwarders' operation and execution of orders is then followed up and evaluated. At this last stage, on which this paper focuses, "it becomes clear whether the supplier can substantiate his promises about service" as outlined in the contract (Weele 2009, p.62). There is a little focus in the literature given to follow-up and evaluation stage and as such this paper attempts to fill this gap, with an emphasis on green and sustainability issues.

Process of purchasing of logistics services with a focus on green and sustainability was approached in the literature from three perspectives: shippers (Large et al. 2013), forwarders (Rossi et al. 2013), and both in a dyadic approach (Sallnäs 2016). However, both shippers and forwarders may have multiple relationships in the supply chain that extend beyond dyadic relationships (Panayides and So 2005) and as such need to be investigated in a broader context. This broader context approach to investigating role of shippers and forwarders in procurement of green and sustainable logistics services was applied by Jazayrli (2017). As his paper focussed only on three stages of the aforementioned purchasing process: specification (RFP), negotiations, and contracting, this paper explores perspectives of shippers and forwarders on green and sustainability in the little explored area of follow-up and evaluation.

Environmental concerns related to purchasing logistics services

Green procurement is defined as procurement of "goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (European Commission 2012). Recent literature on purchasing of green and sustainable logistics services presents a tension between attitudes of shippers and forwarders on this topic. For example, Large et al. (2013) suggests that shippers consider sustainability to be high on their agenda during the purchasing phase, but at the same time they're not engaging with their selected forwarders in green projects. It is assreted that shippers influence plays a minor role on green conduct of the forwarders, which is in opposition to the view presented by Carter and Dresner (2001). According to Kudla and Klaas-Wissing (2012) buyers on the shippers' side "barely... integrated logistics services within their sustainability management", while those shippers who made attempts to integrate sustainability into their contracts did not consider how these issues should be measured or how the poor compliance should be handled (Björklund and Forslund 2013). This is the context within which the research objectives of this paper were developed.

Development of research objectives

To gain some insights into role that green agenda and sustainability plays in follow up and evaluation stage of purchasing of logistics services, the authors conducted interviews with managers representing two groups: shippers and forwarders. This approach adopts the lesson of Geertz (1973, p.5) who stated that "if you want to understand what a science is, you should look in the first instance not at its theories or its findings ...you should look at what the practitioners do".

Based on the above the specific objectives of this research study are:

1. To develop new insights into the practice of purchasing of logistics services, with a focus on follow up and evaluation stage and a role played by green agenda and sustainability.
2. To compare practitioner perspectives with the body of academic knowledge;

Methodology

Data collection

The interview sample comprised of nine managers, five representing shippers (manufacturers and retailers) and four representing forwarders (3PLs), all based in Britain. Seeking insight into research questions from practitioners representing three main echelons of the supply chain mirrors the approach used by Lummus et al. (2001). Table 1 presents some of the interviewees characteristics.

Company code S=shipper; F=forwarder; RET=retailer; 3PL=logistics; MAN=manufacturer;	Industry	Goods/services offered	Company presence
S-RET-1	Retailer	Non-food goods	UK
S-RET-2	Retailer	Clothes, food, home	Global
S-MAN-1	Manufacturer	Dispensing equipment	Global
S-MAN-2	Manufacturer	Agri-food	UK and Europe
S-MAN-3	Manufacturer	Furniture	UK and Europe
F-3PL-1	Logistics	Logistics services	Global
F-3PL-2	Logistics	Logistics services	Global
F-3PL-3	Logistics	Logistics services	Global
F-3PL-4	Logistics	Logistics services	Global

Table 1: Interviewee characteristics

This sample of companies handles a wide variety of product groups thus enabling the authors to generate a breadth of perspectives. Individual respondents were senior managers with a responsibility for purchasing logistics services on the shippers' side, and a responsibility to oversee the fulfilment of contracts on the forwarders side. Each person was sent an indication of topics that will be discussed to consider for their upcoming interview. The research then involved carrying out focussed (i.e. semi-structured) interviews with each respondent. Interviews were recorded and transcribed.

Data analysis

Regarding interview transcript analysis, Easterby-Smith et al. (2008) describe two approaches: content analysis and grounded analysis. The overall approach in this study involved a combination of both methods, thus integrating their strengths and mitigating their shortcomings. The transcript analysis employed by the authors (as shown in Figure 2) involved four main stages in distilling the raw transcript data into information that was analysed based on comparing and contrasting the main issues set out by respondents.

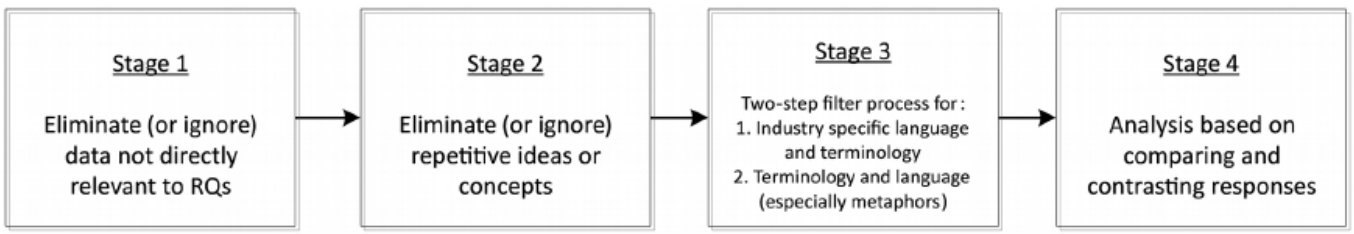


Figure 2: Transcript Analysis Process

Discussion of results

Shippers perspective

All shippers indicated that green agenda and sustainability was important for their business and was defined in terms of: caring for the environment, minimising waste, limiting CO2 emissions, green mile, fuel efficiency, and minimising power and water usage. For shipper S-RET-2 green procurement meant "going beyond carrying just for the environment" and he included in it people welfare - "how people are treated and protected, example being modern day slavery".

There is a divergence of practice between manufactures and retailers in regard to addressing environmental concerns during the initial stages of purchasing process. S-MAN-1 suggested that any such concerns were driven by their upstream clients, which led to pragmatism in this area – "we were looking for solutions that we could sell to our customer, that we could put on a presentation slide". S-MAN-2 doesn't specifically ask about anything sustainability related, as in his view it may limit a response to tender and requires only general statements about corporate social responsibility (CSR) policies. The primary focus of S-MAN-2 and S-MAN-3 is around filling the trucks and minimising empty runs. Conversely, retailers are very up front about their environmental concerns. Both retailers request details of "any environmental policies, standards and targets for green levies, CO2 emissions" (S-RET-1) and work under the assumption that "a participant in the tender, especially in the contractual stage, is committing to green principles that we're operating under" (S-RET-2).

Follow-up and evaluation stage is very important to all shippers, and they carefully follow up on each element that was agreed within the contract. Some of the metrics that are monitored include: fuel consumption, mileage (mpg – miles per gallon), trailer utilisation and maximising fill, fleet level, CO2 emissions, driver behaviour (road safety), water efficiency, and energy use. S-MAN-1 suggested that although the primary focus of follow-up and evaluation is cost control, "you can see some environmental benefits as well – lowering costs and sustainability is closely linked". S-MAN-3 summarises the importance of monitoring driver behaviour with telematics – "drivers driving in the best way is a benefit to the environment". In addition to using metrics, both retailers also follow-up with visits to physical facilities of the forwarders to "make sure they don't pose any risk to people and environment" (S-RET-2).

There is a breadth of practices among shippers when it comes to specific processes to handle poor compliance of forwarders in area of green agenda and sustainability. Manufactures rely solely on periodic reviews with the forwarders "where all aspects of performance are evaluated, including any green and sustainability issues" (S-MAN-3). Retailers make use of periodic reviews, but also have "internal audit teams, who make sure that contract terms including any green and sustainability obligations are complied with" (S-RET-1). All respondents indicated that a forwarder who was failing in regard to their contractually agreed green and sustainability obligations would be challenged, even if they were exceptional on all other metrics – "we would seriously consider if they are a right company to take our business forward" (S-MAN-3), "green issues cannot be compromised or overlooked" (S-RET-1). Retailer S-RET-2 suggested that while contractually "agreed... measurable sustainability metrics can be followed up quite easily" a problem arises when "you've engaged with a company believing that they're sharing your green and sustainability principles" and they aren't, "it would be tricky to manage this disconnect".

Forwarders perspective

Green agenda and sustainability was important for all the forwarders and was defined in terms of: their CSR policy, CO2 emissions control, carbon footprint, and fuel efficiency.

All forwarders indicated a wide range of approaches to addressing environmental concerns during the initial stages of purchasing process – "it varies between the customers" (F-3PL-2). Forwarder F-3PL-3 indicated that many of their customers "are interested in how to save the environment and there are specific questions [in the tender] about what we're doing in terms of our environmental agenda". This sentiment is shared by F-3PL-2: "it depends on how much a customer is interested in these green issues, or are they just interested in our services and prices". Green agenda and sustainability questions in tender documents are summed up by F-3PL-1: "Somewhere in the request there is that question... it's still not the first question, but probably the last one".

Follow-up and evaluation stage is very important to all forwarders, but they unanimously agree that it's rare that they're asked for any direct service level agreement (SLA) or KPI linked to environmental issue. Costs and operational service levels "are higher on [customers'] agenda, before any green points are raised" (F-3PL-4). However, some operational metrics are indirectly related to the green and sustainability issues. For example, a better utilisation of the shipping units (i.e. container or truck) leads to "less impact on the environment" and in this case although a decision is cost driven "any green benefits are an add-on" (F-3PL-1). Forwarders admit that green and sustainability issues are rarely raised during performance reviews: "Not all our customers evaluate environmental issues, but we do get a couple who ask" (F-3PL-3). Measurable sustainability metrics that forwarders are asked about include: carbon footprint, CO2 emissions, fuel consumption, use of energy.

According to forwarders the shippers don't have any specific process to handle poor compliance in the area of green agenda and sustainability – "I've never came across any process like that with our customers" (F-3PL-2). Forwarder F-3PL-1 notes – "I've never heard of any contract that's been lost on green and sustainability issues" – and alludes that commercial and quality team on their side "would spin the data" anyway. "Maybe we're using more CO2 than we agreed or planned, but you – Mr Customer – are asking us to do some more emergency airfreight shipments" concludes F-3PL-1.

An apparent lack of environmental scrutiny on the shippers' side doesn't impede some forwarders from their own sustainability efforts. F-3PL-3 aims to be a leader in this area and their regular internal communications include reports on how they're "doing in terms of green and environmental targets, CO2 saved, wastage, recycling, etc." with all sites reporting these metrics to a centralised unit.

Bringing it all together

Follow up and evaluation plays an important role within the contract for both shippers and forwarders. Although shippers indicated that green and sustainability concerns are high on their agendas, it is not apparent in discussions with the forwarders about how they're evaluated. Nevertheless, both groups indicated a growing importance of measurable metrics linked with sustainability such as CO2 emissions and fuel usage. Additionally, both groups recognise a positive link between cost saving and green and sustainability. Despite these advances, a typical focus on price and service levels in purchasing of logistics services seem to remain, which corroborates with earlier findings (Wolf and Seuring 2010; Lammgård and Andersson 2014).

Research limitations and future work

In reflecting on the validity and reliability of this research, the four qualitative criteria recommended by Lincoln and Guba (1985) have been adopted – credibility, transferability, dependability and confirmability. The credibility criterion involves establishing that the results of qualitative research are credible from the perspective of the participants in the research. Whilst there is room for improvement in this area in the research described in this paper, this issue was addressed to some extent by inviting interviewees to comment on summaries of the research findings. The small sample used in the current research is not intended to be definitive and transferability is difficult. However, use of the focussed interview methodology enabled some potentially useful contributions to be developed inductively. The process of relating the empirical findings back to the literature helped in this regard. The next stage of the work is to empirically test these findings using a larger survey of firms. Dependability emphasizes the need for the researcher to account for the changing context within which research occurs. In this regard, the authors fully documented the whole focused interview process, from design through to analysis and feedback. Confirmability refers to the degree to which the results could be confirmed by others. Future work should build on the findings of this research using a combined inductive/deductive approach based on methodological triangulation.

Conclusions

The first objective of the research described in this paper was to develop new insights into the practice of purchasing of logistics services, with a focus on follow up and evaluation stage and a role played by green agenda and sustainability. To this end, the views of practitioners in manufacturing, third party logistics and retail have been solicited through a series of focussed interviews. The findings suggest that although green agenda and sustainability issues grow in importance in the initial stage of purchasing logistics services, they have a minimal impact during follow-up and evaluation stage. This provides some insights into the second objective of this piece of research and opens up some potentially fruitful avenues for future research.

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Supply chain deglobalization in an increasingly nationalistic world

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Introduction

Economic nationalism is the product of neo-liberal influence on international trade regulation (Bovis, 2015a, b, c). The latter has promulgated a price-only and price-related decision making capacity in all aspects of government and corporate interfaces, investment and production, paving the way to a global customs union. This has had an eroding influence on the relative strength of individual states and their governments to plan for systems of trade which could embrace both free trade and domestic considerations. Globalisation was founded on the assumption that free trade is beneficial for national and regional systems. An integration agenda has been sought by international institutions and governments across the world with the objective of trade liberalisation and the elimination of protections and preferences by governments to national industries. However, globalisation and the fully-fledged neo-liberal approach to market integration in international trade, has revealed significant side effects which were not previously accessed. Recent political developments in the European Union, particularly in Great Britain and in the USA have verified the assumption that free trade does not always serve national interests and have opened up the fundamental debate related to globalisation and the ensuing principle of market access and its implications on international trade.

We accept that globalisation and free trade serve national interest partially however, we also believe that international trade functions in an increasingly nationalistic and populist world that, combined with a greater appreciation of total supply chain costs, may trend towards deglobalization of supply chains and related activities. Deglobalization suggests there would be major changes to supply chain design and implementation from a number of perspectives. *The Economist* attributed the term deglobalization to the sociologist and author Walden Bello, who wrote *Deglobalization: Ideas for a New World Economy*. Bello's (2002) thesis is that market fundamentalism driving neoliberal globalization, starting in 1989 with the fall of the Berlin Wall, provided economic benefits but also had social costs, thus rendering it unsustainable and prompting the world economy into retreat. The economic crisis of 2008-09 exacerbated this retreat when world trade fell by about 20%, and Escaith (2009) blamed global value chains and 'trade in tasks' through outsourcing and global production for deepening that crisis, arguing global supply chains influenced the depth of such trade elasticity and the speed or trade volatility.

Almost ten years later the UK's 'Brexit' referendum vote and the presidential election of Donald Trump have signalled a trend towards more nationalistic and less global outlooks in both the UK and US while following a populist trend. This trend also appears to be shaping and influencing elections and government policy elsewhere in the world, e.g. Hungary and Poland, resistance to global trade agreements such as the Trans-Pacific partnership (TPP), and global climate change considerations. Notwithstanding, many companies had already begun reviewing their global supply chains over the past decade due to total cost, risk and sustainability issues, and such reviews haves led to some localized deglobalization through 'nearshoring' production to their home country or economic trading union. If deglobalization is indeed a growing and important trend, it is timely and relevant to examine the various effects it will have on business, economic systems, trade, governments and policy, and society, in general, and logistics and supply chain management (SCM) structure and operations, in particular.

However, in the year following Brexit and the US election much discussion in the popular press and online postings by companies, consultants and trade associations have been narrow in focus are regards own-country national concerns, i.e. Brexit for the UK or the Trump presidency for the US, and specific impacts on one sector or method of production or logistics/supply chain management (see for example Resilinc, 2016; Thatcher, 2016). As a result, a holistic or systemic approach to this topic is lacking as is relevant academic literature due to the recency of this topic. This paper presents an objective and holistic appreciation of supply chain deglobalization in this increasingly nationalistic and populist world. Our purpose here is to bring together some of the disparate thoughts on the effects of this phenomenon on logistics and SCM and usual academic considerations of risk, to synthesize what we do know and possibly don't know, and to suggest a research direction for academics to take a lead in expertly informing companies and governments, despite an assertion by the current UK government's Secretary of State for Environment, Food and Rural Affairs, the Rt Hon Michael Gove MP, that "people in this country [UK] have had enough of experts" after the Brexit referendum vote in 2016 (Guardian, 2016).

Approach and Background

We used a qualitative and inductive approach with two aspects. We critically reviewed disparate literature that has surfaced over the last two years and also conducted an academic literature search using Web of Science from 2015-17 in the first aspect. Our keywords were Brexit (630 articles), populism (636 articles), nationalism (3.186 articles), deglobalization/deglobalisation (21/4 articles) and Trump US presidential election (30 articles) that we searched in various combinations alogn with logistics and supply chains as second level or sub-filters to determine what academic literature exists. Only two articles were found using these sub-filters: one discussing rare earth mineral supply chains and economic nationalism, particularly as regards China, and the other discussing issues surrounding 3D printing implementation globally, of which deglobalization was one issue. Our lack of success with our search suggests these topics are indeed quite recent, particularly as regards logistics and SCM and thus academics and practitioners are operating in a partial vacuum on these matters.

Our second aspect included industry presentations/seminars on these topics in two forums (Grant, 2017; Menachof, 2017) to gather feedback from participants. These events were focussed on Brexit given their UK settings. However, we will also host a third on deglobalization in particular in September 2017 at the US Council of Supply Chain Management Professionals (CSCMP) Academic Research Symposium, part of CSCMP's annual conference in Atlanta. Feedback from the two UK sessions indicates that most people attended because they don't know what to expect from Brexit. Most of them could identify downside risks or threats to their operations from Brexit. Participants concurred Brexit be turbulent to some degree and that it will hurt the UK overall, although each of the participating companies considered they will survive, which may occur by shifting resources to Europe or elsewhere. One company at the London session has a Turkish parent company and see UK domestic operations continuing as normal, and actually see an advantage as overseas competition may face higher tariffs to enter a post-Brexit UK market. However, any expansion they undertake may need to occur outside the UK, and they consider the tradeoffs are higher exports of their UK products due to the British Pound countered against standard i.e. higher World Trade Organisation (WTO) tariffs being levied on imports.

From the literature, Bello (2002) argued there are eleven key tenets driving a deglobalization paradigm that are geared for smaller economic and governance units such as local communities and contain socialist tendencies. However, six of his suggestions are appropriate for nationalist and populist environments which will be smaller units of analysis and activity and are useful to derive elements constituting any framework or typology. These six specific tenets 1, 2, 3, 4, 7 and 8 are useful to are listed in Table 1.

1	Production for domestic market must again become centre of economic gravity rather than production for export markets.
2	Subsidiarity should be enshrined in economic life by encouraging production of goods at the community level and at the national level if this can be done at reasonable cost in order to preserve community.
3	Trade policy - i.e., quotas and tariffs - should be used to protect the local economy from destruction by corporate-subsidized commodities with artificially low prices.
4	Industrial policy, including subsidies, tariffs and trade, should revitalize and strengthen the manufacturing sector.
5	Development and diffusion of environmentally congenial technology in both agriculture and industry should be encouraged.
6	Strategic economic decisions cannot be left to the market or technocrats; the scope of democratic economic decision-making should be expanded so that all vital questions, e.g. which industries to develop or phase out, what proportion of a government's budget is devoted to agriculture, become subject to democratic discussion and choice.

Table 1: Bello's eleven key tenets for a deglobalized paradigm (TNI, 2009)

Luce (2017) views the Trump presidency as a 'terminal phase of elite apathy' that has taken popular support for granted through unchecked groupthink and 'data gurus and analytics'. In that regard Luce concurs with Bello that there is racial and cultural pluralism, but not income diversity, which has manifested populist and nationalist notions among national populations. Furthermore, while the April 2017 general election in France was touted to stop and/or reverse this trend the new President Emmanuel Macron, a former investment banker who supports a neoliberal agenda, has already dropped 10 points in popular support ratings to 54%, lower than either of his two predecessors, François Hollande or Nicolas Sarkozy at the same stage of their presidencies (Fenby, 2017). Wee (2017), supporting her discussion about sock manufacturing in the US, noted the broad appeal of working in manufacturing hasn't changed but that since the economic crisis job gains have been concentrated in lower-wage industries and occupations, employing 2.3 million more American workers than at the start of the 2008-09 recession. As a result, such jobs erode upward mobility and lead to frustration with entrenched governments as noted by Bello (2002), Luce (2017) and Packer (2013). Wee cites the Equality of Opportunity Project, which projects that children's prospects of earning more than their parents have dropped to 50 % from 90% over the past 50 years. In the UK, Delis (2017) argues that in the year after the Brexit referendum gross domestic product (GDP growth has slowed, the British Pound has depreciated 15% internationally, inflation has increased from 0.5% in June 2016 to 2.9% in May 2017, real weekly earnings in the UK have fallen 1% resulting in household savings of around 5% (the lowest since records began in 1963), and the UK's trade deficit had worsened to £35 billion by the end of March 2017. Thus, choosing populist and nationalist politicians and policies has not resulted in positive economic effects in either the US or UK, much of which may be related to uncertainty.

To summarise, are modern, global supply chains at fault here? And whether or not they are, how should managers approach this uncertain and turbulent situation and how can academics help inform their decisions? Altomonte & Ottaviano (2009) argued the rise of global supply chains was not the main cause of the severe, sudden and synchronized fall in global trade flows during the 2008-09 recession, however they also noted then there was insufficient data to corroborate that claim. Mandják et al. (2017) argued that an economic crisis may moderates a firm's relational behaviour, described by their focal company's network behaviour model (FCNBM) which uses constructs of valuable customer ***and*** supplier relationship, relationship strategy, delivery and innovation. They tested this model with 300 companies in Hungary, 253 SMEs and 47 MNEs, with marketing and sales managers answering questions related to

'customer' issues and manufacturing/operations managers answering questions related to 'supplier' issues. Mandják et al. found that strength of crisis perception has an effect on company network behaviour; the stronger the perception the more a company focuses on customer relationships.

We argue that effects of deglobalization depend upon whether a company only operates domestically or conducts business in international markets. We further argue, in a neoliberal context anathema to Bello, that for the most part those companies operate domestically are likely small to medium sized enterprise (SMEs) while those that operate internationally are likely multi-national enterprises (MNEs). Figure 1 presents proportionate levels of business and risk which SMEs and MNEs face in either domestic or international markets. The proportionate amount of business 'bubbles' and level of risk 'arrows' are not data based but are our intuitive considerations, which we consider representative. I.e. an MNE will derive most of its business in international markets and also face higher levels of risk (lower right quadrant) whereas an SME will derive most of its business domestically and high much lower levels of risk (upper left quadrant). However, our lack of evidence leads to our ***first suggestion*** that ***empirical research should be conducted on levels of business and risk both domestically and abroad for both SMEs and MNEs, including operations in the other two quadrants***, to validate our intuitive assertion.

However, we also consider we need a framework or typology of appropriate measures to assess deglobalization and its potential impact on logistics and SCM to add to our research suggestions. We examined three of the more rigorous consultancy/association reports to determine which measures may be useful. The first two discussed are not aimed specifically at deglobalization but feature many factors that we intuitively generated from our reading and seminars discussed above, while the third considers Brexit specifically. Brooke (2016) noted that supply chains have evolved into grids (as opposed to linear chains or network) and have five important criteria for consideration: *procurement*, *rules and regulations*, *manufacturing*, *logistics*, and *marketing and sales*. FrontierStrategyGroup (2016), in developing an attractiveness index for manufacturing in five Association of Southeast Asian Nations (ASEAN) countries, used six measures to build their index:

- *Labour conditions*: average wages, minimum wages, engineer's salaries, redundancy costs, literacy rate;
- *Transport infrastructure*: Quality of roads, quality of ports, quality of railroads, provision of infrastructure, ownership of infrastructure networks, quality of air transport, logistics competence;
- *Utilities (support infrastructure)*: Quality of electricity supply, electricity production, energy production, market access, broadband penetrations, mobile penetration;
- *Regulatory environment*: Investment freedom, tax rate, openness to foreign investment, prevalence of trade barriers, intellectual property rights; price control, quality control;
- *International trade conditions*: Efficiency of import-export, number of days to import and to export, cost to import and export;
- *Risk factors*: Gini coefficient of wealth distribution i.e. income inequality, corruption, equity risk premium, banking sector risk, natural disaster risk, critical infrastructure risk.

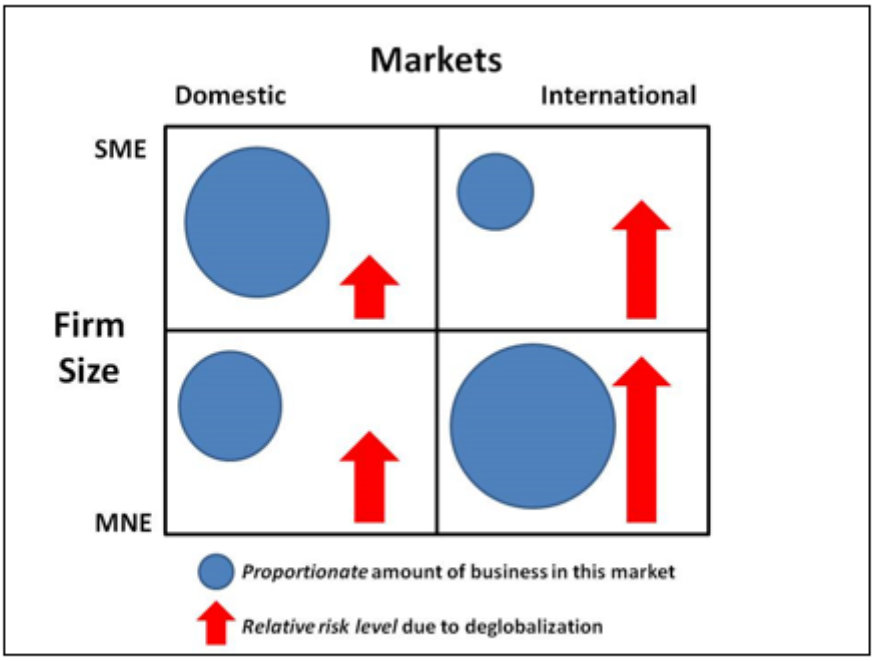


Figure 1: Deglobalization impact relative to firm type and size (Authors)

Finally, PA Knowledge Limited (2017) suggested there are four impacts on the automotive sector in the UK and European Union (EU) individually and combined: *margin erosion*, *added cost*, *longer lead times* and *higher vehicle prices*. They considered added costs due to tariffs and longer lead times would provide the most significant impact in all three scenarios, with margin erosion and higher vehicle price having less of an impact. The risks from these reports that would impact a company with such dramatic changes in its external environment appear to be costs related to labour, operations including procurement and production, and changes in rules and regulations. In a specific logistics/SCM context we see direct labour costs, rules in regulations as regards tariffs/customs costs, and operations as regards direct fuel costs. We would further add currency or financial costs, which was not specifically noted in the foregoing three but may have been implicit in several factors. Hence, our ***second research suggestion*** is to ***investigate these costs as they relate to deglobalization in logistics and supply chains*** to verify and validate their appropriateness and impact.

Risk registers have long been used in project management to identify, quantify and evaluate risks in terms of likelihood and potential impact (see for example Williams, 1994). We developed a simple risk register with a three value scale, a positive effect, no or a neutral effect and a negative effect to demonstrate a framework for considering deglobalization risk. Due to space restrictions for this paper we only show transport as one area of logistical and supply chain activities, and also only consider ocean shipping and road freight as two prime modes in the supply chain. Our framework is shown in Table 2.

Table 2 is self-explanatory and we again note it is based on our intuitive views from our inductive research approach. Hence, our ***third suggestion*** is for researchers to ***develop and empirically test such a framework for all logistical and supply chain activities***, building on findings from the second suggestion to verify and validate costs. Returning to Mandják et al. (2017), the nature of SCM as enumerated by CSCMP in its definition is built around relationships. While much work has been undertaken in logistics

service, satisfaction and relationship, some of it by this paper's author, our ***fourth suggestion*** is for researchers to ***investigate the nature and impact of deglobalisation on supply chain relationships in domestic and international markets from both a short-term and long-term perspective***. Finally, and in consideration of our fourth suggestion, our ***fifth suggestion*** is to ***undertake interdisciplinary and international research to investigate legal implications affecting various international trade agreement blocks*** such as the TPP, ASEAN, EU, and the North American free Trade Agreement (NAFTA); ***international business implications*** affecting inward or foreign direct investment, mergers and acquisitions and international market access; ***national, regional and international economic system trade-offs*** affecting regional/ free trade and their effects on industrial policy; and operational, cost and structural implications affecting domestic/ international supply chains, strategic procurement, local content, and regional trade agreements.

Conclusions

We began this paper with an assertion we are living in an increasingly nationalistic and populist world where deglobalization of logistics and supply chains, and related activities, is a real concern. This paper has provided a timely and relevant synthesis of deglobalization's major aspects as we see them affecting logistics and SCM together with five research suggestions. Our proposed research suggestions should informs logistics and SCM research over the next decade to address this paradigmatic shift. Further, this paper's discussion and research suggestions will provide practitioners with guidance for strategic management and decision-making in light of this uncertain phenomenon and associated risks.

Pivotal to this debate and the authors' research horizon is the promulgation of introducing a regulatory system which could strike a meaningful and workable balance between free trade and national concerns and embrace the positive dynamics of fit-for-purpose industrial policies. The need to install such a system balancing the facilitation of free trade whilst protecting national interests is imperative, although such a balance is difficult to strike, because its inherent features run against the grain of international normative and political dogma over the last century. The fundamental thesis of this paper is that we have been witnessing a *dilution of globalisation*, in the same pattern and analogy of having witnessed global warming and its effects on the environment. Although the fundamental principle of free trade is paramount to the world's political and economic systems, priorities of national or even regional systems will attempt to balance the positive effects of free trade with any adverse effects arising out of uninhibited market access to trade. How can this be achieved?

We offer a two-fold approach. First, free trade is only one dimension of globalisation. Free trade allocates resources where there is most beneficial to the owners of production factors. On the other hand, free trade opens numerous possibilities for economic growth based on diversification, mobility and policy intervention. The latter epitomises the need to instigate contemporary industrial policies. This approach aims at creating framework conditions under which improvement of national or regional competitiveness would compensate where necessary for market failure.

Secondly, a responsive and responsible political and economic leadership will provide contemporary and fit-for-purpose industrial policies across the world to harness the benefits of free trade whilst balancing negativities from ensuing industrial reorganisation. Such policies should be interoperable and aim at several tasks. The first is to set out boundaries within which industry and enterprise can flourish. The second task is to ensure that conditions are present for industry to develop and to realise its competitive potential. Finally, the third task is to ensure that the frameworks, institutions and instruments that are necessary for the business environment and for industry are able and capable to accommodate contemporary societal needs and requirements.

Logistical/Supply Chain Activity: Transport	Description	Likely Risk	Potential Effect (+positive, =neutral, - negative)
Ocean Shipping	Currency costs	Increase across borders without control	--
	Customs and regulatory costs	Increase due to reduced trade agreements	--
	Labour costs	Neutral or lower due to domestic sources	+
	Fuel costs	Increase due to purchasing abroad	--
	Modality capacity	Container Availability	+
	Infrastructure	Ports accessibility and control of infrastructure	+
Mode Overall Effect			≈ =
Air Freight	Currency costs	Increase across borders without control	--
	Customs and regulatory costs	Increase due to reduced trade agreements	--
	Labour costs	Neutral or lower due to domestic sources	+
	Fuel costs	Increase due to purchasing abroad	--
	Environmental costs	Increase due to air traffic and pollution effects	--
Mode Overall Effect			≈ --
Road Freight	Currency costs	No real effect within country but possible effect across borders	≈ -- → =
	Customs and regulatory costs	No real effect within country but possible effect across borders	≈ -- → =
	Labour costs	No real effect within country but possible slight effect across borders	≈ -- → =
	Fuel costs	Increase due to purchasing abroad	--
	Environmental costs	Increase due to traffic and pollution effects	--
Mode Overall Effect			≈ -- → =
Rail Freight	Currency costs	No real effect within country but possible effect across borders	≈ -- → =
	Customs and regulatory costs	No real effect within country but possible effect across borders	≈ -- → =
	Labour costs	No real effect within country but possible slight effect across borders	≈ -- → =
	Fuel costs	Increase due to purchasing abroad if diesel	--
	Infrastructure utilisation	Authorisation of track use and logistics issue of intermodal transport functions	--
Mode Overall Effect			≈ -- → =

Table 2: Example of an ocean, road and rail transport risk register due to deglobalization (Authors)

As in all research there are some limitations in this paper. The paper lacks significant evidence due this topic being nascent however our research suggestions will enable researchers to provide same. Also, our views may not be shared by the mainstream of logistics and supply chain researchers as there has been a critical mass related to globalization and its impetus due to global supply chains – hence our views may challenge orthodoxy and not be fully appreciated by colleagues.

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Urban Logistics

Towards a sustainable urban freight transport system – axes for intervention

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1. Introduction

Urban freight transport (UFT) is predominantly road oriented and despite its relatively low share as part of total traffic, it contributes disproportionally to the unsustainability of our cities (i.e., air pollution, noise, congestion, accidents) (Quak, 2008). Furthermore, UFT becomes increasingly challenging and expensive for the transport sector itself (Dablanc, 2007). Problems are present anywhere in the world but research mostly concentrates on specific cities, certain measures and distinctive freight flows. Generic research across multiple cities and freight flows is scarce (Kin, Verlinde, and Macharis, 2017). Although different authors apply the term '(sustainable) urban freight system', an actual definition of what such a system consists of is lacking (Lagorio, Pinto and Golini, 2016). A holistic framework that places UFT in the wider socio-economic context has recently been developed (Kin et al., 2017).

A framework to characterize the 'UFT system' in an urban area allows capturing its diversity. Additionally, it can be used to compare cities when focusing on the effectiveness of (sustainability) measures. Subsequently this contributes to the potential transferability of measures between areas, a recurring issue in UFT research (Timms, 2014). The purpose of this paper is to extend upon the framework and herewith list the different inefficiencies in our current UFT system. These inefficiencies are supported with data from different cities. Hereafter we elaborate on potential interventions to minimize these inefficiencies in the wider UFT system. The paper and its framework are based on previous research of the state-of-the-art in UFT.

2. Framework

UFT is studied from different angles but a holistic approach is lacking. Although the term UFT 'system' applied, it is not defined, what such a system consists of. In Kin et al. (2017) a systemic approach is used to develop a framework that allow characterizing the UFT system. The framework consists of three components: demand, supply and context. Any UFT system starts with a *demand* for goods that are produced elsewhere and must be transported to the demand location. This results in a demand for transport services that is met by a certain *supply* of logistics (facilities) and freight vehicles. The interaction between demand and supply leads to operations in logistics facilities and actual freight vehicle movements. Supplying transport requires the availability of infrastructure and land for logistics facilities. These are provided by the physical environment, or urban area, in which

both demand and supply take place: the *context*. Each component is influenced by different factors as shown in the figure below. Demand is affected by the size of the population in a city and its growth, as well as the gross domestic product (GDP). Furthermore, a distinction must be made between different supply chains as these are related to distinctive freight flows and a different organization of transport. Deliveries to a restaurant have different characteristics from consumer goods to retail chains, which again are different from home deliveries, waste and construction. We can link each component to one or more UFT stakeholders. The multi-stakeholder environment is a recurring topic in UFT research. Generally accepted as UFT stakeholders are receivers, shippers, logistics service providers, local authorities and citizens (Behrends, 2011; Verlinde, 2015). *Receivers* generate demand for goods and for transport. There are many types of receivers, ranging from households (home deliveries), to retailers, offices and restaurants. On the supply side, *shippers* who send goods, fulfil this demand (e.g., e-tailers, manufacturers). This interaction leads to logistics operations and actual deliveries by *logistics service providers* (LSPs). The movements take place in the context, which is regulated by *local authorities* and inhabited by *citizens*. These stakeholders have different roles and interests.

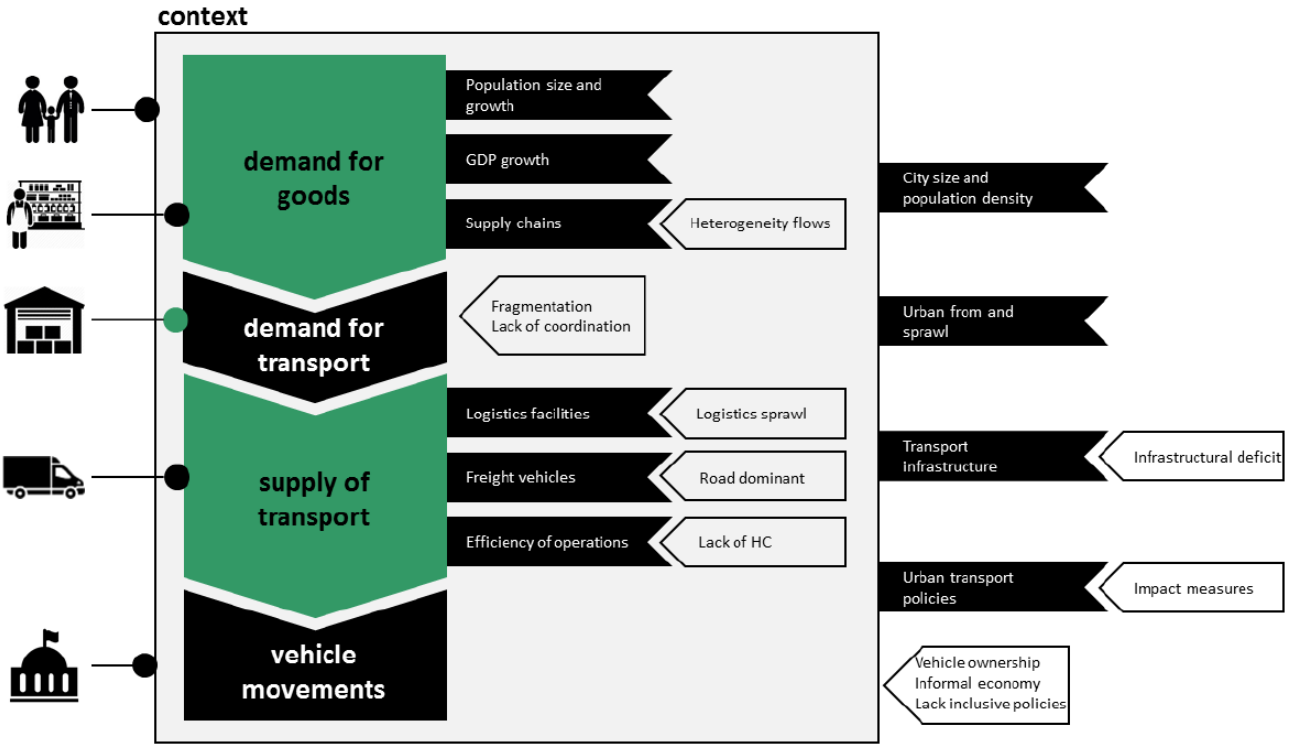


Figure 1: UFT framework including components, stakeholders, factors and inefficiencies

3. Inefficiencies

The interaction between the components in the current UFT system leads to three groups of inefficiencies (white arrows in the figure above), which might result in unsustainable freight transport.

3.1 Demand-Supply

A *fragmentation* of different freight flows, especially at a city level, is observed. This is driven by different factors: smaller volumes, more delivery addresses, increased replenishment frequencies, tight delivery time windows, lower inventory levels and just-in-time (JIT) deliveries (Alho and de Abreu e Silva, 2014; Macharis and Kin, 2017). Exemplary are home deliveries which is exacerbated by options such as same day delivery (Savelsbergh and Van Woensel, 2016). Additional problems are failed first time home deliveries and returned orders. In the UK, the failed deliveries amount to 12% (Visser, Nemoto, and Browne, 2014). The same applies to other freight flows that are not organized and coordinated centrally (e.g., restaurants, pharmacies). The similarity between the deliveries is that these are less-than-truckload (LTL) (Arvidsson, 2013; Quak, 2008). The inefficiency reveals itself in the inability of suppliers – both shippers and LSPs – to meet demand requirements. This leads to vehicles with a lower vehicle fill rate (VFR), sometimes even empty running (Arvidsson, 2013). There is an increase in the number of smaller vehicles, mostly vans. In Belgium the number of vans increased 6.5% annually (1997-2011) and in Brussels they represent 81% of all motorized freight vehicles in 2014 (Lebeau and Macharis, 2014). At the same time, Lebeau and Macharis (2014) indicate that 80% of these vans have a VFR of less than one tonne. Altogether, the main effects are the unnecessary presence of freight vehicles and increasing costs for companies. It is estimated that 28% of total transport costs occur in the last mile, in case of home deliveries this can be up to 75% (Arvidsson, 2013; Gevaers, 2013). With five stops in ten km, fuel consumption increases with 140% (Martensson, 2005).

A *lack of coordination and contractual obligation* is another efficiency that appears – particularly between the LSP and receiver (Verlinde, Macharis, and Witlox, 2012). In most cases, a receiver orders with a shipper, who contracts a LSP. The receiver and the LSP mostly do not consult each other on appropriate delivery time and place (Verlinde et al., 2012). A retailer, for instance, cannot easily agree on alternative delivery hours that might be beneficial to both himself and the LSP. Another example is uncoordinated deliveries to construction sites (Macharis, Kin, Balm, and Ploos van Amstel, 2016).

There is a *lack of horizontal collaboration* (HC) between stakeholders operating at the same level in the supply chain – particularly LSPs. Horizontal collaboration between LSPs is a mantra in UFT. Despite its potential benefits – higher VFR, reduction in costs and emissions – it is severely hampered by several barriers. These include finding a reliable party, a fair allocation mechanism to share workload, costs and benefits, and privacy issues (Cruijssen, Cools, and Dullaert, 2007). This is closely related to the competitiveness in the transport market. In Europe, 85% of the short-distance truck companies employ less than five drivers, while they carry out 80% of deliveries (Dablanc, 2011).

Supply chains in urban areas are highly *heterogeneous* with respect to different attributes such as product characteristics and receiver demands. For instance, some goods are perishable or fragile (food, medicines) and have to be transported conditioned. This hampers bundling potential with other goods. Waste is suggested as a reverse flow to decrease the number of empty rides (Gevaers, 2013). However, this cannot be easily be transported in vehicles that also deliver other goods. Other deliveries take place outside regular business hours (e.g., newspapers early morning).

3.2 Supply-Context

UFT is *road dominant*, mostly with motorized vehicles (Kin et al., 2017). This dominance is particularly worrying because commercial road vehicles are one of the least sustainable transport modes. It is also acknowledged that the negative impact of these vehicles is worse than of other motor vehicles such as cars and motorcycles (Anderson, Allen, and Browne, 2005). In London in 2005, 14% of all collisions involving goods' vehicles resulted in serious or fatal injuries. The numbers are worse for heavy goods vehicles (HGVs). In London, HGVs only compose 4% of total traffic, but they contribute to more than half of the fatal cyclist and pedestrian accidents (Arvidsson and Pazirandeh, 2017). These problems are reinforced by three factors. First, there is an unnecessary presence due to low VFR of vehicles. Second, some deliveries could easily move to more tailored road vehicles such as cargobikes. Finally, there is a considerable amount of old and polluting vehicles. In 2004, 25% of all vehicles used to supply the inner-city of Dublin were manufactured in or before 1994; only 15% of the vehicles were one year old or less (Dablanc, 2011). In Delhi, India, freight will contribute in 2021 to 5% of the vehicle kilometres but to 63% of PM and 48% of NO2 emissions (Jain et al., 2016).

An *infrastructural deficit* or overcapacity on the road network – caused by all traffic – is observed in most urban areas. The authorities (can) provide less infrastructure than is demanded by individuals and transport companies. The main outcomes are difficult accessibility to urban areas and congestion in general. The latter can be expressed as the congestion level, being the percentage of delay of a trip compared to a free flow situation. This is a permanent issue in cities globally: Mexico City (66%), Bangkok (61%), Istanbul (49%), Los Angeles (45%), London (40%), Paris (38%) and Brussels (38%) (TomTom, 2016). This has a twofold effect. On the one hand, traffic congestion in general leads to external costs for society and the economy as a whole. Congestion in European towns and cities is estimated to cost 1% of European GDP (European Commission, 2007). In Mexico City, the annual loss as a result of congestion is estimated to be $1.1billion and in Buenos Aires it costs an estimated 3.4% of GDP (Ifmo, 2013). On the other hand, the private sector faces increasing costs and difficulties to maintain their service level. Moreover, delays are said to be contributing to low VFR; drivers cannot finish their delivery round during their shift. During an eight hour working day, a driver can on average deliver 30 parcels or make 30 stops (Arvidsson and Pazirandeh, 2017). Next to roads, other types of infrastructure are also lacking for UFT. First, in different urban areas there is a problem with loading and unloading zones. The lack of these zones is caused by land scarcity, because they are simply not provided or because they are provided but not controlled (Muñuzuri et al., 2005). Finding a vacant spot leads to further delays for UFT. Many freight vehicles switch to on-street parking. In Kyoto, 85% of lorry and van drivers admit to perform on-street loading and unloading routinely (Aiura and Taniguchi, 2006). Other types that are insufficiently accustomed to UFT are rail and waterways. This is caused by different factors including the interference with passenger transport, the lack of (intermodal) terminals and their actual presence in urban cores (Behrends, 2011).

Traffic measures, including restrictions, are important in the light of liveable cities, but might hinder efficient UFT and even create additional problems (Quak, 2008). Local authorities are either less concerned or not aware of the interests of companies when they implement measures complicating UFT (Lindholm, 2012; Macharis and Kin, 2017). Therefore, *measures* do not always reach their intended effect or even produce *adverse effects*. The growth of vans in urban areas is not only driven by other delivery requirements but also by vehicle weight/size restrictions. In Manila, the Philippines, a truck restriction policy during certain times as well as on central roads has been implemented. In order to offer the same service level towards their customers, LSPs deployed more vehicles during a shorter period leading to more vehicle kilometres and a higher impact (Castro and Kuse, 2005). The lack of harmonization of policy measures between cities also causes inefficiencies and negative environmental effects (Quak, 2008). What further complicates the implementation of measures is the problem of transferability. A measure that is successful in one city is not necessarily working in another city due the local specificities (Timms, 2014).

The distances of facilities to urban cores are increasing because of *logistics sprawl*. This causes additional costs (fuel consumption, delays), contribution to congestion and higher emissions due to more vehicle kilometres travelled (Dablanc and Rakotonarivo, 2010). For the drivers the amount of non-value added time spent in traffic increases (Arvidsson and Pazirandeh, 2017). Again, this affects the VFR. Logistics sprawl is largely inevitable. Especially as cities grow and become denser, there is simply less space available for logistics facilities, whereas the available space becomes too expensive. Sprawl can also be uncontrolled. This is mostly the case in emerging economies where cities grow at an unforeseen pace. Governance is further complicated when this sprawl grows beyond administrative borders (Kin et al., 2017).

3.3 Demand-Context

Although the interaction between demand and context does not lead to freight transport operations directly, the wider socio-economic environment surely affects it. Rising GDP in urban areas leads, amongst others, to an increase in *vehicle ownership*. This considerably contributes to congestion. Besides wealth, motorization is further caused by two factors. First, some cities are car-dependent. These cities are characterized by low densities, sprawl, long length freeway per person and low or no share of public transport. Therefore, mobility needs are totally met by private cars (Ifmo, 2013). Obviously, this also influences the type of freight vehicles used. Second, the use of the car is further enforced by the lack of adequate public transport (Ifmo, 2013).

Cities, particularly in Latin America, Africa and Asia, are characterized by two economic systems: a formal and an informal one. The *informal economy* is more cash-based and labour-intensive. These parts are often located in the poorer socio-economic parts of cities. Although this is vital to the livelihood of many people, it leads to two types of inefficiencies. First, the existence of the informal economy reflects itself in the high presence of independent retail outlets (50 million globally). Supply of these stores is highly fragmented (Blanco and Fransoo, 2013). The second inefficiency relates to the lack of decent tax collection because of unregistered vehicles and businesses. This subsequently hampers the implementation of policies by the authorities (Kin et al., 2017).

The *lack of inclusive policies* is multifaceted. First and foremost, there is often no or only a marginal role for UFT in transportation policies (Lindholm, 2012). Furthermore, many cities lack comprehensive sustainability policies, including transport. UFT is a derived demand, coupled to economic growth and is an outcome of the larger socio-economic system. It is not a separate phenomenon as such. It is closely linked to other areas such as land use planning and the informal economy. Inclusiveness also relates to the involvement of stakeholders prior to implementing policies. The lack of stakeholder involvement is argued to be one of the core reasons for the failure of several (freight) transport policies (Behrends, 2011; Lindholm, 2012; Verlinde, 2015).

4. Discussion: axes for intervention

Efforts to minimize the negative impact of UFT focus mostly on the ones conducting the transport operations – the LSPs (Macharis and Kin, 2017). This has resulted in a range of approaches. A distinction can be made between two groups (Quak, 2008). On the one hand, *policy measures* implemented by the local authorities (for overviews, see Muñuzuri et al., 2005 and Quak, 2008). Although these can negatively affect the efficiency of UFT operations, they are unavoidable because of heavy urban traffic, worsening air quality, etc. Other policy measures drive positive changes; e.g., support for consolidation points (Kin, Verlinde, van Lier and Macharis, 2016). On the other hand, there is a wide array of *company driven initiatives.* As argued in this paper, the private (supply) sector, represented by shippers and LSPs is caught between the context (constraints physical environment and regulations) and demand. This is further reinforced by inefficiency caused by the stakeholders themselves – particularly due to a lack of collaboration. It is therefore argued that companies must adapt (for overviews, see Macharis and Kin, 2017 and Quak, 2008). Obviously, there are no clear-cut solutions as inefficiency is a combination of different factors and the inefficiency for one freight flow has a different origin than for another. We argue, that based on the framework, intervention can take place at two different levels. First, at the level of the components by the behaviour of the respective stakeholders themselves. Second, at the interaction between the components and their stakeholders. Below these interventions are illustrated with cases.

First, we discuss intervention at the three components (demand, supply and context). At the origin of the *demand*, behaviour by receivers is an important aspect. Although there are many differences between receivers, this mostly relates to ordering behaviour. Retailers located in the same district, for instance, can agree on a mutual delivery day or time. This has been demonstrated in the Motomachi shopping street in Yokohama, where the retailers' association decided to start a cooperative delivery system (Dablanc, 2011). Currently there is a lot of focus on minimizing the negative impact of home deliveries. Not only due to the high fragmentation but also since residential neighbourhoods are not necessarily suited to handle many freight vehicles. In this regard, another behavioural change is to offer customers the option to send parcels to pick-up points such as lockers. From a logistical perspective, shipments can then be delivered consolidated (Macharis and Kin, 2017). Bottom line is to minimize fragmentation in ordering and bundle different freight flows. Intervention on the *supply* side has different aspects. First, horizontal collaboration is a genuine possibility. Not only between LSPs, but also between shippers when they send their orders. Although they are acknowledged as an important stakeholder in UFT, they are only addressed directly in few studies. Due to specific requirements shippers pose on the ones to whom they outsource deliveries (e.g., order to delivery lead-time, delivery frequency), they influence the efficiency of last mile

deliveries. Moreover, it can be questioned whether the actual price of the delivery should be charged to the receiver. There is, for instance, no such thing as 'free home deliveries'. This could raise awareness and steer behavioural change. More coordination by shippers can also lead in increased VFR as demonstrated in Brussels. In the European CityLab project, the spare vehicle capacity of service-driven companies is utilized to supply independent retailers (CityLab, 2016). Second, action by LSPs mostly relates to more tailored transport. For instance, by using cargobikes rather than underutilized vans. Intervention in the *context* mostly relates to local authorities regulating urban areas. As elaborated, implemented measures might have an adverse impact. On the one hand, there is often little focus on freight transport, but more on passenger transport. This is for instance apparent with the implementation of pedestrian areas (Verlinde, Kin, Strale, and Macharis, 2016). On the other hand, there is little knowledge or at least awareness of other stakeholders. The lack of stakeholder involvement and consultation prior to the implementation of measures should be improved (Lindholm 2012; Macharis and Kin, 2017).

Intervention between the components and the respective stakeholders first relates to the axis of *demand-supply*. To minimize the inefficiencies, coordination between receivers and shippers/LSPs should be increased. This can lead to an agreement on delivery time (e.g., deliveries during less congested off-hours) as well as bundling deliveries. The latter refers to the widely studied concept of urban consolidation centres (UCCs) (Kin et al., 2016). Another possibility to optimize freight flows is to include reverse flows to minimize empty running of vehicles. A more recent possibility is to make use of the enormous amount of data that is being collected through mobile applications, sensors, etc. This cannot only be used to improve the efficiency of the supply chain, but also to align better with receivers (e.g., track and trace). Finally, supply stakeholders can offer benefits to receivers if they agree on an alternative delivery; i.e., pick-up, alternative – less congested – hours, etc. (Macharis and Kin, 2017). In this way, they raise awareness and can steer behaviour. Eventually the aim is to decrease the number of fragmented shipments and consolidating different freight flows (heterogeneity). *Supply-context* intervention also relates to more consultation and collaboration. Different studies show the lack of understanding between the different stakeholders. The discussion here is grouped around two aspects. First, rather than solely consulting prior to the implementation of measures, authorities can formalize cooperation in a freight quality partnership (FQP) or public-private partnership (PPP). FQPs can be used by policy makers, LSPs, retailers, environmental groups, etc. to meet regularly to address specific freight transport topics. Outcomes are the initiation of projects and the development of local transport plans (Lindholm, 2012). In a PPP, a partnership is established between the public and private sector, amongst others to fund, construct, renovate, manage or maintain infrastructure (Lindholm, 2012). Second, authorities can also reward behaviour. Particularly when LSPs conduct deliveries more efficient which leads to a decrease in the number of freight vehicles and herewith alleviate the pressure on the road network. Possibilities are (financial) support for UCCs, allowances for night deliveries, benefits when cleaner vehicles are used (e.g., wider time windows, less access restrictions) and the provision of infrastructure for intermodal transport (e.g., unloading quay for boats) (Macharis and Kin, 2017). Finally, intervention regarding *demand-context* is relevant since UFT takes place in the wider socio-economic context, which is constantly changing. It is, therefore, important to formulate inclusive sustainability policies that also include (freight) transport. Stakeholder consultation with citizens and receivers is important since they are the ones inhabiting urban areas. To alleviate the pressure of vehicles, investments in public transport are widely addressed (e.g., Ifmo, 2013). More specifically for UFT, the control and enforcement of specific unloading zones is put forward as important to avoid on-street parking and unnecessary detours. To enforce parking regulations, the city of Lisbon tested adapted parking meters and loop vehicle detection sensors (STRAIGHTSOL, 2014). Finally, a difficult but inevitable point is to tackle the issues related to the informal economy (Kin et al., 2017).

5. Conclusion

UFT is not a separate phenomenon but rather an outcome of the interaction between different components and the related stakeholders. These components are multifaceted and operate in a wider socio-economic system. The developed framework aims to bring structure in the complexity of the topic of UFT. Inefficiencies contribute to the current unsustainability of UFT; i.e., disproportionate contribution to transport-related emissions, a deficit between demand and supply for infrastructure leading to congestion, the lack of stakeholder involvement leading to ineffective measures, a fragmentation of freight flows. Intervention minimizes the challenges society and companies are facing. Supply is mostly caught between the demand side (e.g., requirements, heterogeneity freight flows) and the constraints of the context (e.g., congestion, restrictive regulations). At the same time, there are inefficiencies inside the supply component, such as a lack of coordination. Stakeholders operating in the UFT system have different objectives and play different roles across these components. Obviously, clear-cut solutions for every problem are not available. Nonetheless, improvements can be reached by stakeholder interaction (to create common understanding as well as consultation and actual cooperation) and considering the limits of the urban space. Nonetheless, inefficiencies are expected to remain to some extent; e.g., not all freight flows can be easily bundled and the informal economy continues to exist. It remains a difficult balance between those governing an urban area, mostly to improve liveability, and those conducting transport operations, mostly driven by financial incentives. Specific demand requirements by receivers further complicate this matter.

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Logistics organisations in smart cities: an exploration on theory

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Introduction

The emergence of smart city

During the last decade, the world has witnessed a rapid growth of cities. Nowadays, cities have developed into complex systems with high concentration of population. It has been estimated that by 2050, 70 per cent of the world's population will be living in urban areas (Lierow, 2014). This has increased the pressures on traffic congestions and environment pollutions (Kim & Han, 2012; Wu, 1999).

To coordinate this growth, the strategy of "smart growth", which encompasses a range of new policies for urban planning (Harrison & Donnelly, 2011), was proposed in late 1990s with the focus to sustainably control the growth of urban settlements at their fringes (Besussi et al., 2010). However, these strategies have been proved to be largely inefficient, and lessons have been learnt that more "*informed and intelligent*" strategies are needed (Besussi et al., 2010, p. 17).

Several years later, a number of technology companies (such as IBM, Cisco and Siemens) started to incorporate complex information systems into these strategies to integrate the operation of urban infrastructure and service such as buildings, transportation, electronic and water distribution, and public safety (Harrison & Donnelly, 2011). In this context, the exploration of how new technologies could be beneficial to manage our urban environment has emerged (Neirotti et al., 2014), and the concept of "smart city" started to populate.

Smart city

The smart city concept seeks to address how information and communication technology based solutions can contribute to a more liveable city environment (Manville et al., 2009). The notion of smart city is different from our current city due to its pervasive application of ubiquitous computing and digitally instrumented devices in the urban environment (Kitchin, 2014), which can be used to monitor, control and regulate city flows and activities, often in real-time bases (Kitchin, 2014). Consequently, smart cities are generating rich sets of data (Kitchin, 2014; Tachizawa et al., 2015).

Although, these data will be primarily used to better describe, model and predict urban processes and simulate the likely outcomes of future urban development (Batty et al., 2012), they can also be used to support business activities and growth (Kitchin, 2014). In this case, smart cities will be stimulating

new forms of service related organisations (Kitchin, 2014). This argument is supported by Lagorio et al. (2016) from the logistic perspective, who believe that smart cities are the creation of data-sharing platforms that provide solutions for logistics problems emerging from the lack of data regarding vehicle traffic flows and deliveries (delivery points, load factors, etc.). As such, the notion of smart cities will push future research on how organisation can exploit and make best use of this growing amount of data (Lagorio et al., 2016).

To understand logistics organisations in smart cities

Researches on smart cities have prioritised transport, mobility and logistics as one of the major enable dimensions (Giffinger & Gudrun, 2010; Neirotti et al., 2014). These researches (Atzori et al., 2010; Correia & Wünstel, 2011; Nam & Pardo, 2011; Greca et al., 2011) have demonstrated the benefits of the smart transport systems, with the focus on public transportation (Neirotti et al., 2014), such as intelligent road lane management systems for buses and private cars (Wang et al., 2014), smart parking systems for private vehicles (Tesoriere et al., 2014) and government funded projects aiming to improve public transport performance (Brdulak & Brdulak, 2015).

Freight transport, as part of city transport systems, seems to receive less attention. Although, there have been attempts to understand supply chain management in smart cities, the focus is on supply network complexity (Tachizawa et al., 2015; Öberg & Graham, 2016) and does not consider a logistic organisation perspective.

Theory has advantages over explaining and predicting phenomena (Hunt, 1991), and understanding theories provides an efficient way for field development (Wacker, 1998). As pointed out by Kuhn (1962), the use and development of theory is crucial for a discipline to progress and mature.

Numerous researches (e.g., Mentzer & Kahn, 1995; Stock, 1997) have described a greater need for use of theory in logistics and supply chain. Since no study has examined the theories in smart cities describing logistics organisations, this study will focus on exploring theories that are applicable to explain/predict the organisations of logistics in smart cities.

Methodology

In this study, the structured literature review been selected for its effectiveness on understanding trends and exploring gaps in the scientific literature (Lagorio et al., 2016), which is the nature of our research aim. This method has been previously applied to explore emerging topics in logistics studies (see Gligor & Holcomb, 2012; Gimenez & Tachizawa, 2012; Lightfoot et al., 2013).

The structured literature review aims to "*minimise bias through exhaustive literature searches of published and unpublished studies*" (Tranfield et al., 2003, p. 209) and "*report the evidence in such a way that allows reasonably clear conclusions to be reached about what is and is not known*" (Buchanan & Bryman, 2010, p. 671). Structured literature review involves certain research protocols (Denyer & Tranfield, 2009) and detailed documentation of the performed steps (Kupianine et al., 2015), which enables an in-depth evaluation of the conducted study (Lagorio et al., 2016).

By referring to studies (e.g, Lagorio et al., 2016; Cocchia, 2014) that have adopted the method of structured literature review, the following steps are developed:

Step 1: inclusion/exclusion criteria

First of all, a list of keywords was developed for initial search by referring to researches (e.g., Lagorio et al., 2016; Neirotti et al., 2014) that are related to our phenomenon of interest. Moreover, three databases were selected to provide a more comprehensive result. The starting year was selected as 2006 because, even though the words "smart city" was mentioned in paper in the 1990s (Cocchia, 2014), it was around the 2006 that the research attention of "smart city" started to develop (Cocchia, 2014).

In order to gain an overarching picture of the research on smart city and logistics, not only journals but also conference papers and reports were included for search. Based on the set of criteria presented in table 1, the literature search produced 698 articles across the three databases.

Criteria included	**Description**
Database	ProQuest, Business Resource Premier and Science Direct
Language	English and Chinese
Key words	*"Smart city" OR "Smart cities" OR "Smarter cities" OR "Smarter city"* AND *Logistics OR Supply chain OR "Freight transport" OR "Home delivery" OR "Urban delivery"*
Time range	2006 to Present
Resource selected	journals, reports, conferences papers

Table 1: Selection criteria for research search

Step 2: selection based on title and abstract

The first round of review was then carried out, trying to eliminate non-relevant articles. Based on reviewing the titles and abstracts of resultant papers, the number of relevant papers is reduced to 63. By eliminating duplicate articles, the final number of papers for full text reviewing was reduced to 26. The statistics for this are presented in table 2.

Database	*ProQuest*	*BRP*	*SD*	**Total**
No.	477	17	204	698
First round review	26	11	26	63
Eliminate duplication				37
Full text review				26

Table 2: Results of literature search

Step 3: full text reviewing and snowballing

The last step is to review the full text of the papers and identify the theories applied. After reading all the papers, 4 papers were not in the scope of our research, i.e., approach to computer systems design for smart city logistics. Moreover, the references of relevant papers were also checked to enable a more comprehensive search.

Theory identified

To the best of the authors' knowledge, only structuration theory and institutional theory are used to explain the interplay between smart cities and logistics organisations in articles reviewed.

Institutional theory. Öberg & Graham (2016) have applied the component of institutional theory to identify the environment pressures that smart cities have put on firms within supply chains. In their research, it is suggested that smart city initiatives have: 1) forced organisations to adopt technologies (in order to increase possibility of survival), and 2) led organisations to imitate each other's or one leading organisation's behaviour due to uncertainties (Öberg & Graham, 2016), once the environment is established (Dimaggio & Powell, 1983). Through the lens of institutional theory, they are, respectively, seen as coercive and mimetic pressures (Dimaggio & Powell, 1983).

Structuration theory. Both Tachizawa et al. (2015) and Kumar et al. (2016) have applied structuration theory in their research to studying the interplay between smart city with big data and supply chain reconfigurations. While Tachizawa et al. (2015) have taken an overall perspective on supply chains, Kumar et al. (2016) have focused on manufacturers. Tachizawa et al. (2015) argue that smart cities, in terms of better information availability, will push supply networks towards a denser and more decentralised structure. This conclusion seems to complement with Kumar et al. (2016) who take a technology perspective (e.g., 3D-printing, Internet of Things, automation) in manufacturing process, and argue that the manufacturers in smart cities will be moving towards a distributed paradigm with small scales that are located near to consumption (Kumar et al., 2016), resulting from less labour intense requirements, consolidation of production processes and suppliers collaborations in smart cities. In this case, it will eliminate nodes in supply chains both upstream and downstream.

Discussions on theories

Institutional Theory

Institutional theory emphasizes the role of environment pressures on firm activities (Ketchen & Hult, 2007) and explains what leads to the organisational isomorphism (Dimaggio & Powell, 1983). In order to conform to the environment pressures, organisation members within a field start to make rational decisions. As a result, a collective normative order (professions and widespread agreements shared by members of organisational fields) is conceived (Zucker, 1987). This common shared view broadly reflects the mutual responses of organisations in a field to their environment (Dimaggio & Powell, 1983), conforming to which increases organisations' probability of survival in long-run (Meyer & Rowan, 1977), thereby making organisations similar (Dimaggio & Powell, 1983).

Through the lens of institutional theory, it can be understood that smart cities are creating a new environment for organisations and new norms coming from external environment will be expected. These new norms will pressure firms within to adopt technologies and face with the uncertainty created by big data. For logistics organisations, once a leading company in the field starts to incorporate higher level of technology in business, others will follow. In the case, institution theory tells us that logistics organisations in smart cities will have a higher level of technology adoption and these technologies will be similar across different companies.

Structuration Theory

Structures, in structuration theory, are viewed as codes of behaviour and knowledge storage existing in workers' heads, which steer individual and collective organisational actions (Giddens, 1984). Barley (1986) applied the structuration theory to study information technology, and argues that the adoption of information technology in organisations will alter workers' thinking and behaviour, and thus physically and socially changes the structure of the organisation (Barley, 1986). By extending Barley's (1986) work, DeSanctis and Poole (1994) developed a framework called "adaptive structuration theory" and argue that advanced information technologies "trigger adaptive structuration processes which, over time, can lead to changes in the rules and resources that organizations use in social interaction" (DeSanctis & Poole, 1994, p. 142-143).

Smart cities provide organisations within a better chance to adopt more advanced information technologies to business. The new wave of technology adoption will, according to structuration theory, affect people's opinions on decision-making: managers and employees within organisations will steer their business in a different way, thus affecting how their business performs. Information technologies currently have a pervasive role in logistics organisations (Lewis & Suchan, 2003), and this role will only be amplified in smart cities. As such, structuration theory seems to suggest that in smart cities, the adoption of technologies will change the business performance of logistic organisations. This performance change could be reflected in better efficiency or a new business model.

Summary

Institutional theory and structuration theory have explained how smart cities, as a different form of city planning, affect organisations by creating news norms and pushing new business structures. However, smart cities may be seen as the results of technology advancement and city innovation (Nam and Pardo, 2011), they are based on our current cities after all.

Following this logic, the theories that have been used to explain current logistics organisations should have their contributions in smart city context. The question to ask is why they are not spotted in our literature review, for example, transaction cost economics and resource-based view. Of course, this can possibly result from the authors' knowledge limitation and research scope. Therefore, the next discussion will focus on the exploration of some popular theories in current logistics research and their potential applications in smart cities.

Popular theories in current logistics research

According to the research by Defee et al. (2010), transaction cost economics (TCE) and resource-based view (RBV) are the most two commonly applied theories in logistics and supply chain manage research. The following discussions will be carried out around these two frequently used theories.

Transaction cost economics

TCE, which has the origin in economics theory, was further developed by Williamson (1979). As pointed out by Garfamy (2012), TCE is the combination of the economic theory with the organisational theory, to decide the best type of relationship one company should build up with others in the marketplace. In TCE, the transaction costs are the costs of creating, using, changing, maintaining and governing the organisation of economic activities within a vertically integrated firm or in a market (Garfamy, 2012). The overarching goal of TCE is to maximise the performance while minimise the transaction costs within and between organisations (Ketchen and Hult, 2007). In logistics and supply chain research, TCE has been applied extensively to explain, for example, supply chain process integration, supplier selection and inter-firm collaboration (Defee et al., 2010).

In smart cities, logistics organisations will be impacted by how non-logistics organisations are going to make "buy or make" decisions, which offers a perfect fit for TCE (Williamson, 1979). On the one hand, big data environment and new technologies may enable non-logistics organisations with an easier access and low costs to doing logistics by themselves, thereby diminishing the level of asset specificity on logistics. As a result, it will result to firms with self-organised logistics.

On the other hand, smart cites have also been identified as uncertain business environment due to information explosion (Oberg & Graham, 2016) and testing phases in large (Manville et al., 2014). In this case, firms will be trying to reduce the environmental uncertainty by staying closer to their partners (Garfamy, 2012) through a more formal mechanism that supports cooperation among them (Tachizawa et al., 2015). This formal mechanism will be based on standards, contracts, formalised processes and control systems (Alvarez et al., 2010). As such, the transaction costs for altering decisions on logistics will inevitably increase.

Resource-based view

According to Barney (1991), RBV examines how certain assets and capabilities lay a foundation for competitive advantage and superior performance. RBV treats an organisation as a bundle of resources, and asserts that resource heterogeneity should exist among organisations (Ketchen & Hult, 2007). These resources are owned by companies that are valuable, rare, imitable and non-substitutable (Defee et al., 2010). The extensions of RBV have resulted in several theoretical refinements, for example, knowledge-based view, core competency and capabilities theory (Defee et al., 2010).

As discussed previously, smart cities are supported by collective implementations of technologies, and will push organisations within to adopt technologies. Through the lens of RBV, however, the simple adoption of freely available and common technologies will not create competitive advantage for logistics organisations in the long-term as these technologies are necessary. In this case, Ray et al (2005) have argued that information technologies should be complemented with an organisation's existing resources, such as culture and relationships.

Other theories

It can be argued that many theories have been applied or borrowed into logistics and supply chain research field. Other theories, such as contingency theory, resource dependency theory and game theory, have also been applied in researches among others. Due to the research limitation, these theories, with less popularity, are excluded from discussions in this paper. However, further research agenda will be scheduled to study their applications in smart cities.

Conclusions

This paper has examined theories identified in current logistics and supply chain research in relation to smart cities. To the best of the authors' knowledge, two theories, institutional theory and structuration theory, are identified from structured literature review. According to institutional theory, it is suggested that smart cities will create new norms for logistics organisations, which may lead to a high level of information technology adaption. In this case, structuration theory suggests that new technologies will alter workers' thinking and behaviour, and thus affect managers' and employees' opinions on decision-making, leading to a different way of steering organisations. This could be reflected in different business performance or a new business model.

By combining the two most commonly theories (TCE and RBV) in current logistics and supply chain research, the following theoretical framework, along with some propositions, are developed to explain/predict logistics organisations in smart cities, which are shown in figure 2.

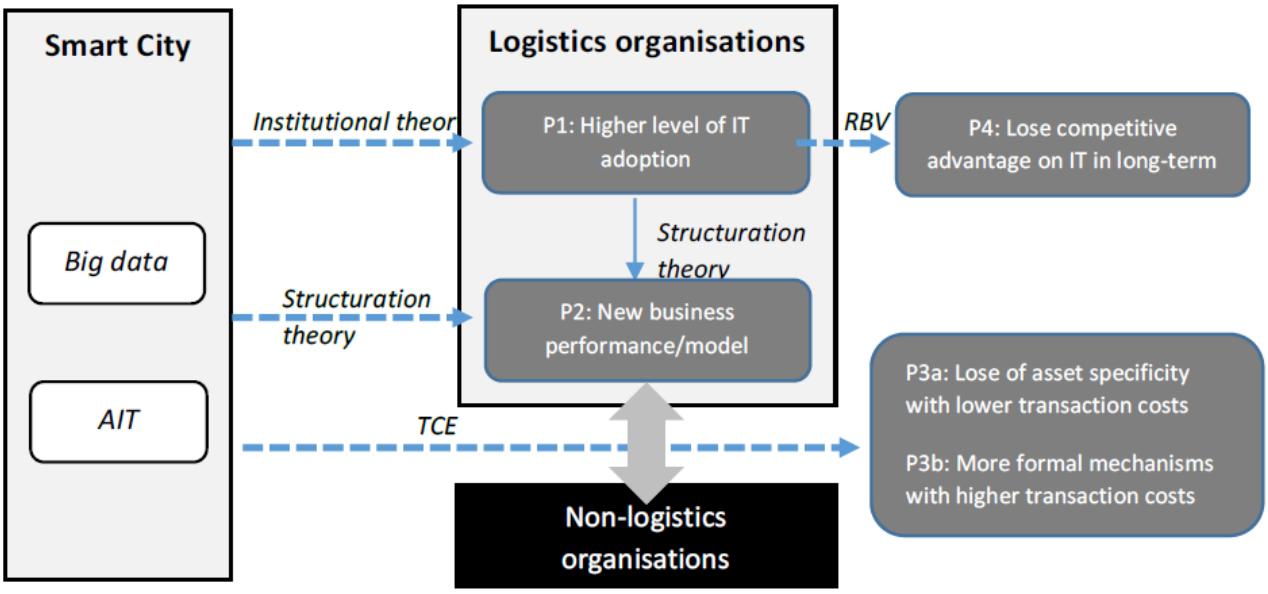


Figure 1: Conceptual framework of logistics organisations in smart cities

- *Proposition 1: Smart cities will push logistics organisations to adopt a higher level of IT.*
- *Proposition 2: The pervasive use of IT in smart cities and higher level of internal IT adoption will lead logistics organisations to a new business performance or model.*
- *Proposition 3a: Smart cities will enable lower transaction costs on non-logistics organisations due to lose of asset specificity on logistics.*
- *Proposition 3b: Smart cities will enable higher transaction costs on both logistics and non-logistics organisations due to a more bounded relationship against environmental uncertainties.*

- *Proposition 4: In smart cities, logistics organisations will lose competitive advantages on IT adoption in the long run.*

Research limitation and further study

The most crucial limitation in this research is shown on the identification of theories for relevant articles, and the interpretation of theories to smart cities. This could be greatly alleviated by experienced researchers with better knowledge of theories. Research time and resource also stand as major factors that limited our research.

Future studies will focus on two parts. First, test of the propositions made in this paper against academic evidences, and second, the explorations on other theories, such as contingency theory and resource dependency theory, along with their applications in smart cities.

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Demand Planning for Novel Modes of Transport: The Case of The Northampton Mole

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The study identified the conditions under which an urban freight pipeline could be viable. Other implementations, e.g. within a port hinterland or SRFI, are also indicated.

Introduction

Urban freight activity is a normal consequence of a healthy town centre. The quest for vibrancy and a sense of community that characterises many local authority strategic plans is often answered, in part, by the development of a strong retail offer and a vibrant night-time economy in parallel with policies to retain a substantial residential population within the town centre. All three of these components result in significant levels of delivery and servicing traffic that must compete for space on the road network with passenger transport.

The challenge for urban planners is to develop predictive models that are able to respond to changes in policy, behaviour and economics, whether planned or unplanned. For many years, it has been known that the most important factor is land use (Mitchell, 1954). Any attempt to forecast demand must therefore begin with a detailed understanding of the spatial distribution of retail, commercial, residential and service infrastructure within the study area.

The accuracy and level of detail of this initial land use data will have a powerful effect on the final model. Ideally, the model should be validated against survey data, such as traffic counts, cordon surveys (Where did your journey start? Where will it end?), interviews with shopkeepers and office managers, etc. However, in practice, such data is not available for the town in question and the planner is obliged to utilise estimates derived from studies of other towns and cities.

The planner is therefore exposed to the risk that the data from the reference location is not easily transferable to the study location. Data needs vary depending on the issue/s concerned, the planning and policy framework in which the issue arises, established practice in data collection, and the availability of previously collected data (Ogden, 1992). Cost may often be an issue (Holguin-Veras, 2012) and relatively few data sets may be available (Browne, 2007).

In investigating the transferability of data, Ibeas et al found that factors such as the structure and size of the town or city and the regulation of freight traffic could not be generalised into assumptions that could be transferred to another study location (Ibeas, 2012). However, the distribution of freight by type followed a very similar pattern, as did the quantities of goods delivered per vehicle.

In the UK, over 30 surveys of urban freight associated with retail activity have been conducted in the past 15 years (Cherrett, 2012). When studied in aggregate, we find that the mean number of visits per establishment is highly variable, at 9 per week with a standard deviation of 5.8. For this reason, Cherrett et al recommend using the median figure of 7.6 deliveries per week. There is an even weaker correlation between delivery frequency and floor area, since larger stores tend to use larger vehicles, especially when they are part of a centralised logistics solution.

This last point is of significance since it is often a stated aim of economic regeneration that a town centre shall develop a “café culture”, comprising many small independent shops. Such a retail structure is more likely to be served by a decentralised supply chain (in contrast to the centralised system that serves many larger retailers) and therefore implies an increase in servicing and delivery traffic over that expected for the amount of retail footprint present (Allen & Browne, 2008).

The Four Step Model

The classical methodology for preparing an urban transportation model (McNally, 2007) requires the researcher to progress through four key stages:

Trip Generation, in which the frequency of journeys between origins and destinations is determines through reference to land use, demographics and other socio-economic factors

Trip Distribution, whereby the various origins are matched with their respective destinations.

Mode Choice, providing an estimate of the choice of mode of transport to undertake each trip, and

Route Assignment, in which each trip/mode pair is allocated to a particular route

The four-step nomenclature of this model is somewhat misleading, since a significant amount of pre-work must be done before the Trip Generation stage can be started. The pre-work comprises the understanding of land-use, socio-economic and other factors referred to above.

Nevertheless, this modelling approach is almost universally applied, even though its failings have been well-documented for many years (McNally, 1986). The successes of the Four Step Model (FSM) are often measured in aggregate terms; its ability to inform transport policy is regularly questioned.

However, in situations such as the introduction of an entirely new mode of transport, such as the construction of a freight pipeline, the FSM can be relied upon to give a reliable estimate of the modal shift on existing traffic volumes.

Land Use and Socio-Economic Factors

If we are to be able to use data from other studies to inform an estimate of freight traffic in Northampton, we will need to be clear how the various influencing factors map across from the original study locations to that of Northampton.

Retail

Northampton's town centre retail businesses have been the subject of several studies in recent years (CACI Ltd., 2008) (Roger Tym & Partners, 2011). All of these studies have highlighted the closeness of Northampton's retail provision to the national averages.

Northampton has been assessed as being capable of sustaining a further large grocery store, and is considered to be under-provided with healthcare and household goods retailers. All other categories are within +/- 2% of the UK average, with the vast majority within +/- 1%.

Economic activity within Northampton is also very close to the UK national average (Roger Tym & Partners, 2011), as are many other statistical indicators. Comparing Northampton to data gathered through surveying any given town may carry with it the risks of transferability outlined above. However, we find ourselves in the fortunate position of being able to apply the central estimates derived by Cherret et al to Northampton's retail situation, without concern of over-extrapolating from dissimilar locations, since Northampton retail is so close to the national average.

Retail activity in Northampton town centre is geographically concentrated around the market square. This situation has changed little since the town's expansion in the 18th Century, however the greatest concentration of larger retailers is to be found in the Grosvenor Centre and along both the North and South sides of Abington Street.

The importance of the Grosvenor Centre is reflected in the relative rents for retail units. A brief survey of available units, undertaken in May 2015, showed a wide variation of asking prices (Table 1).

Rents were strongly correlated to the known density of shopper footfall within the Centre and in Abington Street outside. The upper floor of the Grosvenor Centre is less-favoured over the lower, whilst the Western end of Abington Street is greatly favoured over the Eastern end.

Zone	Description	sq.ft	Annual rent	Rent/sq.ft	Max.	Min.	Mean
A	Abington Street	1200	40000	33.33	69.21	27.53	48.34
		2440	85000	34.84			
		997	69000	69.21			
		1453	40000	27.53			
		913	52000	56.96			
		440	30000	68.18			
B	Drapery	257	14500	56.42			
C	Grosvenor	684	55000	80.41	80.41	25.08	44.12
		2089	120000	57.44			
		2267	75000	33.08			
		2239	115000	51.36			
		1495	37500	25.08			
		1160	33000	28.45			
		909	30000	33.00			
D	Gold Street						
E	St Giles						
F	Market Square	2337	75000	32.09			
G	St Peters	1277	20000	15.66	21.95	15.66	19.22
		748	15000	20.05			
		911	20000	21.95			
H	Bridge Street						
I	Guildhall	1048	15000	14.31			

Table 1: Indicative Rents by Zone, May 2015

Comparative retail is responsible for over half of the retail floorspace in the town centre, nearly twice that taken up by services, though the number of units is almost the same (Table 2).

	sq. ft	sq. m	% sq. m	Units	% Units
A1 Comparative	794162	73780	52%	215	38%
A1 Convenience	108220	10054	7%	42	7%
Services	411074	38190	27%	219	38%
Vacant	225073	20910	15%	97	17%
Total	1538529	142934	100%	573	100%

Table 2: Town Centre Diversity by Floor Area and by Unit

The figure of 17% vacant units is slightly higher than the UK average. Vacant units may be found in all parts of the town; there is no particular focus to their distribution.

There is some evidence that the high rents in the Grosvenor Centre (and especially the adjacent Peacock Place) result in vacant units remaining vacant for longer than other locations.

Large Industrial Concerns

The majority of industrial businesses in Northampton are located outside the town centre, typically in locations to the West and South-West.

The exception is the local brewery, which has an entrance to the immediate South of the town centre and one of the lower ring road. The brewery is one of three significant operations in Northampton: the brewery and bottling facility itself in the town, a national Distribution Centre to the West of the town and a container store in to the North. The NDC and Container Store are operated by third-party logistics contractors.

In March 2014, a planning application was made to centralise the NDC and container operations on a new site to the East of the town. This application met with significant resistance from local residents, chiefly over concerns about HGV traffic. The application was withdrawn in July 2014.

The application process was supported by a significant body of operational data, which we are able to use to develop an estimate of HGV and other goods traffic that would be compatible with transport by freight pipeline.

A proposal for a district heating / energy centre was similarly used to model a flow of biomass to the facility and of ash away from it. The energy to power the freight pipeline system can be supplied from the energy centre, which in turn, can receive its biomass feedstock via system.

Large Office Locations

Most of the largest office complexes in Northampton lie outside of the town centre. The largest employer with offices in the town centre is the Borough Council.

Project Angel is a development of former industrial land to the South of the present Town Hall. The new building will facilitate the consolidation of multiple local authority offices into a single location.

In contrast to retail locations, very few delivery and servicing studies have been completed on large office developments. The two most comprehensive reports relate to the former Croydon Council buildings and to Palestra, the headquarters of Transport for London in Southwark.

A further study was undertaken by the Crown Estate in support of their plans for the redesign of the public realm in Regent Street, in London. All three surveys date from 2009.

Forecasting Demand for Urban Freight in Northampton

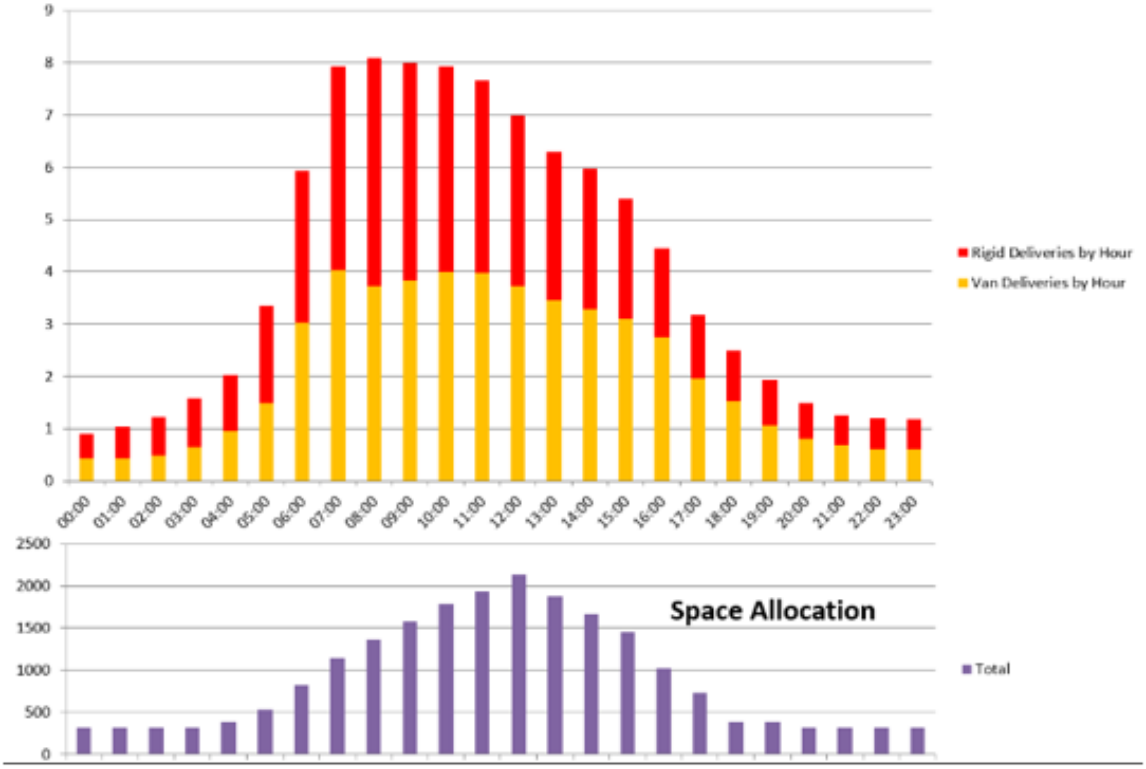
Published data concerning the occupancy and type of activity located at addresses within Northampton Town centre was verified and/or updated through a combination of Google Earth searches and pedestrian survey.

Two early morning surveys were conducted to establish the frequency of servicing and delivery traffic to the principal retail streets. Delivery schedules to the principal retailers was established through a combination of prior knowledge (the research group contained a nationally-significant 3PL contractor) and direct enquiry to the store management.

Freight activity for the main industrial user was assumed to match that identified in recent planning applications. Freight and servicing activity for the large office locations was derived from trip generation observed at Croydon and Palestra. Transport of packaging waste was also considered at accepted rates of generation.

The initial output of this sequential approach was to derive an overall freight potential for the pipeline system. This figure was then used to select a specific construction and capacity configuration, ensuring that the selected system was capable of providing the speed of response that the retailers, in particular, would require whilst offering the capacity for future expansion.

The consolidation centres are required to hold stock, to provide the necessary buffer against variations in consumer spending during the day. By way of illustration, one of the intermediate operational profiles (for decentralised retail) is reproduced below:



The choice of system – a 2.4m dual bore pipeline constructed by a cut-and-cover method – applied a restriction on load height to 1.4m. This constraint affects the attractiveness of the system to certain users, and necessitates a further iteration of the trip generation/trip allocation process.

One of the principal lessons of the Regent Street consolidation centre project was the reluctance of users to consider the alternatives if their existing deliveries were provided by centralised networks. The larger multiple grocers are an obvious example, but many smaller pharmacies, for example, are also served by centralised wholesaler networks.

The process of trip generation / trip allocation therefore evolves into a process of estimating uptake of the new system. Given the front-loading of the project with construction cost, this estimate of uptake can be very influential on the overall viability of the pipeline.

The differentials between retail rents and storage rents are a key driver in promoting uptake. Lessons from the Meadowhall consolidation centre have shown that retailers are able to increase

their customer-facing floor area by as much as 10% if remote stock is reliably available within 20-30 minutes transit time.

The geographical concentration of likely users was established by postcode. This spatial data was then used to inform further assumptions on the location and number of access/egress points from the system and also the "last mile" route to the town centre.

A decision to utilise a disused railway line for the majority of the length of the route was easily taken, especially since the nature of the pipeline construction (a partially-submerged box) was found to enhance flood defences in the area. The "last mile", however, was more problematic, since it necessitated construction of a fully tunnelled approach to the town centre terminus.

Results

A 3.4km freight pipeline, running along a disused railway line for ca. 85% of its length, was found to be financially viable under a range of operating scenarios. However, all of the viable scenarios required the participation of the industrial sector, whether the brewery or the energy centre.

Retail and leisure activities were not, in themselves, sufficient to produce a viable commercial proposition.

The benefits arising under the best-case scenario can be categorised as:

- Direct cost savings of approximately 15% of truck operating costs
- Indirect cost savings from being able to design, operate and achieve the benefits of reliable Just in Time supply chains for users without centralised distribution
- Social benefits from a reduction in the levels of congestion, increased safety
- Increased resilience as unaffected by weather, accidents, road works, etc.
- Environmental with reductions in carbon, other air pollutants, noise levels and infrastructure damage.

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Workspace Capability design

Transport poverty in the logistics workforce: an empirical investigation

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Introduction

In the current globalised economy, many segments of the value chain have been off-shored to other economies still strongly relying on manufacturing. Thus, the logistics industry has become a prominent source of employment in the UK. Within this scenario, local authorities are taking an active role towards improving the local economy by attracting businesses to their area in order to maximise added value, promote growth and create employment opportunities for the local communities. This growth strategy often involves the regeneration of former industrial (brownfield) sites into new establishments, such as office spaces, business and retail parks. The logistics and distribution industry has played a prominent role in this regeneration process and, as supply chains become ever-more global, these new logistics facilities provide a response to an increasing need for the coordination of product flows and consolidation of imported goods in preparation for onward distribution.

However, these new business parks are often located on the outskirts of town and city centres that are very easily accessible from the existing road network (including motorways and major highways), but suffer from a distinct lack of public transport accessibility options (Lucas, 2006). This presents a problem around access to work for the many hundreds of low and semi-skilled workers employed by organisations located at these out-of-town parks, many of whom will be employed on the minimum wage, basic salaries, temporary or zero-hours contracts. These dynamics may pose huge obstacles to the development of the industry, as they may result in poor workplace accessibility for employees that are often employed on very precarious conditions; this might also lead to recruitment difficulties for companies, due to the perceived insecurity of jobs.

In today's service sector economy, the work in the logistics and distribution industry revolves around a 24hour – 7days per week operation, and is staffed over multiple shifts that require employees to commute between work and home during often unsociable hours. Thus for many employees, the nature of their work (warehousing and logistics related activities) is far from the traditional Monday to Friday, 9am to 5pm working patterns that the UK public transport system generally conforms to. To add to this, workers are resourced from far and wide, often residing in more urbanised areas (towns and cities) where housing is more affordable but that are some considerable distance from their place of work (McQuaid and Chen, 2012), and are unlikely to be situated on a direct public transport link/route to these new distribution parks. Evidence suggests that there is clearly a 'mismatch' between the identified logistics park locations and the pre-established public transport network that could result in a number of potentially negative impacts, including: worker quality of life (especially those on minimum wages); relative ease of recruiting employees; sustainable transport commuting behaviour; and operational effectiveness.

This research adopts a case study approach to investigate the impact of current transport systems on access to work for employees in the UK logistics and distribution industry. Specifically, this paper considers the workforce at a major distribution centre located on the outskirts of a major conurbation in the South Yorkshire (UK) area. Employees were surveyed (using a structured questionnaire), in order to evaluate their travel-to-work habits and related employment challenges. Based on the analysis of the responses to the questionnaire, key findings are drawn.

The remainder of this paper is organised as follows. The next section provides a concise literature review, mainly focused on the issues of transport poverty and on its potential impact on the workforce in the logistics industry. Then, some methodological notes are illustrated, in order to describe the research approach and the data collection and analysis methods that were followed for conducting the study. Some preliminary results are shown, from which some implications are drawn. Finally, conclusions and directions for further research are provided.

Literature Review

The regeneration and conversion of former industrial out-of-town sites into distribution centres and warehouses raises the issue of access to labour. Indeed, with many hundreds of employees required to work in these establishments, the low skilled nature of many positions will mean that, in many cases, these workers will be employed on low wages, thus they will mostly be reliant upon public transport to get them to and from work. Also, the nature of work in these establishments (i.e. warehousing) is often a 24-7 operation that is staffed over multiple shifts, meaning that employees will be required to get to and from work during unsociable hours. The nature of the public transport system is often following established schedules that conform to traditional Mon-Fri 9-5pm working patterns. To add to this, workers are resourced from far and wide, often living in more urbanised areas (towns & cities) that are some distance from their workplace and unlikely to have direct public transport links to these new parks. Thus there is clearly a mismatch between logistics parks locations and the pre-established public transport network that could be having negative impacts on workers' quality of life (especially those on minimum wage); relative ease of recruiting employees; and operational effectiveness.

With two-thirds of job-seekers not having access to a car and the cost of public transport rising, it is not surprising that these issues are becoming increasingly relevant in many parts of the UK, as the lack of access to transport alternatives is at risk of cutting off from work at least half a million people (Sustrans, 2015). According to research by O'Hara (2015), lack of affordable public transport is one of the main reasons for the unemployed turning down job offers, a situation that has significantly worsened in the last few years due to funding cuts to both local authorities budgets and benefits induced by the current austerity regime. Focusing on selected case studies from the logistics industry in the North of England, this research will perform an initial review of the connectivity between out-of-town logistics parks and local transport networks.

Over the last two decades carbon reduction policies, rapidly fluctuating oil prices and stagnating real incomes have drawn increasing attention to the overall efficiency of the transport sector in Europe. Also, the evaluation of the social performances of transport systems has become an element of interest to many scholars and policy makers (see, for instance, Schwanen.et al., 2015). Specifically, it has been acknowledged that poorly-designed transport systems may have the potential to have a detrimental effect on people's quality of life and employment opportunities. In this context, Kenyon et al. (2002) defined the concept of *mobility-related social exclusion* in terms of *the processes that prevent people from participation in the economic, political and social life of the community because of reduced accessibility to opportunities, services and social networks*.

In the UK context, there has been an ever-increasing trend in terms of car-ownership (Department for Transport, 2014). It is worth reporting that, in 2010, 22% of women and 17% of men lived in households that did not have car; in 1975, both these proportions were about twice as high. While this phenomenon has been described as generally positive, car-dependency has produced a significant alteration in terms of transport policy development. Specifically, there is evidence to claim that, coupled to public transport deregulation, it has reduced the viability of other modes and significantly contributed to poorer local environments, playing a significant role in the exclusion of already vulnerable sectors of the British population (Lucas, 2004; Dibben, 2005; Lucas, 2006).

In fact, in many parts of the UK it is now virtually impossible to perform simple day-to-day tasks by relying purely on public transport. Indeed, the proportion of households who find it difficult to access essential local services is much higher for those without cars than for those with cars. For example, around 5-8% of car-owners report difficulties accessing supermarkets, post offices and GP surgeries, compared with 18-20% for those without a car. Access to hospitals is much more difficult for both groups, with 20% of those with a car and 40% of those without a car reporting difficulties (Department for Transport, 2014).

The impact is even more dramatic when looking at the interaction between the transport systems and the job market. As revealed by PTEG (2015), about three quarters of the jobseekers outside London do not own (and do not have access to) personal motorised transport (i.e., car, van or motorbike); therefore, they can face significant barriers in finding work as a result. In the UK, unemployment levels remain high following the recent economic recession, particularly amongst the Under 25's. From May to July 2015 there were reportedly 8.99 million people aged between 16 and 64 who were regarded economically inactive or unemployed; and in August 2015 the number of people claiming unemployment benefits in the UK rose by 1.2 thousand (Trading Economics, 2015). The PTEG (2015) study reports that the most significant barriers to employment opportunities include expensive public transport tickets; poorly connected employment sites; mismatches between working hours and available transport; and limited travel horizons. According to research by O'Hara (2015), lack of affordable public transport is one of the main reasons for unemployed people turning down job offers, a situation that has been significantly worsened in the last few years due to funding cuts to local authorities budgets, allowances and benefits induced by the current austerity regime. These findings are consistent with the international academic literature stating the positive correlation between availability of public transport and employment rates in urban areas, with a special emphasis on deprived neighbourhoods (see, for instance, Ricciardi et al., 2015; Tyndall, 2015).

The logistics and distribution industry is traditionally labour intensive, requiring high numbers of low-skilled workers to be employed as warehouse operatives working on round-the-clock shift patterns to facilitate a 24hrs a day, seven days a week business operation. For logistics companies the selection of location for distribution centres is generally focused on adopting a site that provides a balance between the lowest costs and greatest efficiency in order to meet operational and strategic objectives (Thai and Grewal, 2005). Thus, these large warehouses and manufacturing sites are usually located some considerable distance outside urban areas for ease of access to motorway networks and or port terminal infrastructure, as opposed to proximity to public transport alternatives for the workforce. Coincidentally these locations are also where local authority planners encourage large developments due to the cheaper, available land and ability to segregate the visually intrusive warehouses from popular residential areas and green spaces, thus avoiding nimbyism related objections.

Research approach

The research presented in this paper reports on the results of a questionnaire survey conducted at a case study distribution centre in South Yorkshire, UK. The case study site is a large distribution centre that operates 24 hours a day, seven days per week; and employs approximately 3000 staff, many of whom are working as warehouse operatives and are employed on varying shift patterns.

The questionnaire survey was prepared hard-copy for dissemination on-site, which was deemed the most appropriate mechanism for in-person data collection due to the nature of the survey, location

of planned data collection, and the expected demographic of the targeted participants. Responses were collected over a period of two days (a Wednesday and a Thursday, including a night shift) which were selected to cover the majority of shift patterns at the site. Surveys were distributed amongst employees in the staff canteen for completion during their shift-breaks. Demographic profiles of the respondents are provided in the next section, along with some preliminary findings presented through some descriptive statistics.

Survey Findings

A total of 329 employees took part in the travel survey. Table 1 below reports the age profile of the respondents (note that six respondents did not provide their age). It can be noticed that an extremely young workforce was surveyed, as 67.80% of the members of staff are under 35 years of age. Furthermore, the vast majority (68.00%) of the people surveyed are male, as shown in Table 2 (note that four people did not answer this question). 64.73% and working at the site are on a permanent contract, while a good proportion of staff (28.42%) are employed on temporary contracts. Staff work on both fixed and rotational shift patterns.

Age Group	%	Count
18-25	28.17%	91
26-35	39.63%	128
36-50	21.67%	70
51-65	9.91%	32
65+	0.62%	2
Question not answered	0.00%	*(6)*
Total	100%	323

Table 1 – Age profile of the respondents

Gender	%	Count
Male	68.00%	221
Female	32.00%	104
Other	0.00%	*(4)*
Total	100%	325

Table 2 – Gender of the respondents

Of the respondents surveyed, 56.92% (185 out of 325) own a motor vehicle. In the vast majority of the case (see Table 3) this is a pre-owned vehicle; Table 4 provides additional data about vehicles owned by the workforce. It turns out that the average vehicle age is 8.51 years; and the median age of vehicles is 9 years. As such, private vehicles are generally old and might not conform to the most recent environmental standards, thus impacting on the sustainability of staff commuting to and from the site. The majority (66.29%) of the surveyed workforce owning a car also state that this vehicle was mainly bought for commuting purposes.

Answer	%	Count
Pre-owned	77.14%	135
New	22.86%	40
Total	100%	175

Table 3 – Demographic of vehicles owned by respondents

Average age of owned vehicles	8.51
Median age of owned vehicles	9.00
Standard Deviation of age of owned vehicles	4.76

Table 4 – Age of the owned vehicles

Was this vehicle bought for commuting purposes?	%	Count
Yes	66.29%	116
No	33.71%	59
Total	100%	175

Table 5 – Vehicle ownership and commuting

Coherently to the results emerging from the previous questions, the complete overview of the commuting choices for the surveyed workforce reveal an overall dominance of car travel as the dominant mode of transport to work (Table 6). 62.31% of the 329 surveyed staff travel to work by using their own motor vehicle, or through a self-organised car share scheme they've put in place with their colleagues. Public Transport is the second most preferred option, chosen by 32.83% of the respondents. 8 people (2.43%) travel to work regularly taking a taxi, while cycling and walking-only options are marginal (1.22%).

How do you travel to work?	%	Count
Own motor vehicle (or car share)	62.31%	205
Taxi	2.43%	8
Public Transport (Bus/Tram/Train)	32.83%	108
Cycling	1.22%	4
Walking	1.22%	4
Total	100%	329

Table 6 – Preferred mode of travel to work

Table 7 reports the average (23.14 minutes) and median (20 minutes) journey times for car commutes, also showing the standard deviation (computed across the 205 respondents who indicated they travel to work by car). This same pool of respondents was asked whether they could come to work by using public transport; 47.64% of them stated that this would be possible, with 52.36% declaring that using public transport would not be an option for them, mainly due to the lack of feasible alternatives. For those who stated that a public transport option is theoretically available, journey times however are much higher (90 minutes in terms of average; 60 minutes in terms of median travel time) than the ones they currently face by car.

Average car journey time	23.14
Median car journey time	20.00
Standard Deviation of car journey time	17.90

Table 7 – Average car journey times

Average journey length of potential public transport journey	90.0
Median journey length of potential public transport journey	60.0
Standard Deviation journey length of potential public transport journey	48.4

Table 8 – Average public transport journey times for employees who travel to work by car

This clearly explains the findings reported in Table 9, where respectively 145 and 130 of the employees travelling to work by car state that this option is easier or saves them time if compared to other options (multiple answers were allowed to this question). Twenty-five surveyed employees stated explicitly that they do not have any public transport option alternative.

Why do you travel to work by car?	%	Count
It is easier	37.47%	145
It saves me time	33.59%	130
It is cheaper	16.28%	63
I don't have any public transport alternative	6.46%	25
Other (please specify)	6.20%	24
Total	100%	387

Table 9 – Reasons for travelling to work by car

Conversely, when the 108 employees who stated that they were travelling to work by public transport were asked the same question, 78 of them clearly stated that the main reason behind their opting to travel by public transport is the fact that they do not own a motor vehicle (with 20 also clarifying that they cannot afford to take a taxi to work). Clearly, their travel times (with over 37 minutes of average and 30 minutes of median time; see Table 11) are much higher than the ones of employees travelling by car, mainly due to the need to wait for buses to arrive and any time spent between connecting services.

Answer	%	Count
It is easier	13.66%	22
It saves me time	3.73%	6
It is cheaper	17.39%	28
I don't own a motor vehicle	48.45%	78
I can't afford to take a taxi	12.42%	20
Other (please specify)	4.35%	7
Total	100%	161

Table 10 – Reasons for travelling to work by public transport

Average journey length of public transport journey	37.62
Median journey length of public transport journey	30.00
Standard Deviation journey length of public transport journey	26.69

Table 11 – Average public transport journey times

Discussion

Results of the survey clearly highlight some of the typical problems mentioned in the initial literature review about out-of-town logistics parks and distribution centres. Indeed, due to the location of the surveyed site, the employed workforce needs to face a long commute in order to get to work. Most of the surveyed workforce travel to the site by using a car; in most of the cases, this vehicle was

specifically bought for commuting purposes. This is coherent with findings from Dibben (2005) and Lucas (2006) regarding increased car-dependency. Particularly the high proportion of car commuters travelling in older vehicles (second-hand cars averaging 9 years old) is reflective of the low income demographic of the workforce employed at this site who are often priced out of newer vehicles, and are unable to benefit from the environmental advantages that newer vehicles would bring (Lucas, 2006), such as improved fuel consumption and lower emissions.

The reliance on cars for commuting to this site further highlights the fact that public transport does not seem to be designed to support the operations of the site. Many staff that travel to work by car point out that using public transport would be impractical (due to a much longer commuting time); even staff travelling to work by public transport seem to point out that the main reason behind their choice is the fact that they lack access to a vehicle, and that the current organisation of public transport schedules and routes does not serve this large site and its 24/7 operations particularly well.

Conclusions & Limitations

By adopting a case study approach, this research has investigated the impact of current transport systems on access to work for employees in the UK logistics and distribution industry. Specifically, the workforce of a major distribution centre located on the outskirts of a major conurbation in the South Yorkshire (UK) area was surveyed (through a structured questionnaire), in order to evaluate their travel-to-work habits and related challenges. Based on the analysis of the responses to the questionnaire, some key preliminary findings have been highlighted. Specifically, coherently to the extant literature, these findings highlight the car-dependency of the workforce and the lack of support provided for round-the-clock shift-workers from the existing public transport options.

Next steps of this research will involve further analysis of the questionnaire data, along with an extensive review of the public transport network serving the case study distribution centre. This could lead to the formulation of a set of recommendations for site operators, involved local authorities and transport companies.

Whilst this research has just considered a single distribution centre, options are being considered at the moment for extending the analysis to similar industrial establishments, in order to generalise the findings and examine, to a wider extent, the impact of access to work within the logistics and warehousing sector on the local and national economy.

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