ICLT 2019

THE 11TH INTERNATIONAL CONFERENCE ON LOGISTICS & TRANSPORT 2019

ISSN: 2392-5728

GLOBAL SUPPLY CHAIN CHALLENGES FOR EMERGING ECONOMIES

TRƯỜNG ĐẠI HỌC NGOẠI THƯƠNG
FOREIGN TRADE UNIVERSITY

THAMMASAT BUSINESS SCHOOL

SEAOIL PETROLEUM

14-16 NOVEMBER 2019

PRESS CLUB HANOI

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INTRODUCTION

This is the 11th international conference organised by the Centre for Logistics Research at Thammasat Business School, Thammasat University and the Excellence Centre in Logistics and Supply Chain Management, Chiang Mai University. This is major event for researchers in transport, logistics, supply chain and value chain management especially in the Asia Pacific region. This year's event in Hanoi (Vietnam), is a continuation of past successful conferences held in Chiang Mai (Thailand), 2009; Queenstown (New Zealand), 2010; Malé (Maldives), 2011; Chiang Mai (Thailand), 2012; Kyoto (Japan), 2013; Kuala Lumpur (Malaysia), 2014; Lyon (France), 2015; Singapore, 2016; Bangkok (Thailand), 2017 and Okinawa (Japan), 2018. This year's event is held during November 14th to 16th, 2019 and is hosted by the Foreign Trade University based in Hanoi, Vietnam.

Under the theme of "**Global Supply Chain Challenges for Emerging Economics**", the following topics were welcomed at the conference:

- Procurement & Supply Management
- Planning & Forecasting
- Relationship & Collaboration
- Production Planning & Operations
- Inventory Fulfilment
- International Logistics
- Humanitarian Logistics
- Maritime Logistics
- Logistics Services Providers
- Logistics Development Policies
- Supply Chain Design/Configuration
- Supply Chain Risk Management
- Sustainable Supply Chain
- Production & Inventory
- Supply Chain Performance
- Global Supply Chain
- Multimodal Transport
- Freight Logistics
- E-Logistics
- Logistics Facilitation

The conference best paper will be invited and considered for publication in the International Journal of Logistics Research and Applications.

WELCOME ADDRESS FROM THE CONFERENCE CHAIRS

On behalf of the organizing committee, we would like to welcome all participants to the 9th International Conference on Logistics and Transport (ICLT2019). It has been 11 years since the first conference was hosted in Chiang Mai (Thailand) and this year we are in Hanoi, Vietnam. This ICLT conference is expected to continue on an annual basis in order to facilitate the sharing of ideas, research findings, and teaching directions related to logistics and supply chain from an academic perspective. This year, we have 34 papers from 8 countries from Australia, Belgium, Finland, New Zealand, Singapore, Vietnam, United Kingdom, and Thailand.

The theme for this year's event is "Global Supply Chain Challenges For Emerging Economies". The trade war between the US and China has put a spotlight on key supply chain issues, especially for developing economies trying to integrate into the global value chain. These are exciting times for our research field as current best practices may become obsolete in the near future due to this new trade war.

We would like to sincerely thank all presenters, reviewers, our scientific committees, and keynote speakers for their appreciated contribution. We cannot forget the important contribution of our main sponsor, SeaOil (Public) Co. Ltd, who has supported us through the years. We also apologise in advance if there are any difficulties you may encounter while participating the conference. Finally, we hope that you will enjoy this conference and we hope that the deliberations will be fruitful and successful.

Ruth Banomyong
ICLT General Chair

Apichat Sopadang
ICLT General Chair

WELCOME ADDRESS FROM THE LOCAL CHAIRS

We warmly welcome all of you to the 11th International Conference on Logistics and Transport (ICLT 2019) in Vietnam. Foreign Trade University (FTU) is indeed very honoured to host the ICLT this year. The 2019 conference's theme is "Global Supply Chain Challenges for Emerging Countries".

Emerging countries are commanding half the world population and increasing wealth. In the context of globalization, many emerging countries have more and more links to worldwide active supply chains and relied on the roles in global supply chain to drive growth. There is a growing realisation that worldwide production system has been shifted to emerging markets and these can substantially impact global supply chain for many years to come.

Today, the world has witnessed unpredictable and complex economic and political change which extremely powerful effects on the global supply chain. Within this context, emerging countries are considered to be most vulnerable to these risks. The intensifying trade war between the United State and China is an example. This war has changed a lot of global supply chain configuration, as well as business strategy orientation of global corporate sector. To address these challenges, each country tends to the suboptimal situation, shifting manufacturing onshore, thereby reducing the role of global supply chain.

The theme of this conference is indeed timely as emerging countries will continue to feature prominently in driving global economy in the future. We are delighted that there are many professionals from around the world at this conference to discuss the latest research results as well as challenges and opportunities of global supply chain for emerging countries. We do hope that ICLT 2019 will be a wonderful platform for inspiring international and interdisciplinary exchange in the filed of logistics and transport. And to our friends from overseas, we also hope that you will find some time from busy schedule of the conference to enjoy many beautiful sightseeing and unique culture of Vietnam.

We wish you a memorable experience at ICLT 2019!

Assoc.Prof. Dr. BUI Anh Tuan
President of Foreign Trade University

CONTENTS

A CONCEPTUAL FRAMEWORK TO EVALUATE THE ROLE OF DRY PORTS IN THE PORT-HINTERLAND LOGISTICS PERFORMANCE

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Introduction

In the light of port regionalization (Notteboom and Rodrigue, 2005), the evolution of dry ports plays a vital role in boosting the port-hinterland integration. Such inland nodes might locate in the different positions of the logistics chains to facilitate the movement of cargo between the hinterland and seaports (Notteboom and Rodrigue, 2009, Roso et al., 2009, Nguyen and Notteboom, 2016). A close dry port or satellite terminal locates in the proximity of seaports and works as an extension of such maritime terminals. A distant dry port/load center is situated close to economic zones as a logistics hub for consolidating/de-consolidating cargo. Lastly, a transmodal terminal is in the middle of the logistics chain to transload cargo between two transport systems. The study of Nguyen & Notteboom (2018) have proved that there exists the relations between dry port's characteristics and regional port-hinterland settings. The role of dry ports in facilitating the logistics performance depends on different characteristics, i.e. the size and performance of terminals and the connection between dry ports and seaports.

The purpose of this paper is to propose a conceptual model that evaluate the impact of dry ports on the overall port hinterland logistics performance from the market driven approach. We built a criteria hierarchy for the assessment based on three perspectives, i.e. cost, time and reliability dimension (Banomyong and Supatn, 2011). The framework will consider the characteristics of dry ports and the integration between such terminals and maritime ports. Finally, we apply this framework to evaluate three types of dry ports (satellite terminal, load center and transmodal terminal) to enrich the literature of inland nodes.

Literature review

The concept of dry ports

The researches of inland nodes have been evolved and developed greatly over last decades (Witte et al., 2019). Such concept has been more diversified than only the logistics hub and maritime terminal's extension. There are a variety of terminologies used to refer to inland nodes, including dry ports, inland clearance depot, inland container depot, inland terminal, inland port, logistics centers, logistics parks, freight villages and the same name in the local languages (Rodrigue and Notteboom, 2009). Each term focus on different functions of such inland nodes, of which dry port is the most popular (Nguyen and Notteboom, 2018). As defined by UNESCAP (2013b), a dry port of international importance should be located "in the vicinity of: (a) inland capitals, provincial/state capitals; and/or (b) existing and/or potential production and consumption centres with access to highways and/or railways" with connections to "other dry ports, border posts/land customs stations/integrated check posts, seaports, inland waterway terminals and/or airports". A full concept of dry port is an inland terminal with a direct and high capacity connection to seaports which provide interchangeable services with seaports (Nguyen and Notteboom, 2016).

The port-hinterland logistics

The hinterland of a specific seaport is the area over which such seaport provides its service and interact with the inland customers (Rodrigue et al., 2016). The hinterland implies the regional market of a seaport where the import and export cargo of such region going through the seaport (Economic Commission for Europe, 2009). The seaport therefore works as a convergence node for the inland transport coming by roads, railways or inland waterways. Rodrigue et al. also classify port hinterland into the fundamental hinterland and competitive hinterland. The former implies the market area are located in the proximity of the seaport, where the seaport plays the dominant role in serving the majority traffic. The later refer to

the overlapped hinterland of two or more seaports where the competition is intensive. The port hinterland is contrast with the concept of port foreland, which refers to the other ports and oversea market connected by maritime services from the port (Figure 1).

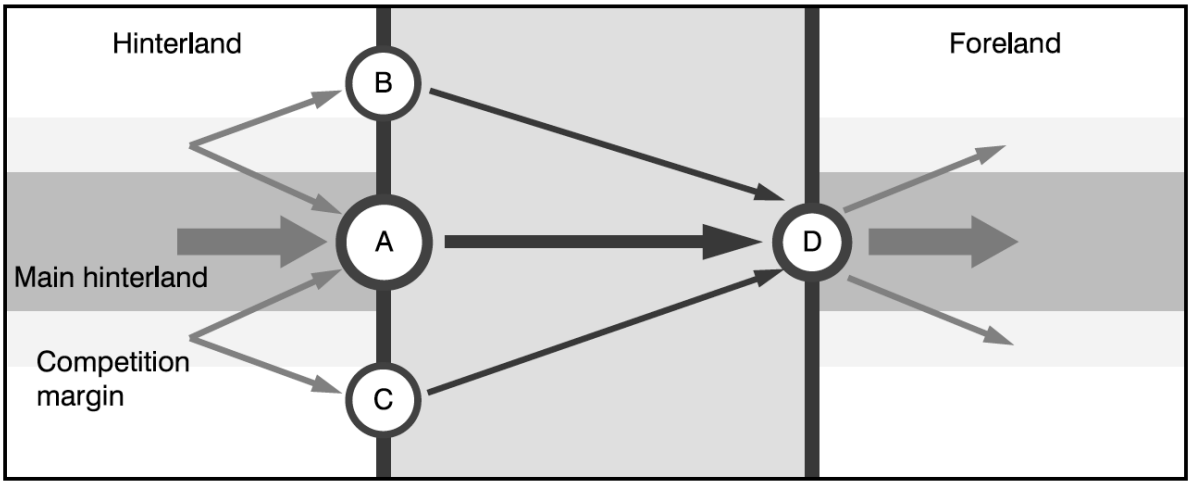

Figure 1. Port foreland and hinterland (Rodrigue et al., 2016)

The port-hinterland connection refers to the logistics between the maritime terminals and their customer in the hinterland. In terms of import cargo flow, the port-hinterland logistics implies the cargo movement from the seaports to the inland market, such as big cities with concentrated consumption area. In contrast, the port-hinterland logistics for the export goods are departed from the production bases, like industrial zones, to the maritime terminals. According to De Langen (2008), the cost of port hinterland logistics is more than the combination of maritime transport cost and port expenses, which stress out the increasing importance of attention in terms of hinterland logistics. More specifically, Martinho (2008) points out the hinterland transport costs could be as high is 5 to 30 times of maritime transport cost, depending on the connecting inland transport mode, which led to the focus shift from port performance to supply chain performance. This shares the similarities with Notteboom (2008), demonstrating that shipping lines are paying more attention on improving the land connection with their inland clients.

As a result of cargo massification and containerization, the port development has approached the phase of regionalization with high port-hinterland integration (Notteboom and Rodrigue, 2005). In the conventional system, the separate activities of the port-hinterland logistics are carried out by a wide range of parties, i.e. shipping lines, inland transport companies, forwarders, shipping agents. In the phase of the port regionalization, such activities are now within the scope of few or even a single player to increase the logistics integration and hence reduce the inland cost. This requires dedicated transport port hinterland network with the development of inland terminal and high capacity corridor linking them with maritime terminals (Figure 2). The port regionalization is supported by the concept of dry port and extended gateway (Roso and Lumsden, 2009, Nguyen and Notteboom, 2015, UNESCAP, 2013a, Veenstra et al., 2012). From the seaports, the import cargo is moved directly to the inland terminal through a dedicated transport leg with high capacity and reliability, preferred by railway or inland waterway. The inland customers then could collect their cargo from the inland port as if they are delivered at seaports. In terms of export flow, cargo is gathered at the inland port and forwarded to the maritime terminals through the same corridor.

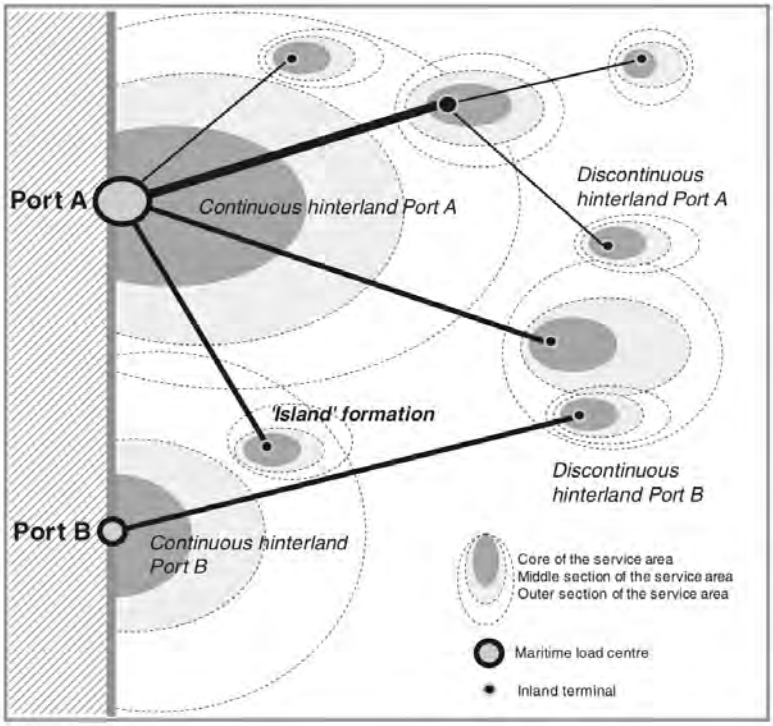

Figure 2. Port regionalization (Notteboom and Rodrigue, 2005)

The role of dry ports in the port-hinterland logistics

As synthesized by Witte et al. (2019), the inland port research have been evolved and developed rapidly over recent decades. The important role of dry port in the port-hinterland logistics is well recognized in the literature. Roso & Lumsden (2009) define the potential benefits of dry port according to the stakeholder group of inland logistics. From the maritime side, port operators benefit from the dry port implementation at less congestion, increased capacity and extend their hinterland. Seaport cities also enjoy less amount of trucks and have more land saving from seaport land substituted by inland terminals. Rail and barge operators will probably expand their market as they play the vital role in intermodal connection between dry ports and seaports. Although losing markets to other transport mode, road operators still benefit from lest congestion at road and terminal as dry ports evolve. From the hinterland side, shippers gain better access to maritime services by sending their cargo to nearby dry port. Finally, the whole society benefit from the greener logistics by shifting from road to intermodal inland transport.

UNESCAP (UNESCAP, 2015) access the dry port operation and sustainability in a three perspectives as follows. First, dry port evolvement contributes to the reform of customs and border control procedures which reduce the dwell time of import/export containers at terminals and therefore expand the terminal throughput. Second, the development of dry port minimizes the total logistics cost between seaports and the inland cargo origin/destination. Such logistics cost includes local pick-up/delivery, terminal handling, cargo storage, linehaul transport and customs clearance cost. Third, the study access dry port according to the adoption of mechanized cargo handling technology.

Another study of UNESCAP (n.d.) evaluate the role of dry port from the economic and environmental & social benefit views. In the former point of view, dry port development could (i) promote the growth of special economic zones; (ii) reconciliate transport infrastructure and supply chain management; (iii) shifting distribution activities from maritime terminals to inland ones; (iv) add value to the market parties and (v) facilitate intermodality. In terms of the later viewpoint, dry ports help reduce the congestion at road and seaports, minimize the pollution and risk of accidents and increase job opportunities for society.

Wei et al. (2018) in the study of hub-and-spoke network under Belt and Road Initiative evaluate the logistical quality of dry port according to four factors, i.e. social and economic development, providing

and demanding state of logistics marketing and infrastructure construction, customs clearance condition, and financial support for local cargo movements. They set a number of index with regards to each factor as show in the Table 1 for such assessment.

Table 1. Evaluation index system of dry ports for logistics quality.

Factor	Index
Social and economic development	Gross regional domestic product
	Gross domestic product per capita
Providing and demanding state of logistics marketing and infrastructure construction	Total volume of import and export trade
	Total retail sales of consumer goods
	Total value of agricultural output
	Total industrial output value
	Total freight volume
	Transportation, warehousing postal service workers
	Highway mileage
	Total investment in fixed assets
	Total of posts and telecommunications business
	Internet broadband access port number
	Mobile telephone subscribers
Customs clearance condition	Customs clearance convenience
	Customs clearance cost
Financial support for local cargo movements	Logistics cost subsidies status

Source: (Wei et al., 2018)

FDT (2007) points out that the most advantages of dry port implementation are avoiding traffic bottleneck and realizing multimodality, followed by connecting cargo handling, reducing land use at ports, reducing environmental and transport cost, ensuring quality and integrating port areas with cities.

Building the conceptual framework for evaluating the role of dry port

We develop the conceptual framework for evaluating the role of dry port in port-hinterland logistics following a number of steps. First, we define the horizontal and vertical approach in evaluating dry ports. The vertical approach includes all the activities of which a cargo unit experience between hinterland-port logistics. The horizontal approach is used to assess the logistics performance of each activity from different perspectives, i.e. time, cost and reliability. We then indicate the key performance criteria for each activity in the matrix created by the horizontal and vertical approaches.

Vertical evaluation with activity-based approach

The significance of activity-based approach is well synthesized by Mcnally & Rindt (2007). Conventionally, there are two popular approaches in explaining the travel behavior of people and goods, i.e. trip-based and activity-based approach. Trip-based approach is appropriate in analyzing the whole framework of transport system from the travel demand location and current transport network. The approach is exemplified in the four-step model, i.e. trip generation, trip distribution, mode choice and route choice. Macnally & Rindt points out a number of limitations of this approach, i.e. ignoring the activity participation decision as transport is a derived demand; lack of spatial and temporal interconnection among all trips and activities; and can not explain the behavior generating the trip. In contrast, the activity-based approach explains the travel behavior based on a collection of activities including in the participating schedule. The main theme of activity-based approach that fit our evaluating framework's scope is that it explains the transport demand derived from the logistics activity demand and reproduce the schedule of port-hinterland logistics activities in spatial and temporal approach.

As discussed before, shippers have options to send their cargo directly to seaports, or use services of dry ports instead. In order to evaluate the role of dry ports in the logistics performance, we need to compare the performance of the system with dry ports and the one without dry ports. The study of Nguyen & Notteboom (2018) noted that dry ports provide services which could be interchangeable with seaports. In other words, the main contribution of dry ports in the port-hinterland logistics is to provide

the interchanged services of seaports with higher utility for inland clients. We then develop our evaluating framework from the activity-based approach, which assess the performance of each activities in the port hinterland logistics to define the differences between the system with dry ports and the one without dry port.

According to Vietnam Ministry of Transport (2016), there are three options to move the container cargo from the inland customer's warehouse to the vessels. First, containers could be sent directly to the container yard of seaports for customer clearance and loading on board. Second way is transport bulk cargo to the container freight station at seaports for containerization and customs clearance. The third option is moving cargo in containers or in bulk to the inland terminals for containerization (with bulk cargo) and customs clearance. The cleared containers are then shipped to seaports for loading on board or storage at maritime container yard (Figure 3).

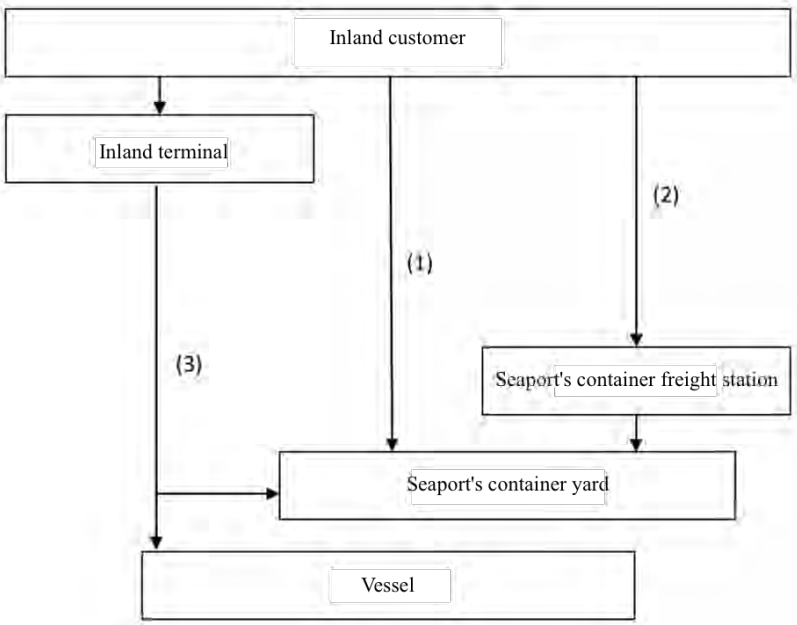

Figure 3. Options for sending export cargo to seaports (Vietnam Ministry of Transport, 2016)

Annex XI: **Diagrammatic Representation of Import Flows for a Dry Port**

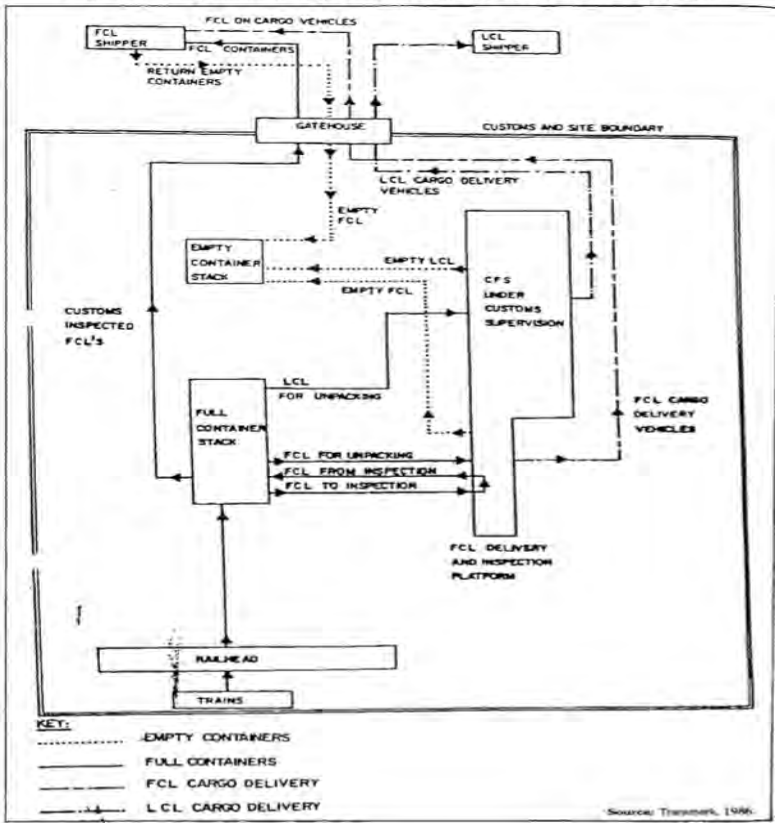

Figure 4. Diagrammatic representation of import flows for a dry port (UNCTAD, 1991)

UNCTAD (1991) describe the export and import flow for a dry port as follows (Figure 4 & 5). Dry port operators' activities of import cargo include: (1) reception of transport means from seaports (truck, train or barge); (2) unloading and stacking containers; FCL containers are loaded from stacks to road vehicles while LCL containers are taken to CFS unpacked, returned to stacks; (3) removal of container/cargo for delivery to final destination. Operator's activities of export cargo at dry ports are consist of (1) reception of cargo/container from shipper; (2) stacking FCL or breakbulk cargo to CFS; (3) load container onto transport means to seaports. Within the hinterland-port logistics, the freight includes:

- Rail/barge freight rate
- Container lifting
- Storage of containers
- Consolidation and organization of cargo
- Storage of cargo
- Customs inspection and duties
- Road transport
- Ancillary operation, e.g. sorting and internal shifting of containers

Annex X: **Diagrammatic Representation of Export Flows for a Dry Port**

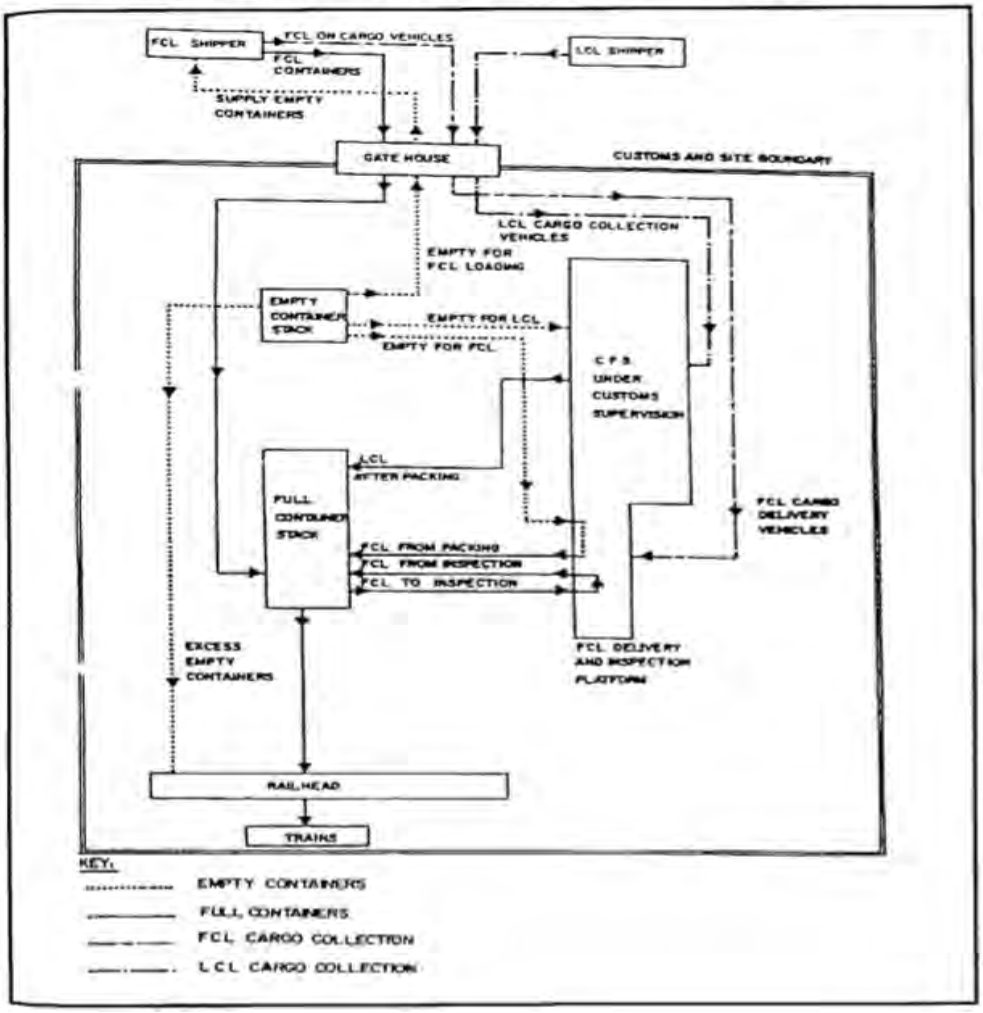

Figure 5. Diagrammatic representation of export flows for a dry port (UNCTAD, 1991)

Based on main dry port activities pointed out by UNCTAD (1991) and UNESCAP (UNESCAP, 2015) we define the main value added components of dry port to the port hinterland logistics (Table 2)

No.	Dry port activities	Dry port value added to port hinterland logistics
1	Inland transport	actual transport activity between customers' warehouse and the designated seaport. Instead of moving directly by road, cargo could be bundled and transshipped to rail or inland waterway before moing to seaports. Over long distance, the total transport cost and time should be saved thanks to the advantage of multimodality. The dedicated corridor linking dry port – seaport could improve the reliability of such shipment as well.
2	Cargo handling	Going through dry ports would add more handling cost and time as cargo pass one more transport node. Unless these are trade-off by other benefits of dry ports, customer would choose sending cargo directly to seaports.
3	Warehousing	Thanks to the land abundance, dry port could offer better cargo storage and warehousing service to their customers than seaports, where capacity is limited. Different types of warehouses, bonded and unbonded, are found at dry ports.
4	Container stripping & stuffing	As dry port has depot function, it is also convenient for customers to do these activities where the empty containers are stored.

5	Customs inspection & clearance	Having cargo cleared at dry port could save time waiting at congested seaports. This is also convenient for cargo owner to deal with arising customs problems at a dry port close to their location.
6	Container maintenance & repair	This is one of the dry port core services.
7	Freight forwarding and cargo consolidation services	As an inland hub, dry ports offer freight forwarding service to their surrounded customers and save cost from cargo bundling.
8	Banking/ insurance/ financial services	These services could be co-located at the same place with dry port to approach the customers.
10	Value-added services	As a logistics center, dry port could provide a wide range of value-added services to the customers, such as inventory management, labelling, assembling and packaging.
11	Customer service & support	Locating close to cargo owner, dry ports have potential to offer good customer service and support for their customers than seaports.

Table 2. Main dry port value added to the port-hinterland logistics

Horizontal approach

In the horizontal approach, we define a set of perspectives to evaluate the performance for each activity of the port hinterland logistics. As synthesized by Banomyong & Supatn (2011), a number of studies have proposed the framework to assess logistics and supply chain performance. Neely et al. (1995) and Shepherd and Gunter (2010) assess the supply chain performance according to the effectiveness and efficiency of the activity. The former refers to the level of meeting the customer's requirement, and the later implies the utilization of existing resources in carrying out the activity. More specifically, Caplice & Sheffi (1994) use three performance dimensions, i.e. utilization, productivity and effectiveness. In which, utilization metric assesses the use of input resources, such as financial resources, physical assets or inventory assets, while productivity metric refers to the ratio of actual output quantity to the actual input quantity in the process. Other evaluation would base on the quantitative approach, which try to quantify the performance like benchmarking techniques. Foggin et al. (2004) points out that such approach would require a lot of data which might not be available in the logistics and supply chain practice.

In line with Banomyong & Supatn (2011), we measure the performance of the port-hinterland logistics from three perspectives, i.e. cost, time and reliability. As logistics services is market driven, we argue that the implementation of dry ports should be taken from the customers' perspectives. Since the inland shippers have the option to go directly to seaports, they will only use the dry port's service if that provide higher utility for them. While direct charge for services seems to be the first priority of the customer's choice, fast and timeliness are also another crucial factors which influence the hinterland logistics performance. In this sense, dry ports and seaports are competing to attract the customers at the interchangable services, i.e. lift on lift off, storage and value added services. The one that provide lower cost, faster and more reliable services will get more market share of the port-hinterland logistics.

As discussed before, dry ports add values to the port hinterland logistics thanks to the utilization of multimodality, the abundance of land and the proximity of the customers. In the advanced dry port system, dry ports become an inland hub to consolidate and deconsolidate cargo for surrounded customers. In other words, cargo is bundled at dry ports before moving to/from seaports using a dedicated transport leg of rail or inland water way. While intermodality is not necessary beneficial in the short distance, it might save huge transport cost and time over long movement with higher consistency, especially with an effective transport corridor. Second, many seaports are facing capacity constrains due to the fast increase in the maritime transport demand (Nguyen and Notteboom, 2016). That results in the diseconomies of scale caused by the congestion and delay at maritime terminals. Dry ports then offer a

solution for customers to save their time waiting at maritime terminals for customs clearance or container services. With the advantage of land abundance, dry ports could provide cheaper price for land consuming services, i.e. cargo storage, than seaports. Being in the proximity of economic bases, dry ports could offer the distribution service for their customers which give them more convenient and control over their cargo. The key for this service is collating the inland terminal with the logistics center to form a full advance dry ports.

Conceptual model for evaluating dry port impact to the port hinterland logistics

From the horizontal and vertical approach, we develop the metric matrix of conceptual framework to evaluating the role of dry port in the port-hinterland logistics. The framework is summarized on the Table 3 as below showing 20 criteria to define the impact of dry ports on the traditional seaport hinterland logistics.

Port-hinterland logistics activity	Cost dimension	Time dimension	Reliability dimension
Inland transportation	Saved transport cost when using dry port	Saved transport time	Improved delivery rate in full and on time
Cargo handling	Increased handling cost at dry port	Increased handling time at dry port	
Warehousing	Different warehousing cost between dry port & seaport	Saved warehousing time	Reduce damage rate at warehouses
Container stripping & stuffing	Differences in CFS charge between dry port & seaport	Saved time at dry port CFS	Variability of working time at CFS
Customs inspection and duty		Saved time when clearing at dry port	Variability of customs clearance time
Container maintenance & repair			
Freight forwarding and cargo consolidation services	Saved cost	increased time for cargo bundling	
Banking/ insurance/ financial services		Saved time	
Value-added services	Saved cost		Improve accuracy
Customer service & support		Saving time in customer services	Improvement at success rate

Table 3: Proposed metrics for evaluating dry port impact to the port hinterland logistics

Conclusion

This paper aims at developing a conceptual framework to evaluating the role of inland nodes in port-hinterland logistics performance. We first review the literature of port-hinterland settings and point out the imperative role of dry port and dedicated corridor in high integration logistics system. The conceptual framework then is built according to the vertical and horizontal approach. The former implies the main components and activities reproducing the schedule of port-hinterland logistics activities in spatial and temporal approach. The later approach refers to three perspectives for assessing the action performance, i.e. time, cost and reliability. The proposed framework includes 24 metrics, which is the combination of 8 port-hinterland logistics components and three performance perspectives.

This framework provides a number of potential implications for different stakeholders. First, it could be used as an analytical tool for seaport and inland terminals operators to understand the behavior of customers in choosing the seaward path. By using proposed metrics, terminal operators could define their service strength and weakness for improvement. As dry port system provides a lot of benefits for society through facilitating modal shift, the central government might consider the customer behavior to better promote dry port development by subsidies and other supports. The inland customers could also use the framework to compare and contrast different options of moving their cargo from warehouses to

seaports. Last but not least, other studies could be carried out to benchmark different port-hinterland systems or different models of inland nodes.

The limitation of this research lies on the lack of empirical studies where all data and analyzes are based on secondary data. A future study in this domain could be applying this framework to evaluate the role of dry ports in a specific case or a specific system of a country. This will help demonstrate the applicability of the conceptual framework and identify the collaborative mechanism to optimize the port - hinterland logistics.

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AGRICULTURAL RESIDUAL BIOMASS SUPPLY ANALYSIS FOR PRODUCING ALTERNATIVE ENERGY GENERATION

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Introduction

At present, Thailand has developed a form of alternative energy. This form of energy is being used to replace conventional energy, with the exception of those currently in use and in accordance with Alternative energy development plan and alternative energy which aims to enable the country to develop renewable energy as the main energy of the country instead of importing it. The future plan is to strengthen the country, to support the production of renewable energy technology in the country, and to research and promote Thai renewable energy technology to be able to compete in the international market with renewable energy that can be used in various forms.

We recognized the importance of biomass energy production which is another form of alternative energy that can solve the energy shortage problem and reduces the import of electric energy from abroad. Thailand is a country of agriculture which allows it to produce more plants than domestic demand. Thailand can also increase the productivity by using other techniques and processing agricultural products to increase product value. This results in agricultural residues that can be processed into energy. By utilizing the residues effectively, we can increase the amount of alternative energy production in Thailand.

At present, there has been no collection of information on the production of agricultural residues and residues that have the potential to produce clear alternative energy. This includes the analysis of the cost for collecting and transporting in a way that is suitable for distribution to the point of alternative energy production, such as Inter Far East Energy Corporation Public Company Limited or Bua Sommai Biomass Company Limited, etc.

Methodology

1.1. Collected basic information about agricultural waste based on the production of energy crops that have the potential to produce biomass throughout the country.

Conducted research from various databases of the Ministry of Agriculture and Cooperatives and on the internet which contains the following information

2.1.1 Overview of agricultural production data in 2016
2.1.2 Information on plants that have the potential to be transformed into alternative energy
2.1.3 Information of the types of waste materials in agriculture, agricultural use
2.1.4 Data on agricultural production by plant

1.2. Created a database for the collection and transportation of biomass in agricultural material types that are important in Thailand.

Analyzed the data collected in Step 2.1 and used it to create a database for easier analysis, and then analyzed the biomass formation by assuming that if the amount of agricultural products was large, the amount of agricultural waste would be large as well. Then compared the amount of electrical potential, heat value equivalent to thousands of tons of crude oil and heat value of each type of biomass.

1.3. Analyzed the amount of agricultural waste materials used in most regions.

Analyzed the amount of agricultural waste in each region, which was divided into provinces, by selecting from the first 3 provinces that had the highest amount of agricultural production per year (2016), such as sugarcane, which was the largest product in Kamphaeng Phet, Kanchanaburi and Nakhon Sawan respectively

1.4. Analyzed the model of collecting agricultural waste in each region (Consolidation model) of 10 plants

Used the centre of gravity by calculating the common point of finding weighted average. This was based on weight values from the amount of production in each area, latitude and longitude values, which were defined as m, X and Y variables respectively. The purpose of this was to find a suitable location in the center to combine 10 types of agricultural waste materials by searching from the 3 targeted provinces with the highest annual output quantity. Then, further analysis was made using the distance-sharing technique (Load-Distance Technique) to compare the best location for setting up agricultural waste collection center. Next, hierarchical analysis techniques (AHP) were used to identify criteria for decision making.

1.5. Created a model for collecting waste materials in agriculture (Using data from step 2.4)

1.6. Analyzed the appropriate costs of agricultural waste.

After obtaining the location of the agricultural waste collection center, appropriate cost for the sale of agricultural residues was analyzed and set as a guideline for setting agricultural product prices and for those who are interested in using agricultural waste

Results and discussion

1.7. Created a biomass database for agricultural residue types.

From the objective of creating a basic biomass database for agricultural residue types, preliminary data regarding agricultural residues such as plants that had the potential to produce alternative energy were collected. This included the total amount of biomass production per year and the total amount of biomass production in each district, including data on the potential of all 10 types of agricultural waste such as rice, corn, sugarcane, longan, eucalyptus, rubber, cassava, pineapple, palm, and coconut oil. The researcher had also prepared a basic database including the largest amount of agricultural production per year (2016), such as sugarcane, which was the largest product in Kamphaeng Phet, Kanchanaburi, and Nakhon Sawan respectively. This was done by creating a preliminary database for those who are interested in biomass and agricultural waste and for easy use of information in the future as shown in table 1 and 2

Table 1. Example Ratio of agricultural residues

Types of plants	Types of agricultural waste	Scrap ratio		Total productivity (ton)	Quantity of agricultural waste (ton)
1.Rice	Straw	0.49	Tons / Tons Productivity	31,857,190	15,610,023.10
	husk	0.21	Tons / Tons Productivity	31,857,190	6,690,009.90
2.Sugar cane	Leaf	0.17	Tons / Tons Productivity	88,029,484	14,965,012.28
	Bagasse	0.28	Tons / Tons Productivity	88,029,484	24,648,255.52
3.Corn	Tops / leaves / stems	1.84	Tons / Tons Productivity	4,390,185	8,077,940.40
	Corn cob	0.24	Tons / Tons Productivity	4,390,185	1,053,644.40
4. cassava	Cassava rhizome	0.2	Tons / Tons Productivity	31,161,103	6,232,220.60
	Cassava waste	0.06	Tons / Tons Productivity	31,161,103	1,869,666.18

	Cassava shell	0.28	Tons / Tons Productivity	31,161,103	8,725,108.84

Table 2. Example of the largest amount of agricultural waste per year (separated by provinces)

Sugar cane	**Ton/year**	**Rice**	**Ton/year**	**Cassava**	**Ton/year**
Kamphaeng Phet	322,265,610	Ubon Ratchathani	884,846	Nakhon Ratchasima	3,009,113
Kanchanaburi	319,713,255	Nakhon Ratchasima	812,853	Kamphaeng Phet	1,262,022
Nakhon Sawan	313,434,360	Surin	796,566	Chaiyaphum	981,950

1.8. Created a model for collecting waste materials in agriculture using the farmers in potential areas

Used data from the initial database to analyze the center of gravity of 10 plants from 3 sources with the highest amount of waste as shown in table 3

Table 3. Example of analysis of center of gravity (Product center) of rubber at Surat Thani Province

Rubber	**latitude (x)**	**longitude (y)**	**Production quantity (m) tons**
Chaiya District	9.4567	99.1249	207,516,626
Phanom District	8.8756	98.7038	157,510,254
Phunphin District	9.0503	99.2604	130,521,346
Kanchanadit District	9.1545	99.5117	55,627,760
Tha Chana District	9.5893	98.9866	40,002,011

Table 3. Example of analysis of center of gravity (Product center) of rubber at Surat Thani Province

xm	**ym**	**latitude**	**longitude**	**District, Province**
1,962,421,854.54	20,570,068,950.92	9.10	99.07	Phunphin District, Surat Thani Province
1,398,004,153.30	15,546,857,773.58			
1,181,254,727.28	12,955,606,233.35			
509,241,825.67	5,535,611,740.98			
383,591,044.07	3,959,663,662.08			

Based on the calculation of the center of gravity, it was found that some areas could not be set up for containing the materials. Therefore, the data was analyzed repeatedly to find the right choice in setting up the scrap center by using the transportation analysis method combined with distance. Then, sensitivity analysis was conducted to test the hypothesis that in the event when agricultural production changes based on the assumption that if the amount of agricultural products had changed, the coordinates of the agricultural waste collection centers would also change. The researcher analyzed the data of 3 specimens of plants - namely rubber, longan and cassava for the past 3 years, which was the year 2016 to 2018. The results of sensitivity analysis showed that there has been a change in the coordinates of the agricultural waste collection center, but the distance that had changed was not more than 50 kilometers from the original coordinates. This led to the conclusion that changing of agricultural product had no effects on the coordinate

1.9. Analyzed the costs of collecting agricultural residues in potential areas.

Performed a proper cost analysis of waste materials resulted in the appropriate cost of agricultural waste shown in table 4

Table 4. Example of the results of the analysis of distance and transportation (Load-Distance Technique) rubber

Center	latitude	longitude	Choice	District, Province
Center 1	9.45	99.12	Choice 2	Chaiya District, Surat Thani Province
Center 2	6.70	100.31	Choice 2	Sadao District, Songkhla Province
Center 3	8.08	99.66	Choice 1	Thung Song District, Nakhon Si Thammarat Province

Sensitivity analysis resulted in a lot of changes from the coordinates found. This affected the right cost, and the amount of output in each year that had changed would also affect the cost of scrap materials. In addition, the factor determining the appropriate cost price also included the price of fuel for transportation trucks, purchase prices that may change each year and the demand for agricultural residues each year as well. This research project was therefore able to analyze only the appropriate costs. Those who are interested in the cost of agricultural waste materials can apply this preliminary data to study or further analysis.

Conclusion

This project achieves the objectives set forth, which included database preparation of 10 potential agricultural residues in Thailand , analysis of suitable locations for setting up agricultural waste residue centers and appropriate cost analysis of each kind of agricultural residues by collecting the data of the sources that have the highest amount of agricultural residues in the first 3 provinces of each plant and analyzing the location of the waste collection center based on the amount of agricultural waste, distance and cost, and analyzing the appropriate location for setting up the center of agricultural waste. The total suitable areas were 30 points. For example, the rubber waste collection center is located in Chaiya district, Surat Thani. In addition, an appropriate cost analysis of each kind of agricultural residues, such as the optimal cost of rubber, was at 2,921 baht per ton. However, the appropriate costs may change according to the amount of agricultural production each year.

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AN ANALYSIS OF CHINA-PAKISTAN ECONOMIC CORRIDOR ROUTES IN PAKISTAN: MODAL CHOICE, COSTS AND SCHEDULES

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Introduction and Methodology

This research analyses selected routes used for the import / export trades of Pakistan. The China Pakistan Economic Corridor (CPEC) provides the context for this research. CPEC is a multi-billion dollar economic project between Pakistan and China considered to be a vital part of China's One Belt One Road (OBOR) initiative for direct access for China to the Arabian Sea (for main shipping routes) using a network of road, rail, air routes, and ports across Pakistan. Chinese investment ($ 46 billion initially, rising to $ 62 billion) in Pakistan has been in the Industrial, Transport, Agriculture and Energy sectors. Since its inception there has been political and social debate about the distribution and prioritization of investments in CPEC Road/Rail projects on three main routes: Eastern, Central, and Western; there is also a 4th alternative known as Western Route 2.

This research evaluates the overall competitiveness of the CPEC routes on the basis of commercial aspects of distance, freight costs, transit time and risk for transportation of unitised freight using twenty and forty-foot containers from Gwadar Port to the Khunjrab pass on the China-Pakistan border. The case-study was principally conducted using a questionnaire survey for Pakistan based Logistics Service Providers (LSPs), general road transport operators, the National Highway Authority (NHA) and Pakistan Railways. In the full study, different alternatives for each CPEC route (3 options for Eastern, 4 options for Central, 3 options for Western and 3 options for Western Route 2) with unimodal (road only) and multimodal (road-rail only) alternatives were analysed. A selection of the main routes' characteristics are presented here, following the UNESCAP time / cost-distance methodology (Beresford, 1999; UNESCAP, 2003).

Transport Infrastructure and Trade Facilitation in Pakistan

Pakistan has three international deep-sea ports including two fully operational ports (Karachi and Qasim) handling 95 percent of Pakistan's international trade, and one newly developed semi-operational port (Gwadar Port) (Sánchez-Triana, E. et al., 2013; ADB, 2015; GPA, 2017). The Asian Development Bank highlighted the limited depth of the ports (10 - 12 meters) as a key hindrance to their use by larger sized vessels (ADB, 2015). Sánchez-Triana, E. et al (2013) concluded that customs clearance delays, lack of rail service operations and poor logistical facilities for the efficient movement of containers from ports were the major impediments in Pakistani ports. They further highlighted that while ship - shore container handling speeds at Pakistani ports match international standards, on-shore container handling times are double that of efficient international ports.

Concerning roads, the Asian Development Bank (ADB, 2015) considered road transport as the dominant mode for both freight and passenger traffic in Pakistan and it now accounts for about 96% of total freight traffic in the country. In common with many emerging economies, in Pakistan problems such as truck-overloading, poor roads, accidents, pilferage and breakdowns are commonplace. The railways, meanwhile, were once the predominant mode of transport in Pakistan, and in the 1960s handled around 73% of freight traffic. This declined to a low of around 4% in 2011 and the main focus has shifted towards passenger traffic and away from freight services, despite the fact that there is sufficient demand and profit margins are sustainable (Sánchez- Triana, E. et al., 2013). The Asian Development Bank (ADB, 2015) also highlighted the fact that the railways are both neglected and the least prioritised mode both for Government investment and for cargo transport in Pakistan. In respect of customs clearance processes, Pakistan has successfully reduced clearance times from 6 - 8 days in

most cases, to less than 24 hours, through the implementation of the Pakistan Customs Computerized System (PACCS). Enhanced risk management techniques have lowered physical inspection rates on imports from 100% to 4% and to 2% on exports (WTO, 2008 and World Bank, 2012). Further, UNESCAP (2016) reported that the level of implementation of trade facilitation measures in Pakistan (48%) was above average levels in Asia-Pacific (46.5%) and South and South-West Asia (42%).

Route Analysis and Modal Choices

Analysis in this paper is restricted to single twenty and forty foot containers (TEU and FEU) moving from Gwadar Port (Origin) on the South-West coast of Pakistan to the Khunjrab Pass (Destination) on the China-Pakistan border in Northern Pakistan. However, routes discussed also cover Karachi where the remaining two busiest ports of Pakistan (Karachi Port and Port Qasim) are located. Moreover, only two modes of transport i.e. Road and Rail have been examined to allow for feasible comparisons of TEU / FEU cargo units on the CPEC routes.

Transport distances were recorded in kilometers based on information obtained from the NHA (NHA 2015, 2017) and Pakistan Railways participants in the survey and from official websites wherever not obtained from questionnaires. Step (handling / intermodal) costs amounting to PKR 10,000, PKR 15,000 [1] and step times of 1 hour per container were incurred for loading and off-loading of twenty and forty foot containers respectively. At railway terminals it was assumed that the cost/time value would be considered only once for intermodal transfer. The research revealed that the participants (2 LSPs / 7 Transport Operators) did not charge separately for tolls, rather they were included in the total freight rate. Participants were also asked about their perception of cost and time effectiveness and risk factors (safety of goods / transport due to road / infrastructural conditions and security threat) of the respective routes.

CPEC Eastern Route

All Road: Gwadar - Karachi - Hyderabad – Sukkar - Multan - Khanewal - Faisalabad - Rawalpindi - Havelian - Khunjrab

Total costs for a twenty foot container are PKR 243,750 (including 2 x PKR 10,000 step costs) and for a forty foot container PKR 335,625 (including PKR 2 x 15,000 step costs) with total transit times of 109 and 134 Hours respectively, from Gwadar port to the Khunjrab pass, covering a distance of 2,692 km for one truck from origin to destination. This can be taken as the benchmark solution for alternative transport combinations.

Road – Rail - Road: Gwadar - Karachi – Rawalpindi – Havelian - Khunjrab

It was considered important to include intermodal / multimodal options by including railways for a better understanding of the interplay between the two modes in terms of their cost, time and service performance. Road – Rail - Road was evaluated where rail transport is used as the dominant mode, and road transport is used for both collection and delivery. The freight journey for both twenty and forty foot containers is assumed to be undertaken with 4 cost/time steps, 2 at origin/destination and 2 for intermodal transfer. Analysis shows that for the transport of twenty and forty foot containers on the CPEC Eastern Route from Gwadar to Khunjrab for a distance of 3,075 km costs PKR 272,241 (including 4 x PKR 10,000 step costs) and PKR 429,875 (including 4 x PKR 15,000 step costs) with total transit times of 103 and 118 hours respectively.

Comparing the options on the CPEC Eastern Route shows that **All Road** is most economical in terms of cost and distance, while **Road – Rail - Road** is beneficial in terms of time effectiveness. This strange

[1] As of August 2019 one thousand (1000) Pakistan Rupees (PKR) is equivalent to 6.2 US Dollars

revelation of road transport being cost effective than rail, and rail being time effective than road transport is a deviation from general concept of rail being cheaper than road transport and road transport being more time effective than rail.

CPEC Central Route

All Road: Gwadar - Karachi - Hyderabad – Sukkar - Dera Allahyar – DG Khan – DI Khan – Mian Wali – Rawalpindi – Havelian - Khunjrab

Total costs for a twenty foot container are PKR 450,042 (including 2 x PKR 10,000 step costs) and for a forty foot container are PKR 598,194 (including 2 x PKR 15,000 step costs) with total transit times of 134 and 153 Hours respectively for a total distance of 2,881 km.

Road – Rail – Road – Rail - Road: Gwadar – Karachi – Sukkar – Dera Allahyar – DG Khan – DI Khan – Mian Wali – Rawalpindi – Havelian - Khunjrab

For this option over a total distance of 3,000 km costs are PKR 453,889 (including 6 x step costs of PKR 10,000) and PKR 592,547 (including 6 x step costs of PKR 15,000) and transit times of 126 Hours (including step time of 1 x 6 hours) and 138 Hours (including step time of 1 x 6 hours) for twenty and forty foot containers respectively, utilising rail for two comparatively short links i.e. Karachi to Sukkar and Rawalpindi to Havelian. Comparison of these figures to the All Road alternative for the CPEC Central Route highlights that although the total distance increases by 119 km the transit time reduces by 8 and 15 hours for TEU and FEU respectively with commensurate cost reductions of PKR 3,847 and PKR 5,647. Therefore, this option is considered comparatively both cost and time effective

Road – Rail - Road: Gwadar – Karachi – Hyderabad – Larkana – Multan – Rawalpindi – Havelian - Khunjrab

A further option to evaluate the CPEC Central route is a multimodal option using dedicated freight rail from Karachi to Havelian while using road transport from Gwadar to Karachi and Havelian to Khunjrab. While road transport is still dominant, rail plays a much more important role. Analysis of this alternative route reveals that the freight journey of 3,145 km carried out in four steps incurs costs of PKR 279,249 (including 4 x step costs of PKR 10,000) and PKR 401,715 (including 4x step costs of PKR 15,000) and transit times of 99 hours (including step times of 1 x 6 hours) and 111 hours (including step times of 1 x 6 hours) for twenty and forty foot containers respectively. The enhanced cost and time effectiveness of this multimodal option is the result of using rail for the longer leg which validates the general rule for rail being cheaper than road transport over long distances.

CPEC Western Route

All Road: Gwadar – Basima – Quetta – Zhob –DI Khan – Mian Wali – Rawalpindi – Havelian - Khunjrab

This route includes only two steps at origin and destination. The step costs are PKR 10,000 and PKR 15,000 for twenty and forty foot containers respectively, with step times of 1 hour for both. Total costs incurred are PKR 520,857 (including 2 x step costs of PKR 10,000) and PKR 711,916 (including 2 x step costs PKR 15,000) for a total distance of 2,628 km and total transit times of 122 and 153 hours respectively. Comparison of this option with similar options used for evaluation of the CPEC Eastern and Central Routes i.e. **All Road** (Unimodal) CPEC Eastern Route and **All Road** (Unimodal) CPEC Central Route reveal that under this option the CPEC Western Route is more time effective. However, the perception of the customers and transporters is also vital for such route choices and the risk factor on this route also needs to be considered as 25% of participants considered the Western route as least cost and time effective and 50% considered it to have a low risk of damage to goods and transport due to security and road conditions.

Road – Rail - Road: Gwadar – Basima – Quetta – Zhob –DI Khan – Mian Wali – Rawalpindi – Havelian - Khunjrab

This multimodal option incorporates rail transport from Rawalpindi to Havelian (short distance) and uses road transport for the dominant and feeder legs. The distance of 2,698 km is distributed into 4 steps, incurring total costs of PKR 529,487 (including 4 x step costs of 10,000) and PKR 730,496 (including 4 x step costs of 15,000) with total transit times of 121 and 149 hours for twenty and forty foot containers respectively. However, this route is considered congested and less secure for heavy traffic / transport due to road conditions.

CPEC Western Route 2

All Road: Gwadar – Basima – Quetta – Zhob –DI Khan – Kohat – Rawalpindi – Havelian – Khunjrab
This unimodal option includes two step costs at origin and destination. The freight journey of 2,748 km incurs a total cost of PKR 521,072 (including 2 x step cost of 10,000) and PKR 720,951 (including 2 x step cost of 15,000) with total transit times of 120 and 151 hours respectively for twenty and forty foot containers. This route is considered less safe for heavy traffic / transport due to road conditions and congestion. Moreover, while rail is also available between Kohat and Rawalpindi, it is currently not operational and the marshalling yard at Kohat cannot handle containerised cargo.

Road – Rail - Road: Gwadar – Basima – Quetta – Zhob –DI Khan – Kohat – Rawalpindi – Havelian – Khunjrab
This multimodal option (road-rail combination only) incorporates 4 steps of which 2 are for loading/ offloading at origin and destination and 2 are for intermodal transfers in Rawalpindi and Havelian. The total distance is 2,818 km and incurs total costs of PKR 529,702 (including 4 x step costs PKR 10,000) and PKR 739,531 (including 4 x step costs PKR 15,000) with transit times of 119 and 147 Hours (both including 1 x step times of 4 hours) to transport twenty and forty foot containers respectively. Comparison with the All Road option reveals that this option is slightly more time effective but more cost effective. Overall for this route the All Road option is the most cost effective whereas, the Road-Rail-Road multimodal alternative is the most time effective These findings also validate earlier observations that rail is not cost effective compared to road transport for short distance transport.

Analysis
For the transport of twenty foot Containers from Gwadar to Khunjrab, the Road-Rail-Road CPEC Central Route proves to be the most Time Effective with a total transit time of 99 Hours. The second most effective in terms of time is the Road – Rail - Road CPEC Eastern Route at 103 Hours. On the other hand, the All Road CPEC Eastern Route is the most cost-effective route at PKR 243,750 while the second most cost effective route is the Road – Rail - Road CPEC Eastern Route at PKR 272,241. For distance, the All Road CPEC Western Route is shortest at 2,628 km while the All Road CPEC Eastern Route is second longest at 2,692 km. Thus, overall the All Road CPEC Eastern Route is consistently the most competitive route and the best modal option for CPEC Routes in Pakistan for the transport of twenty foot containers.

For the transport of forty foot containers from Gwadar to Khunjrab, the most time effective route is the Road – Rail - Road option on the CPEC Central Route with a transit time of 111 hours, with the Road – Rail - Road CPEC Eastern Route being second most effective with a transit time of 118 Hours. In terms of cost effectiveness, the All Road CPEC Eastern Route achieved the lowest cost of PKR 335,625, while the multimodal Road – Rail - Road CPEC Central Route was second most cost effective at PKR 401,715. As with twenty foot containers, the All Road CPEC Eastern Route is consistently the most competitive route and modal option for CPEC Routes in Pakistan to transport forty foot containers.

However, for both twenty and forty foot containers, the time and cost effectiveness of multimodal Road – Rail - Road alternatives of both the CPEC Eastern and Central Routes are important for or large number of containers to achieve economies of scale, reduced drivers costs and environmental sustainability improvements.

Conclusion

Different aspects of the three main CPEC routes (Eastern, Central & Western) along with a fourth alternative of CPEC Western Route-2 were analysed on the basis of distance, cost, transit time, risk, route and modal choices using an established cost model. The All Road CPEC Eastern Route option was found to be the most competitive route with the unimodal option remaining more competitive than the multimodal options. However, significant time and cost advantages of the multimodal alternatives of the Road – Rail - Road CPEC Eastern and Central Routes routes can also be observed. Therefore, these latter options could be utilised for the transport of large numbers of containers to benefit from economies of scale on long haul rail freight rates and savings for road transport in respect of wear and tear, driver's costs, along with the environmental sustainability.

The general principal of transport regarding cost effectiveness of rail compared to road transport is negated in instances where it is used for short distances, however, it is a valuable alternative in situations where it can be used over longer distances. There is an overall need for cooperation between the rail and road sectors as road transport has dominated the freight transport market in Pakistan, and Pakistan Railways have not taken significant measures to compete and capture freight. Therefore, a Rail option could prove important once the railway links between Gwadar and Karachi, and Havelian to Khunjrab are constructed under CPEC development project between China and Pakistan. However, significant time and cost effectiveness for multimodal/intermodal alternatives of the Road-Rail-Road option on the CPEC Eastern Route and the Road – Rail - Road option on the CPEC Central Route are also competitive as alternative for large numbers of long-haul containers.

The findings also significantly matched to the general perception of the research participants about CPEC routes where 75% rank the Eastern Route as the most cost effective and 100% rank it as the most time effective and being the "no risk"/safest option. For overall total competitiveness covering cost, time and distance, unimodal all-road transport appears to be best suited for the transport of twenty and forty foot containers from origin (Gwadar) to destination (Khunjrab).

In terms of infrastructural improvements that would be required in order to enhance the intermodal transport connectivity of the CPEC routes, the most crucial infrastructural important has been identified as rail terminal capacity with modern loading/offloading and storage equipment for container handling. Moreover, the online connectivity of the toll system had not been appropriately implemented on 100% toll plazas, which otherwise could improve the traveling time performance of the freight transport.

Finally, findings regarding risk perception on the CPEC Routes (safety of goods / transport due to road / infrastructural conditions and security threat) reveal that "the Central and Eastern Routes are considered to be "No Risk", whereas, only 50% of respondents consider the Western Route to have "No Risk". However, the Western and Western 2 routes were considered to be "Low Risk" by 50% and 25% of respondents respectively, whereas, 75% participants perceived Western Route-2 to have "Medium Risk".

Suggestions for Future Research

Despite the above suggestions pertaining to essential infrastructural improvements, the research may not be considered completely conclusive. Therefore, additional in-depth research would be required to identify and rectify the infrastructural impediments in each segment of Pakistan's transport sector.

Additional in-depth research is suggested to identify and rectify the infrastructural impediments in each individual segment of Pakistan's transport sector. Examples of where possible improvements could take place include: construction of modern toll terminals / plazas, modernized online management, more efficient customs clearance management, border crossing efficiency enhancements, expanded storage capacity, intermodal transfer equipment modernization especially in marshaling yards, the development of Dry Ports, and the construction and improvement of relevant link roads and railways especially in the vicinity seaports.

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Acknowledgement

The help and cooperation of the transport operators and organisations, and of the Pakistan Government, in facilitating this research is gratefully acknowledged.

AN ANALYSIS OF MACRO LOGISTICS COST DRIVERS IN THAILAND

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Introduction

Logistics is important to national competitiveness (Havenga *et al.*, 2013; Arvis *et al.*, 2018). In order to gain national competitiveness, researchers focus on national logistics efficiency and evaluate this in terms of the trade-off between macro logistics costs versus Gross Domestic Product (GDP) (Rantasila and Ojala, 2012; Havenga *et al.*, 2013; Havenga, 2018). Thus, macro logistics cost and its cost drivers are important indicators that many macro-logisticians have paid attention (e.g. Banomyong 2008; Banomyong *et al.*, 2008; Rantasila and Ojala, 2012; Havenga *et al.*, 2013; Havenga, 2018). These can be calculated not only by using macro-level data such as economics-related data, infrastructure improvements and industry agglomerations (Havenga, 2015) but also by the bottom-up approach (Havenga, 2010). The latter one is calculated based on the data derived directly from business performances. This is because logistics cost is the major expenditures for businesses that affecting and being affected by other economic activities (Grant *et al.*, 2006).

Macro logistics cost is also an important indicator used in Thailand logistics development plan. Office of the National Economic and Social Development Council (NESDC), under Thai government, has responsibility to develop the country's logistics system and to minimise Thailand logistics cost in order to increase the country's national competitiveness. However, Thailand logistics cost was calculated from macro-level data derived from related-government institutions and state owned-enterprises. As these data were not initially collected for the purpose of logistics cost analysis, an identifying of macro logistics cost drivers for Thailand cannot be done. Current macro logistics policies thus can only focus on a broader view of the national logistics performance. This manuscript aims to know that, based on the micro-level data (i.e. the primary data derived from businesses), how can we identify potential macro logistics cost drivers for an analysis of Thailand logistics costs. Furthermore, based on these findings, this manuscript aims to find what policy can be made for the improvement of national logistics efficiency and competitiveness.

Literature review

National logistics has gained much attention widely. It encompasses both micro and macro levels (Havenga, 2018). At the macro level, the scope is on the national logistics systems (Gleissner and Femerling, 2013), the macroeconomic context (Havenga, 2018) and policy perspective (Banomyong, *et al.* 2008). There already exists a number of global logistics related indicators developed by institutions such as Logistics Performance Index developed by the World Bank, Liner Shipping Connectivity Index developed by United Nations Conference on Trade and Development and the Global Enabling Trade Index developed by the World Economic Forum. These macro-level indicators can be used for calculating national logistics costs (Bowersox *et al.*, 2003; Rodrigues *et al.*, 2005). The results can further be used to reveal drivers of logistics performance (Arvis *et al.*, 2018). However, as these indicators are aimed at capturing data on aggregated-level performance, they cannot reflect actual logistics costs or costs incurred by business's operations (World Bank, 2016; Havenga, 2018). Macro logistics cost can also be calculated by a bottom-up approach (Havenga, 2015). At the micro level, this cost involves firms' own performance (Grant *et al.*, 2006). As firms' logistics costs decrease, this should have an impact on a national logistics cost as well.

Table 1 summarises pros and cons of data derived from macro- and micro-levels. The macro-level data can be gathered from national logistics systems such as traffic system, infrastructure as well as macroeconomic data such as industry agglomerations. These indicators are used for measuring broader-level logistics performance as well as used for capturing performances and improvements at

the national level. However, these indicators are not designed to capture the detailed-level of business performance. This is where the data from the micro level is necessary. This data can be derived directly from the performance of business units (i.e. costs incurred by activities in supply chains) which directly reflect the actual logistics performances of a country (Havenga, 2010; Havenga, 2018; Banomyong *et al.*, 2019). As different levels of data sources can capture different specific details of logistics system, cost drivers identified from different levels of data sources are not similar. For policymakers, indicators used for evaluating national logistics performance need to be not only derived from the existing macro level references but also empirically collected from the micro level references (Banomyong *et al.*, 2019).

Level	Macro (macro-logistics)	Micro (micro-logistics)
Data sources	- National logistics systems (e.g. traffic system, infrastructure) - Macroeconomic data	- Business performances (e.g. costs of supply chains)
Pros	- Broadly measure logistics performance - Capture performance, reflect improvements and can be used as a benchmark of national competitiveness	- Derived from key performance indicators at the sector/firm level - Reflect performance of local users in a country's logistics system
Cons	Not detailed enough	Cannot capture national-level systems

Sources: Banomyong et al., 2008; Havenga, 2010; Gleissner and Femerling, 2013; Havenga, 2018

Table 1: Pros and cons of data derived from macro- and micro-levels

In order to calculate macro logistics costs and identify cost drivers for an analysis of Thailand logistics costs, it is necessary to have a clear definition of logistics costs. At the national level, macro logistics costs compose of four dimensions (Heskett *et al.*, 1973; Delaney and Wilson, 2003; Bowersox *et al.*, 2003; Havenga, 2010). Based on Delaney and Wilson (2003), macro logistics costs are defined as these following activities:

1) Transport costs are the costs related to relocating activities and other transporting costs incurred from different modes of transport (i.e. land, rail, air, sea, coastal and pipe);
2) Warehousing costs are operating costs that incurred from warehousing and storing activities (both in-house and outsourcing);
3) Inventory carrying costs are the cost of carrying inventory units and other opportunity costs;
4) Administration costs are the costs of customer servicing, ordering, and purchasing.

Thailand logistics costs

In 2017, NESDC calculated Thailand logistics costs based on the data derived related-government institutions and state owned-enterprises. NESDC can utilise these data to develop national policies for improving Thailand logistics efficiency and national competitiveness. However, these data cannot be used for identifying Thailand logistics cost drivers due to two reasons. Firstly, these data were not collected for the purpose of calculating macro logistics cost drivers. Some data cannot cover all logistic activities and are misallocated. These missing data may lead to an underestimation of actual macro logistics cost. Secondly, as these data were not originally designed to directly capture logistics activities, any analysis cannot explain the relationships and effects of cost drivers on the national logistic cost. The suggested policies can merely be informed in terms of macro, national or aggregated level. For example, if the findings show that the cost incurred by land transport mode is higher than other modes, policy can be merely suggested businesses to shift to the cheaper modes. In reality, businesses may find challenges in modal shift as they need funds for investing in a new mode. In other way around, if the findings can reflect real logistics cost drivers such as fuel cost, wages and energy consumptions, NESDC may better develop national policies that are more directed to business units. Businesses may better find ways to increase efficiency and reduce their logistics costs. Their cost reductions may then finally affect the total logistics costs of the country.

Methodology

In this session, the methodology of this manuscript is presented as three steps.

Business sectors, population and sample sizes

Thailand Standard Industrial Classification (TSIC) developed by Department of Business Development Ministry of Commerce provided a classification of business sectors in Thailand. There were totally 21 business sectors (TSIC, 2009). A challenge was that logistics has an important role in all businesses. It would be costly if data were collected from all businesses in all sectors. A meeting group organised by NESDC was set up. Participants were experts in Thailand logistics (i.e. officers from NESDC, the National Statistical Office, the Ministry of Industry, the Ministry of Agriculture and Cooperatives, as well as academic experts in the logistics field). A consensus was drawn. There were 6 business sectors that were mostly related to Thailand logistics cost, that are, A (Agriculture, Forestry and Fishing), B (Mining and Quarrying), C (Manufacturing), F (Construction), G (Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles), and S (Other Service Activities). As GDP is usually traded off against macro logistics costs, the GDP values of these 6 sectors were also summed up. As a result, these 6 business sectors contribute as 96.8% of total final demand of GDP value created by all business sectors. This can be concluded that these 6 sectors can be representatives of all sectors.

In 2017, Department of Business Development Ministry of Commerce reported that there were totally 438,857 firms in these 6 business sectors. The calculation of sample size was done by employing a formula provided by the National Statistical Office of Thailand. The formula is illustrated as follows:

$$= \frac{\square\square^2\square^2}{\square^2\square^2 + \square\square^2}$$

where N = Population
n = Samples
Z = Standardised score at 95% confident interval (Z = ±1.96)
V = Coefficient of Variation (C.V. = 1.0)
E = Margin of error (2.5%)

The formula suggested that this study should collect at least 6,000 samples out of 438,857 firms in 6 sectors. The sample selection was purposive and criteria were made. Selected samples were diverse covering all Thailand regions, namely, Bangkok and its vicinities, Northern, Central, North-eastern, East, West and Southern. Companies were ranked according to the capital investments. Companies with higher capital investments were chosen first.

Collecting data based on the definition of macro logistics costs provided in the literature

In order to collect empirical data, this study conducted a full survey within 6 months. A questionnaire was developed based on the definitions provided in the literature. The developed questionnaire contained the questions asking a company profile and its logistics cost structure. Examples of the questions regarding logistics costs are illustrated in Table 2. There are questions asking about warehousing, inventory carrying and logistics administration costs. These three costs were not available in the NESDC data sources that used for calculating Thailand logistics cost. For transport cost, the data used by NESDC provided the costs of all transport modes (i.e. pipe, rail, road, water and air) but was not included the cost of pickup trucks. In Thailand, there are increasing numbers of pickup trucks registered with the Department of Land And Transport and some businesses use a pickup truck instead of other types of trucks (OTP, 2019). With the limited time and budget of this research, this study collected data only the cost of pickup trucks for both in-house and outsourcing. Approaching the selected samples was facilitated by NESDC. Respondents were asked to answer the list of questions presented in the questionnaire. There were 15,000 requests sent covering all regions of Thailand and only 6,020 questionnaires responded. The reason of non-response companies was that they did not want to disclose their business data. Non response bias test was not done due to the limited time of this research.

Cost component	Examples of questions
Transport (only pickup truck)	- In-house operating costs of pickup truck, e.g. fuel, wages - Outsourcing pickup truck costs
Warehouse	- In-house warehousing costs, e.g. types of goods, numbers of employees; - Outsourcing warehousing costs
Inventory carrying	E.g. inventory value, inventory carrying cost, interest rate
Logistics administration	E.g. salaries, rental costs, utility costs, repair and maintenance costs, interest paid

Source: The authors

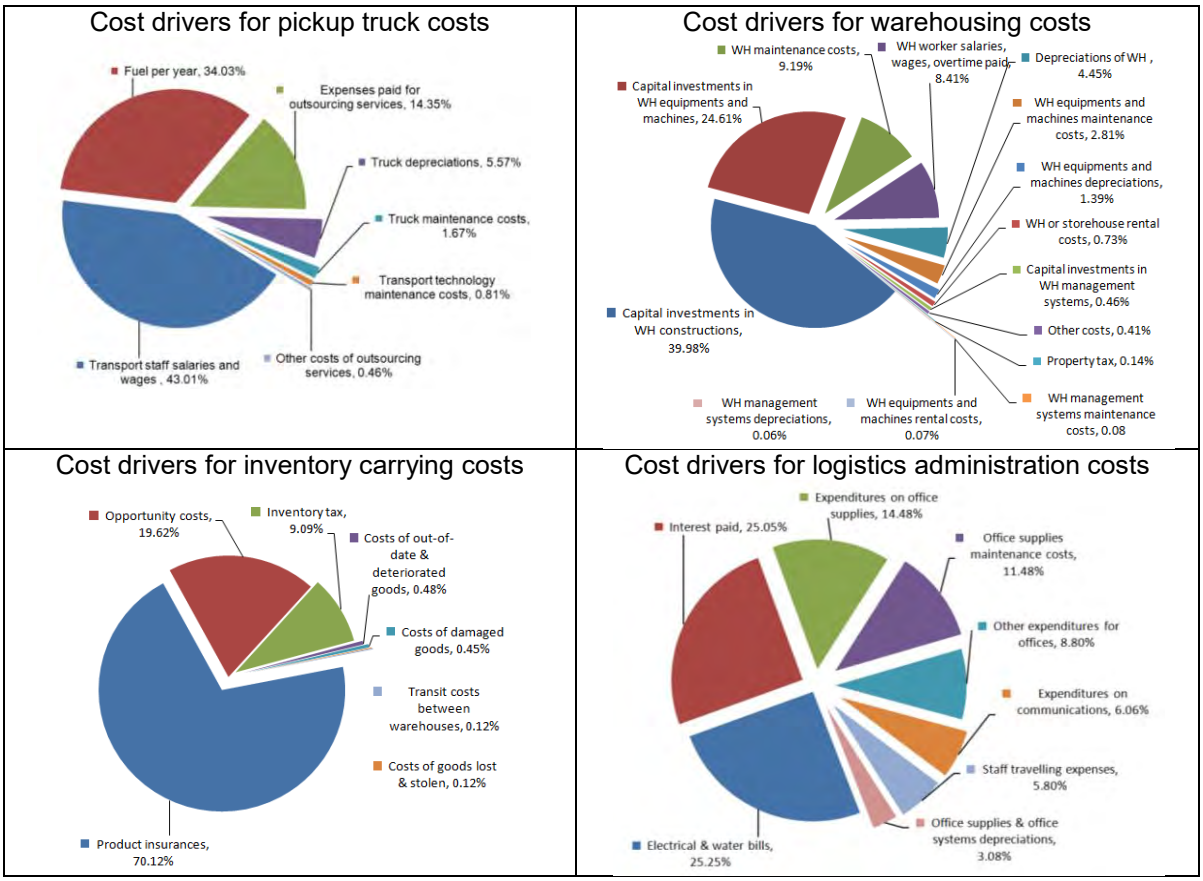
Table 2: Types of logistics costs and examples of items in the questionnaire

Analysing the obtained data

The obtained data were cleaning by excluding outliers (an extreme percentage of a logistics cost per revenue) and the data obtained from a company that reported zero cost in a particular cost component. A ratio analysis of the obtained data was done by comparing each macro logistics cost driver against a sum of each logistics cost component. Macro logistics cost drivers for each key logistics component were identified. A comparative analysis of identified macro logistics cost drivers between business sectors was done.

Findings

Macro logistics cost drivers for each cost components were identified and presented in this section. Figure 1 presents the identified macro logistics cost drivers for each logistics cost component.



Source: The authors

Figure 1: Cost drivers for each logistics cost component (each figure shows an average of all sectors)

The cost drivers for pickup truck costs

85.18% of Thai businesses used their owned in-house pickup trucks instead of using logistics service providers. Averagely for all business sectors, the proportions of cost drivers for in-house pickup trucks are presented in Figure 1. The highest is the cost of transport staff salaries and wages (43.01%). The second and third highs are the fuel cost per year (34.03%) and the expense paid for outsourcing service (14.35%). The top 3 cost drivers for in-house pickup trucks identified by each business sector are presented in Table 3. The fuel cost per year and the cost of transport staff salaries and wages appear to be high and are the two important cost drivers for all business sectors. The businesses in sector C and S seem to spend money for hiring logistics service providers. For sector A, B, F and G, although the pickup truck depreciations are in the list, it does not a major cost driver.

Sector	1st	2nd	3rd
A, B	Fuel per year (50.63%, 52.87%)	Transport staff salaries and wages (41.96%, 41.10%)	Truck depreciations (4.94%, 3.80%)
F	Transport staff salaries and wages (44.95%)	Fuel per year (44.54%)	Truck depreciations (5.29%)
G	Transport staff salaries and wages (50.65%)	Fuel per year (35.04%)	Truck depreciations (7.33%)
C	Expenses paid for outsourcing services (44.79%)	Transport staff salaries and wages (26.93%)	Fuel per year (22.77%)
S	Transport staff salaries and wages (41.29%)	Expenses paid for outsourcing services (28.38%)	Fuel per year (26.20%)

Source: The authors

Table 3: The top three of cost drivers for pickup truck costs

The cost drivers for warehousing costs

92.8% of Thai businesses used their owned warehouses. Averagely for all business sectors, the proportions of cost drivers for warehousing costs are presented in Figure 1. The highest is the capital investments in the in-house warehouse constructions (39.98%). The second and third highs are the capital investments in warehouse equipments and machines (24.61%) and the warehouse maintenance cost (9.19%). The top 3 cost drivers for warehousing costs identified by each business sector are presented in Table 4. The capital investments in warehousing constructions and the capital investments in warehousing equipments and machines appear to be high and are the two important cost drivers for all business sectors. The cost of warehousing worker salaries, wages, overtime paid is another major cost driver for sector A, F and S. The warehousing maintenance costs are a cost driver for sector B, C and G.

Sector	1st	2nd	3rd
A, F, S	Capital investments in warehousing constructions (41.96%, 49.84%, 41.96%)	Capital investments in warehousing equipments and machines (29.09%, 18.40%, 29.09%)	Warehousing worker salaries, wages, overtime paid (7.29%, 12.27%, 7.29%)
B, G	Capital investments in warehousing constructions (51.16%, 46.35%)	Capital investments in warehousing equipments and machines (18.76%, 12.77%)	Warehousing maintenance costs (9.78%, 11.55%)
C	Capital investments in warehousing equipments and machines (69.52%)	Capital investments in warehousing constructions (14.36%)	Warehousing maintenance costs (1.75%)

Source: The authors

Table 4: The top three of cost drivers for warehousing costs

The cost drivers for inventory carrying costs

Averagely for all business sectors, the proportions of cost drivers for inventory carrying costs are presented in Figure 1. The highest is the expense paid for product insurances (70.12%). The second and third highs are the opportunity costs (19.62%) and the expense paid for inventory tax (9.09%). The top 3 cost drivers for inventory carrying costs identified by each business sector are presented in Table 5. For sector A, C, F and G, the expense paid for product insurances is the highest cost driver while the expense paid for inventory tax is ranked lower. Opportunity cost is another important cost driver for inventory carrying costs. Interestingly, sector B and S have only a single cost driver, i.e. opportunity cost. This is because the agriculture, forestry and fishing as well as mining and quarrying businesses in Thailand usually do not have inventories. As products are gathered from the natural resources, they immediately distributed to markets.

Sector	1st	2nd	3rd
A, C	Product insurances (59.35%, 62.70%)	Inventory tax (20.60%, 18.84%)	Opportunity costs (17.71%, 16.36%)
F, G	Product insurances (51.65%, 74.03%)	Opportunity costs (28.10%, 20.27%)	Inventory tax (12.43%, 5.22%)
B, S	Opportunity costs (100.00%)	n/a	n/a

Source: The authors

Table 5: Top three of cost drivers for inventory carrying costs

The cost drivers for logistics administration costs

Averagely for all business sectors, the proportions of cost drivers for administration costs are presented in Figure 1. The highest is the money paid for electric and water used (25.25%). The second and third highs are the interest paid to a bank loan (25.05%) and the expenditures on office supplies (14.48%). The top 3 cost drivers for logistics administration costs identified by each business sector are presented in Table 6. The interest paid is still the major cost driver for every sector. The expense paid for electrical and water bill is another cost driver for sector A, B, C, G and S. The expenses for the purpose of office supplies (i.e. purchasing office supplies and expenditure for office supplies maintenance) are another cost driver.

Sector	1st	2nd	3rd
A, C	Interest paid (62.64%, 30.56%)	Electrical & water bills (14.36%, 23.78%)	Office supplies maintenance costs (10.50%, 16.05%)
S	Interest paid (55.06%)	Electrical & water bills (13.21%)	Expenditures on office supplies (10.11%)
F	Interest paid (41.12%)	Office supplies maintenance costs (12.65%)	Expenditures on office supplies (11.82%)
B, G	Electrical & water bills (26.26%, 26.61%)	Interest paid (18.34%, 22.11%)	Expenditures on office supplies (14.45%, 15.63%)

Source: The authors

Table 6: Top three of cost drivers for logistics administration costs

Discussions

It is found that the data derived from micro-level sources can show insights that are not found in the data derived from macro-level sources. The identified macro logistics cost drivers for each logistics cost component can be further used in an analysis of Thailand logistics costs. Policies can be made from these findings in order to support the national logistics policies. At the end, these may help improve Thailand logistics efficiency and competitiveness. Thai government has announced the 12th National

Economics and Social Development Plan (NESD). This plan consists of policies that aim at improving the national logistics performance. The results found this study can further be interpreted and suggestions for national logistics policy are presented as shown in Table 7.

For transport cost, as noted in the 12th NESD plan, other than the promotion of biofuels uses and improving the quality of logistics human resources, policies based on the findings from micro-level data can be suggested further. Businesses should not only use alternative energies sources but also adopt transport management system in order to manage a company's transport efficiently and effectively. For the wages and salary costs, although these are fixed costs but businesses should allocate workforces efficiently and may use technologies enabling automation that can help supporting a routine task.

For the warehousing cost, the plan aims at increasing the number of warehousing service providers. Policies based on the findings can be suggested that the government should promote the use of outsourcing warehousing services as they are expert in warehousing and have enough warehousing equipments and other necessary supplies than private companies who build their owned warehouses. This may reduce the amount of both warehouse construction cost and investments in equipment and material handling. Businesses should also consider the locations of outsourcing warehousing services in order to reduce the transport costs as well.

For the inventory carrying cost, the plan aims at encouraging the use of information technology (IT) in managing businesses' logistics. Policies based on the findings can be suggested that businesses should have an appropriate amount of inventory carrying units as this affect their opportunity costs. The government should promote the use of IT that helps manage inventory levels or businesses should adopt the just-in-time philosophy. It can also help by reducing inventory tax for a certain period. Furthermore, the government should negotiate with insurance companies in order to allow the revision of insurance contracts. As a debtor's (company) inventory volume has been changed and if insurance paid has been decreased, the inventory carrying cost should be decreased.

For the logistics administration cost, the plan aims at enhancing business capability and competitiveness through low interest rate loans as well as promoting the use of alternative fuels. Policies based on the findings can be suggested that the government should not only reduce tax rate for loans but also leave the interest rate unchanged for a certain period in order to keep a business run. For the energy related policy, similar to the plan, the government should promote the use of use alternative energies sources.

Cost component	The policies in the 12th NESD Plan	Suggested policies
Transport (pickup trucks)	1) Increasing the use of biofuels in the transportation sector by using market mechanisms to lower the price of biofuels to levels competitive with those of fossil fuels 2) Enhance the quality of logistics human resources and planning to meet the demands of the business sector	1) Fuel cost (variable cost): - Using alternative energies (e.g. solar, biogases, wind power) - Transport management system 2) Salaries and wages (fixed cost): - Increase workforce efficiency - Technology supporting routine tasks
Warehousing	1) Encouraging private sector investments in logistics-related industries, as well as the research and development of logistics technology and innovations (e.g., shipment tracking systems, lifting equipment, and maintenance tools used in logistics activities), by using financial measures or investment incentives	1) Capital investments in warehouse constructions as well as in construction, equipment and material handling - Promote the use of outsourcing warehousing services - Consider the locations of outsourcing warehousing

		services in order to reduce costs of warehousing and transport
Inventory carrying	1) Upgrading logistics management in the industrial sector by encouraging businesses to increase their adoption of information technology in managing their logistics	1) Opportunity cost and inventory tax - The appropriate inventory carrying amounts - Just-in-time - Decrease inventory tax 2) Product insurances - Allowing the revision of B2B insurance contracts as a company's inventory volume has been changed
Logistics administration	1) Promote innovative creation by issuing measures to support the agricultural, industrial, and service sectors to create innovations, and enhance capability and competitiveness such as through funds, tax incentives, and low interest rate loans, etc. 2) Evaluating the existing incentives (feed-in tariffs) that aim to increase the share of alternative fuels in power generation, to help develop other incentives that are fair to both the producers and consumers of alternative energy	1) Interest paid - Tax reduction policy - Leaving the interest rate unchanged businesses in order to keep them running 2) Electric and water supply expense - Alternative energies

Source: The authors

Table 7: Potential policies derived from the analysis of macro logistics cost drivers

Conclusions

This manuscript suggests that policy-makers may employ this approach to identify and analyse the national logistics cost. With information from secondary data source, insights obtained from the cost structure approach may help policy-makers in developing and planning strategies for reducing the national logistics costs. Findings from the cost driver analysis should also be announced to public as this will become a baseline for businesses as they want to compare their performances. Businesses can use these results as a guideline for considering and setting a goal aims at reducing their logistics costs and improving their logistics efficiencies. At the end, as businesses have efficient logistics performances, this will affect to the nation's logistics costs.

There are some limitations for this study. Firstly, the findings were calculated based on 6 sectors that majorly contributed to the country's total GDP value. This does not mean that the other 15 sectors do not have logistics activities. They may have different cost drivers. Future research needs to be done by repeating the method of this manuscript. Secondly, the respondents' understanding of logistics administration cost was limited as they often considered it as the firm's overall administration cost. Thirdly, the analysis of cost drivers in this manuscript did not consider the effect of firm size for each business sector. Future research should identify and compare cost drivers between small, medium and large firms. Different firm sizes may be have different advantages in such as scale economies and business circumstances. Thus, they may show other types of cost drivers or indicate cost drivers proportions differently.

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AN ASSESSMENT OF VIETNAM'S LOGISTICS PERFORMANCE

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Introduction

The logistics industry is one of utmost relevance and principally serves as a motor of enterprise development and growth of the economic sectors of a country or region. A logistics industry that is efficient and accessible to everyone is a key element for enterprises to successfully compete in this new global context. In Vietnam, however, the development of logistics platforms is still limited. The Vietnam logistics industry has not yet been highly competitive with those of other countries at both regional and global levels.

The main objective of this study is to conduct an assessment on logistics performance of manufacturing enterprises and logistics service providers in Vietnam in 2018, and to propose recommendations that would enable them to enhance the existing advantages and overcome shortcomings in order to more easily and directly participate in global logistics industry.

The paper is structured into five sections. First, an overview of development of logistics industry in Vietnam is presented. The literature review on logistics performance and determinants affect logistics performance is then discussed. In the third part, the methodology section explains the data collection and the framework for logistics performance assessment. The findings from the study is further presented and explained. Finally, the recommendations for promoting logistics performance of Vietnamese firms are withdrawn.

Literature review

The World Bank (WB) provided national logistics capability measure, the Logistics Performance Index (LPI), which helps countries identify the challenges and opportunities they face in their performance on trade logistics. LPI is the weighted average of the country scores on six dimensions: efficiency of clearance process by border control agencies, quality of trade and transport related infrastructure, ease of arranging competitively priced shipments, quality and competence of logistics services, ability to track and trace consignments, and timeliness of delivery in reaching destination within an expected shipping schedule. Vietnam's position in the LPI in 2018 rose 25 levels compared to two years ago, jumping to the 39th among 160 surveyed countries (World Bank, 2018). This is the best result of Vietnam since 2007 when the WB announced the ranking for the first time, showing Vietnam's logistics performance has been significantly improved in recent years.

Banomyong (2014) has concluded that GMS countries are still at the early stage of bolstering their competitiveness in the global context in terms of 4 logistics dimensions, including shippers, traders and consignees; public and private sector logistics service providers; national institutions, policies, and rules; and transport and communications infrastructure.

Banomyong et *al.* (2015) focus on four factors: infrastructure, service providers, shippers and state agencies to describe and promote Vietnam logistics performance. The study pointed out the strengths of Vietnam logistics system, including political stability, favorable geographical position, huge investment in infrastructure and great potential for attracting FDI.

Banomyong and Supatn (2011) developed a logistics performance assessment tool based on 9 logistics activities proposed by Grant *et al.* (2006) including customs services; planning and demand forecasting; purchasing; inventory management; order procedure and logistics connection; loading, unloading and packaging; transportation; facilities: warehouse location, storage; and receiving returned goods and reverse logistics. Based on the tool developed by Banomyong and Supatn (2011); Banomyong. Trinh Thi Thu Huong and Pham Ha (2014) measured logistics performance of manufacturing enterprises. The study identified 3 factors mainly affect logistics costs of manufacturing enterprises including transportation, warehousing, and inventory carrying costs.

Grant, Huong, and Lalwani (2015) carried out a survey to determine which factors affect logistics service quality using a set of 14 variables containing 8 factors derived from Banomyong *et al.* (2014) and 6 factors in determining LPI from Arvis *et al.* (2014). The findings were cost; customs and borders clearance efficiency; ability of arranging shipments; employee skill; timeliness of delivery in reaching destination within an expected shipping schedule; and reliability mainly affect the quality of logistics services. However, the number of responses with only 30 logistics providers and stakeholder in total is limited, thus the findings need to be validated by a larger sample.

In sum, the number of studies in the logistics performance assessment in Vietnam is still limited, creating the urge to conduct a study with larger number of responses to assess the logistics performance of Vietnam thoroughly.

Methodology

Survey was designed to analyse the Vietnam logistics performance by evaluating the performance of logistics service providers and manufacturing firms. 117 valid responses were received out of 140 questionnaires sent, of which 58 responses from manufacturing enterprises and 59 responses from logistics service providers. Among manufacturing enterprises, the responses varied with 50% of limited liability corporation, 39% of joint stock companies, and 11% others. The manufacturing enterprises operate in many fields including foods (35%), garment (22%), service (10%), electric and electronic (5%), medical equipments and materials (3%), and others. Among logistics service providers, 61% are limited liability corporation, 29% are joint stock companies, and 10% others. The main commodities logistics service firms handle include foods (inbound 51.2%, outbound 44.4%), garment (inbound 9.7%, outbound 16.7%), electronic and electric (inbound 9.7%, outbound 8.3%), and others.

Findings

(1) Logistics performance of manufacturing firms and logistics service providers in Vietnam

Within Vietnamese territory, the road mode is selected for more than 90% of domestic logistics actitivies. For international market, more than 66% of logistics activities are ocean freight, following by road freight and air freight thanks to their advantages of saving time and convenience.

Most manufacturing firms have not taken advantage of logistics outsourcing with only 43% firms outsourcing for access to international markets and 14.3% for the internal market. 23% firms themselves carry out customs procedures and activities related to value added and packaging. The remaining logistics operations including domestic freight forwarding, warehouse and inventory management, logistics IT systems are partially managed by external service provider and partially carried by manufacturing firms themselves.

Logistics service providers provide a variety of services such as domestic freight forwarder (62.7%), international freight forwarder (50.8%), international shipping line (49.2%), domestic shipping line (47.5%), truck operator (45.8%), custom broker (28.8%) and more. They often outsource services such as domestic trucking (54.2%), warehousing (45.8%), international air freight (45.8%), international ocean freight (44.1%), international trucking (37.3%), and packaging (32.2%).

The rate of returned goods at manufacturing enterprises is also quite high with on average more than 10% products being returned. The demand forecast accuracy rate is around average of 71.45%, the percentage of goods delivered on time is just above the average of 82.92% and the average rate of damage is 7%. For logistics service providers, the timely delivery rate is 83.5% and the average rate of damage is 6.1%. The main reasons for inappropriate delivery are the weather (62.7%), delays in receiving cargo (59.3%), additional costs (50.8%), delays in customs process (47.5%). In addition, there are other causes including traffic congestion, accidents, inspection delays, and insufficient logistics services.

(2) Logistics staffs in Vietnam

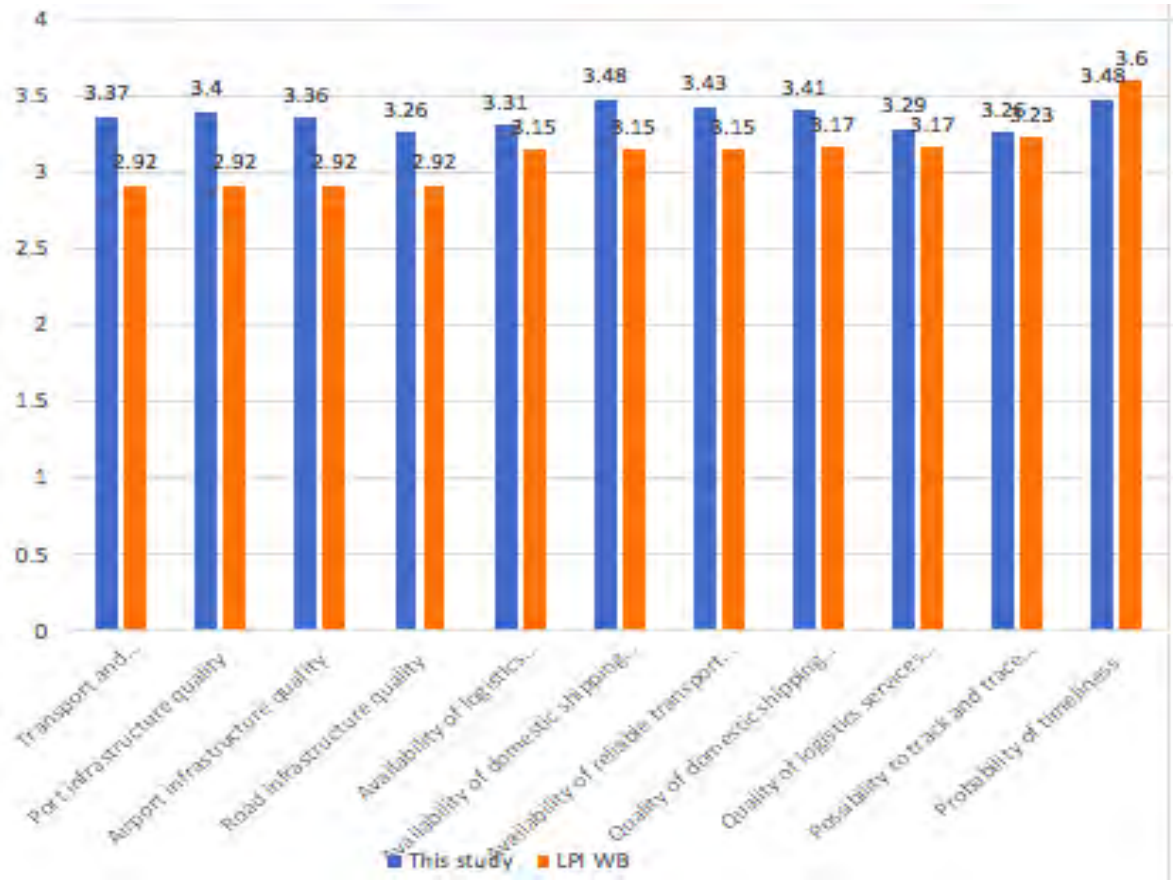
Experienced staffs are available in both manufacturing firms and logistics service providers. In manufacturing firms, 50%-70% surveyed firms have skilled logistics related staffs and about 70% firms have experienced managers. In logistics service providers, the availability of skilled logistics related staffs is even higher than that in manufacturing firms. However, 15.8% do not have planning staff despite forecasting process being vital for the business. That proves the fact that Vietnamese enterprises have not recognized the importance of planning and forecasting process.

Firms' human resource policy related to logistics skill development mainly focus on two forms of training: on the job training and internal development programme with internal trainers. The current workforce of logistics industry is mainly young human resources (trainees, recent graduates, and graduates with limited working experience) who have been relatively well-educated at universities. On the job training programme helps the young human resources to acquire more practical knowledge. In addition, due to limited business resources, internal development programme with internal trainers is quite popular.

(3) Logistics performance assessments from both Vietnamese enterprises and the WB

In comparison to the WB's assessment of Vietnam's logistics performance, responding enterprises are more optimistic. However, logistics performance assessments from both responding enterprises and the WB show that Vietnamese logistics system still need to improve in many aspects.

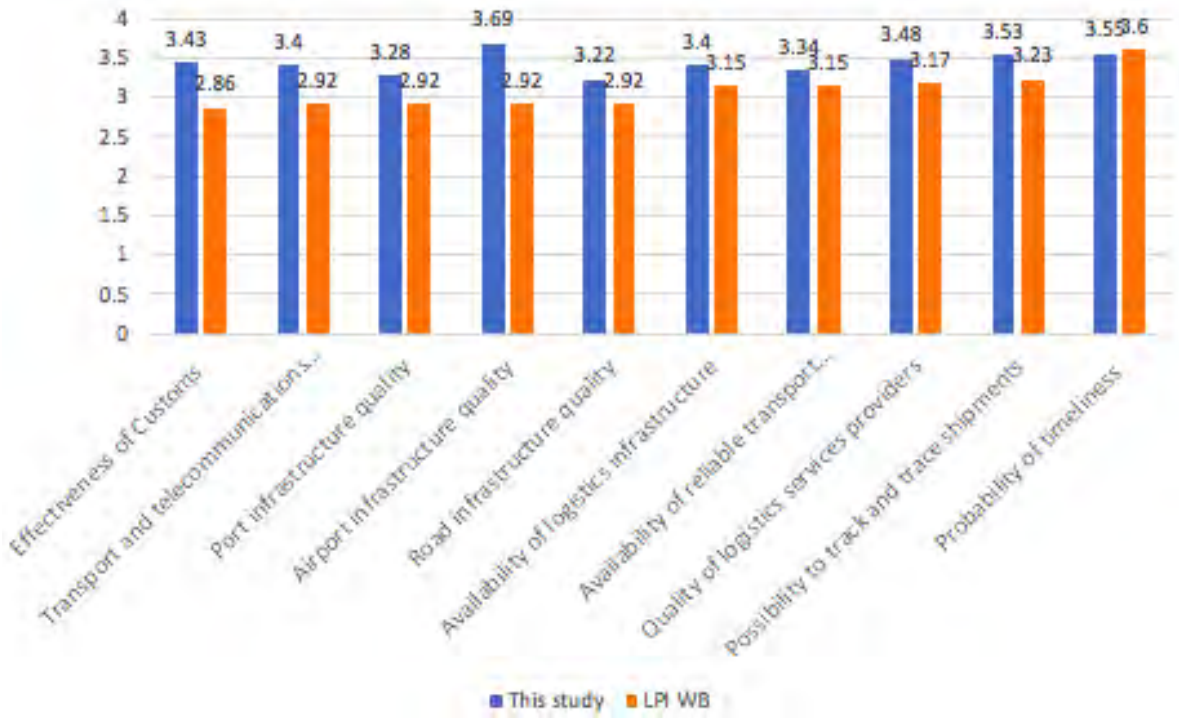
The evaluation of Vietnam's domestic logistics capacity is based on the following criteria: the quality of transport and telecommunications infrastructure; the quality of port infrastructure; the quality of airport infrastructure; the quality of road infrastructure; the availability of logistics infrastructure (e.g. warehouse, distribution centers, etc.); the availability of domestic shipping services; the availability of reliable logistics services; the quality of domestic shipping services; the quality of logistics services and competence of service providers; possibility to track and trace shipments; and the probability of shipments arriving at the promised time. Responding firms are more optimistic than the WB when evaluating the functioning of domestic logistics in the criteria of the quality of infrastructure (transport and telecommunications, port, airport, and road) and the availability of logistics infrastructure, domestic shipping services, and reliable transport services. Among the criteria of quality of infrastructure, firms estimate the quality of airport infrastructure the highest for both the international and domestic logistics (3.69 and 3.36, respectively) while the quality of road infrastructure the lowest (3.22 and 3.26). The main mentioned reason was traffic congestion, especially in big cities. The probability of shipments arriving at the promised time was rated the highest among criteria by the WB (3.6 for both domestic and international logistics) and was also higher than responding firms (Figure 1).



Source: The authors

Figure 1: Comparison of survey functioning of domestic logistics results with LPI 2018

The evaluation of Vietnam's international logistics capacity is based on the following criteria: the effectiveness of customs and other authorities in customs services, the quality of transport and telecommunications infrastructure; the quality of port infrastructure; the quality of airport infrastructure; the quality of road infrastructure; the availability of logistics infrastructure (e.g. warehouse, distribution centers, etc.); the availability of domestic shipping services; the availability of reliable logistics services; the quality of domestic shipping services; the quality of logistics services and competence of service providers; possibility to track and trace shipments; and the probability of shipments arriving at the promised time. In comparison to the WB's assessment of Vietnam's logistics performance, responding enterprises are more optimistic in almost criteria, except the probability of shipments arriving at the promised time (Figure 2).



Source: The authors

Figure 2: Comparison of survey functioning of international logistics results with LPI 2018

In terms of relative importance of time, cost and reliability, manufacturing firms and logistics service providers differ from each other. For manufacturing enterprises, the reliability is priotized (36%), cost is ranked second (33%) and time is considered somehow the least important (31%). Firms indicate that delivering products to customers safely is the most important thing. The lower cost makes firms more competitive is also important. On time delivery is the relatively less important than the two previous factors. Meanwhile, for logistics service providers, cost is the most important criterion, followed by reliability and time.

Recommendations

Based on the result and analysis, here are some recommendations for government and firms in order to improve the competitiveness and boost the development of Vietnam's logistics sectors:

Recommendations for firms

Develop logistics supply system: In near future, Vietnamese firms should joint together with foreign partnets to form joint ventures in order to provide more services. This helps bring a lot of benefits to firms such as gaining management experience, getting financial support, and accessing to a broader market.

Developing logistics infrastructure: Vietnamese firms still lag in terms of applying information technology into business activities when compared to international firms, but there is huge room for growth. Vietnamese firms need to invest in building logistics infrastructure such as warehouse, distribution centers, transport and telecommunication, etc.

Prepare high quality human resources. Well qualified human resouces will help Vietnamese logistics firms to keep pace with logistics firms in the region and to be capable of competing with foreign logistics firms operating in Vietnam. Firms should apply technonoly solutions and on the job training to training and quickly improve the quality of human resouces with professional practical knowledge, foreign language ability, geographical knowledge, and more. Besides, firms should have a detailed and clear human resource plan such as sending employees abroad or have recruiting and retaining programs.

Fund for R&D activities: Firms should develop a sustainable competitive advantage that differentiate them from their competitors as well as minimize logistics costs.

Improve the training process: By improving the research and development process and the standard of logistics professionals to meet business requirements and international criteria and to accommodate the process of developing personnel with higher skills so that they can compete in the international business arena. This will be done through cooperation between educational institutes, research institutes, private training institutes and businesses by updating training courses and teaching methods to ensure they are of international standard, promoting research and development activities to resolve problems for industries or businesses; standardizing the profession, labor standards and wage standards; determining a clear career path and supporting tertiary education institutions to build up excellence in logistics education and produce highly-skilled personnel to support the creation and transfer of logistics innovation.

Support the collection and development of data for logistics management: For both at the macro and the business levels, to help plot and drive strategy. The data will be collected at the national level; namely, information on commodity flows, operating costs and added value in the logistics industry, including KPIs for the country's logistics management.

Support the official establishment of the system for coordinating and monitoring policy: iIt is a mechanism to drive the development of Vietnam's logistics system. This can be done merging related government agencies and the private sector to play the role of regulator, monitor and evaluator of the continuously developing Vietnam logistics system.

Recommendations for Government and local authorities

Development of road infrastructure: Road transport is the main mode of domestic logistics transport. In order to improve the functioning of domestic logistics, the road infrastructure must be invested and strictly managed.

Developing port infrastructure: Sea transport is the main mode of international logistics. To make the most efficience of this mode, the goverment needs to invest in the port infrastructure. Besides, the port infrastructure needs to connect to the telecommunications, airport and road infrastructure. Additionally, improve the quality of telecommunications infrastructure, management of port systems and human resources are essential.

Develop airport infrastructure: Large international airports need to be expanded and upgraded to meet the growing demand for both goods and passengers. Additionally, quality of airport services and human resources at the airports need to be improved to ensure the safety and security.

Improve customs service quality: First, applying information technology in reforming administrative procedures, making the process of customs clearance convenient are necessary. Second, improving human resources quality in order to help customs procedures quickly and conveniently are also needed.

Encourage businesses in agricultural, industrial and service sectors: By implementing sophisticated logistics-management techniques in their industries through the promotion of better understanding among business owners of the value of logistics management, logistics best practices and information technology, as well as the use of logistics and transportation software in both the business itself and in outsourced services.

Provide training to personnel in both the production sector and the logistics-service industry: By creating awareness of the importance of logistics, making sure that entrepreneurs understand how to increase logistics efficiency, urging companies to send staff for training in the field, allowing tax deductions for training expenses, increasing the training capacity of various institutions, creating a system to accommodate the demands of labor, promoting cooperation among training institutes and workplaces

to produce personnel with skills that match business needs through a multidisciplinary education process.

Develop an integrated logistics network: For both locally and internationally, in such a way that the country is linked with overseas markets through the development of, among other things, feeder systems, motorways, logistics centers/distribution centers and container yards at strategic locations throughout the country.

Improve the taxation system and customs-clearance procedures: It related to import and export transportation and shipping businesses with the aim of facilitating the import/export process.

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INTEGRATED QUOTATION PROCESS FRAMEWORK FOR ELECTRONIC MANUFACTURING SERVICES

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Introduction

The formulation of accurate, competitive and profitable quotations is a challenging task in the Electronics Manufacturing Services (EMS) industry. The rising global competition in the marketplace has become increasingly intense and dynamic. Therefore, it is imperative for an EMS provider to respond quickly to requests for quotations (RFQs), which is an important but often neglected clog in the supply chain. Furthermore, pricing must be attractive to satisfy customers and at the same time assure a profit for the EMS (Elgh, 2010). Accuracy is vital as overbidding would mean a lost opportunity to a competitor and underbidding may lead to unprofitable business for the company (Veeramani and Joshi, 1997). Depending on the product complexity, an EMS quotation process usually takes 10 to 21 working days from the RFQ launch call to the submission of a quote proposal to the customer.

The purpose of this paper is to develop a systematic framework to manage responses to RFQs in the EMS industry. This research is primarily based on a case study of the challenges of the quotation process at a major EMS provider (Corporation A) based in South East Asia. A literature review of potential solutions for RFQs is also conducted before the feasibility and impact of implementing these solutions in the case company is assessed.

Literature Review

This review is centered around five themes that are relevant to techniques used in responding to RFQs, namely target costing, value engineering, value stream mapping, quality function deployment, and information technology/management.

Target Costing (TC)

Target Costing is a technique used to determine the target cost of production by subtracting the desired profit margin from an expected selling price of a product. In practice, this is an iterative process in which companies design products to customers' satisfaction, balancing between product functionality and quality while keeping within the targeted cost to achieve pricing competitiveness (Ho and Lin, 2009; Park et al., 2016).

Value Engineering (VE)

Value Engineering is a systematic technique to distinguish the function of a product or service and to establish a monetary value for that function (Farsi and Hakiminezhad, 2012). The first step of functional analysis involves evaluating selected components for its functionality and cost. The aim is to improve the products' design, maintaining quality and performance yet improve the overall cost. Subsequently, possible engineering cost reduction initiatives may include a change in components' designs, utilise lesser parts, use less expensive materials or improve manufacturing processes (Al-Qady and El-Helbawy, 2016).

Value Stream Mapping (VSM)

Value Stream Mapping is a technique that illustrates the sequence of activities related to the flow of materials and information which is required to produce a product or service. The current state of a process is mapped out and analysed with the aim to improve its flow. Possible solutions for improvements are discussed prior to the development of the Future State Map (FSM). VSM allows a Quotation team to identify, reduce or eliminate non-value-added activities, thus improving lead time.

Quality Function Deployment (QFD)

Quality Function Deployment methodology involves translating customer requirements into a functional design or technical requirements (Foster, 2013). QFD aims to systematically understand customers' requirements and it is useful for planning and controlling the development process (Chen, 2009). It is made up of four phases, the production planning, parts deployment, process planning and production planning (Hauser and Clausing, 1998; Ho and Lin, 2009). QFD is an especially relevant tool to apply to

"unusual" cases of RFQs with commodities that may be new or unique to an organisation. It provides a systematic approach to ensure customer requirements are fully understood and to avoid any misinterpretations.

Information Technology (IT) and Information Management (IM)

A product configuration system is an IT solution that serves as a data repository. It stores information related to the product during its life cycle (i.e. the structure and functionality). The aim is to design a system to provide a structural way of sharing information with departments involved in the quotation process (Hvam et al., 2006). A study conducted by Hvam et al. (2006) found that with a common platform for information sharing, teams in a case company experienced an improvement in communication and coordination, which resulted in a reduction in lead-time of their quotation process.

Case Background

As a leading EMS provider, Corporation A constantly receives many RFQs for a wide variety of products and volumes. The quotation process can be demanding, since it relies on the availability of customer's information, efficiency of the internal departments and responsiveness of supply chain partners.

The Quotation Department supports customers from four business segments, namely the Consumer, Communication, Industrial and Medical segments. The Quotation Process as illustrated in Figure 1 begins with the Business Development Management (BDM) team, which launches the RFQ through the internal Customer Relationship Management (CRM) system. The sufficiency of the customer's documentation is critical for the Quote Coordinator to decide whether the RFQ is good to launch or to request the BDM team to obtain better documentation from the customer.

After the launch call, the business units proceed to work on their respective areas of responsibilities. The role of the Value Plus Department is to determine the amount of work (i.e. manpower, facility space, testing requirements, or any special process) required to manufacture the product. At an agreed date, the material cost (from Quotation Department) and data from Value Plus Department will be consolidated to create statements on the expected profitability of the quote. The financial statements will be presented to management for approval before a quote is submitted to the customer.

Over time, the Quote Management function and its processes have been progressively refined according to the evolution of products and customers' expectations. However, the Quote Management function faces rising dis-satisfaction from internal business segments, with regards to the quote process and quality. These dis-satisfactions include pricing un-competitiveness, long quotation lead times, inaccurate quotes and lack of alignment with different practices among quotation hubs. Hence, the senior management team initiated a global internal survey to gather business segments' feedback so as to identify their challenges faced when dealing with RFQs.

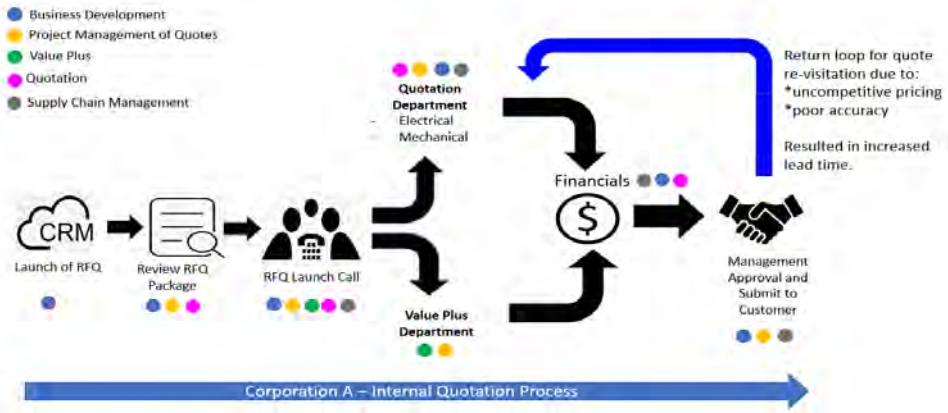


Figure 1: High-Level Quotation Process

Methodology

The survey was designed to incorporate both quantitative (i.e rating evaluation) and qualitative (i.e comments section) elements. This multi-method approach provides a wider scope which enhances data collection, analysis, and interpretation (Saunders et al., 2016). Survey feedback is analysed and categorised so as to identify common key challenges faced by all the segments when dealing with RFQs. A research study was also conducted by considering experiences of other industries facing similar challenges and how they have implemented solutions in their organisation. Methodologies and solutions were identified and assessed to determine its relevance to the EMS industry. Frameworks to match the best solutions to these challenges were conceptualised from the literature review.

Non-value added activities were identified and eliminated from the existing quotation process. The re-designed framework intends to integrate solutions to these challenges, through a systemic step-by-step process to formulate EMS RFQs. Eventually, exemplary embedded cases (i.e. past RFQs) were selected to illustrate the application of the new framework and to evaluate its effectiveness of solutions to the challenges faced generally in EMS RFQs. The case study analysis method has been selected as it is effective in determining what is happening and why. It also provides insights into the outcome of the situation and its application for action (Dubois and Gadde, 2002).

Results & Discussion

For the internal survey, 80 invitations sent out via a web-based survey tool to representatives from various business segments. 58 responses with usable feedback were received. The survey results were being classified into two sections, the rating evaluation (i.e. quantitative data) and the comments section (i.e. qualitative data).

Survey Results - Ratings

Table 1 summarises the participants' satisfaction level for the cost and service level extended by the business units of the quotation process. Rating is based on a five-point scale. A score of "5" indicates "Very Satisfied" and "1" indicates "Least Satisfied".

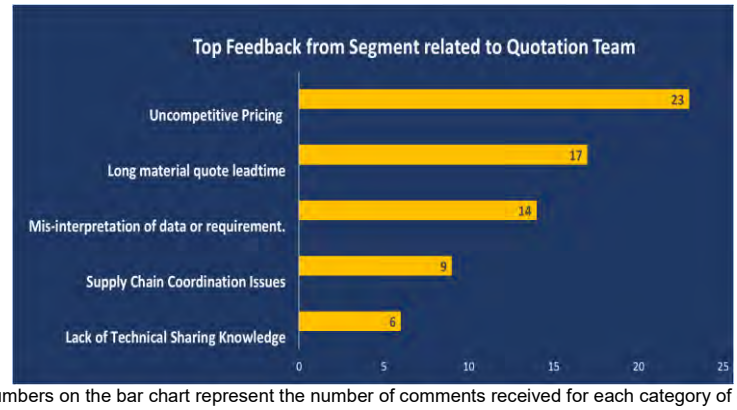
Factors	Quotation Department	Value Plus	Project Management	Executive Approval	Launch Call		Pricing Factors	Quotation Department	Value Plus
Service	2.81	3.56	3.88	3.8	3.82		Electrical	3.15	3.38
							Mechanical	2.73	3.21

Table 1: Rating Evaluation Summary

In terms of service level, the Quotation Department received the lowest level of satisfaction (at 2.81 out of 5) among all aspects of the RFQ process, which is in line with the expectations before the survey was launched. As for cost, mechanical parts pricing has the lowest rating of 2.73 (well below the ratings for electrical parts).

Survey Results - Comments

The feedback for Quotation Department's pricing and service were analyzed to determine the most frequent keywords/comments among the concerns received.



Note: Numbers on the bar chart represent the number of comments received for each category of concerns

Figure 2: Top Feedback from Segment for Quotation Team

Figure 2 shows the top 5 challenges in the bid management and quotation process, as identified from the respondents' feedback. Out of 23 comments on pricing un-competitiveness, a higher percentage were specific to mechanical part pricings. Respondents indicated that at times, customers rejected the quotes (which had already been priced) and requested it to be re-visited. Often, the revised pricing was lower than the first quote submitted to the customer. For long material quote lead time, respondents felt that the Quotation team is taking too long to generate material costs, which resulted in an increase of the overall quote lead time.

Respondents expressed concerns on the Quotation team misinterpretations or not understanding customers' data or requirements which has contributed to the inaccuracy of quotes. This happens for RFQs with commodities that Quotation team is unfamiliar with and do not have an established supplier network to collaborate on the interpretation of the technical requirements.

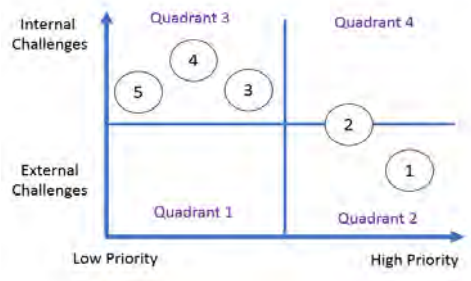
Other concerns include the inefficiency of supply chain coordination whereby respondents felt the lack of alignment among regional quote hubs especially in dealing with multi-region quotes. A lack of technical sharing knowledge to drive competitiveness in the quote was especially an issue for the case of mechanical materials.

Frameworks for Matching Solutions to the Key Challenges

With the key challenges and potential solutions identified from the preceding sections, two frameworks are conceptualized. The first framework (Figure 3) represents the key challenges, which is designed for better illustration of which are the higher priority challenges (X-axis) vs the nature of the challenges (Y-axis). The classification of internal and external challenges vs the priority was reviewed objectively, considering whether the challenge has external or internal influences or both. For example, uncompetitive pricing (no.1), is classified as external challenges as it has external influence (i.e. availability of customer's information, supplier relationship, etc.) which affects pricing competitiveness.

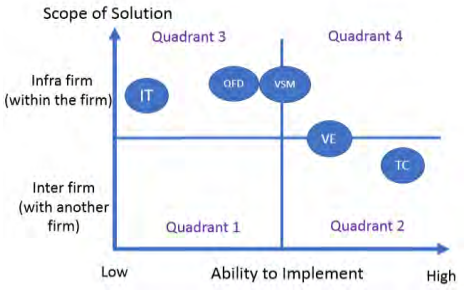
The second framework (Figure 4) represents the potential solutions identified in the literature review. The X-axis represented the level of ability of the Quotation Department to implement the proposed solutions. The Y-axis defines the scope of solutions, i.e. whether it is infra-firm (internal) or inter-firm (external). Inter-firm means that the solution involves either a supplier or a customer, whereas intra-firm refers to an involvement between two or more departments of the same firm. For example, VE is classified as a combination of both intra-firm and inter-firm, VE is a joint effort between internal departments (i.e. design, engineering teams) and suppliers.

Frameworks for Key Challenges and Solutions



(1) Uncompetitive Pricing
(2) Long material quote lead time
(3) Mis-interpretation of data or requirements
(4) Supply Chain Coordination
(5) Lack of Technical Knowledge

Figure 3: Framework for Key Challenges



(1) Target Costing (TC)
(2) Value Engineering (VE)
(3) Quality Function Deployment (QFD)
(4) Information Technology & Information Management (IT/IM)
(5) Value Stream Mapping (VSM)

Figure 4: Framework for Solutions

Matching Solutions to Key Challenges

Table 2 has been conceptualised to match the best solutions to the key challenges. Our approach for this paper is to focus on the higher priority challenges, from Priority 1 to 3. The expected timeline for

priority 4 and 5 challenges could be longer (i.e. 10-12 months) with IT implementation and hence outside of our focus.

Solutions \ Issues		P1: Uncompetitive Pricing	P2: Long Material Quote LT	P3: Mis-interpretation of data or requirements	P4: Supply Chain Coordination issue	P5: Lack of Technical Knowledge Sharing
		Quadrant 2	Quadrant 2 and 4	Quadrant 3	Quadrant 3	Quadrant 3
Target Costing	Quadrant 2	X	X			
VE	Quadrant 2, 4	X				
QFD	Quadrant 3			X		
VSM	Quadrant 3, 4		X		X	
IT Tool	Quadrant 3				X	X

P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4, P5=Priority 5

Table 2: Matrix for matching solutions to key challenges

New Quotation Process (TO-BE) (With TC, QFD, and VE)

There are two types of quotes, namely the Printed Circuit Board (PCB) and System Assembly (SA). SA quotes are mechanicals intensive and complex, which is usually the key bottleneck process. PCB quotes are straight-forward with fast turnaround. Therefore, we only consider the SA quotation process when applying our solutions.

The Value Stream Mapping (VSM) technique is used to identify the waste or non-value-added activities in the quotation process. The checking process (i.e. Quote Coordinator conducts check to ensure the team complies with customers' templates) has been identified as a non-value-added activity and proposed to be eliminated in the new re-designed new quotation process.

The existing SA quote process and the possible solutions discovered from the literature review are being studied concurrently. Resultantly, the new quotation process is conceptualised. The new quotation process exemplifies a systematic framework that integrates TC, QFD, and VE into a systemic step-by-step process to formulate SA RFQs. A simplified framework for the new quotation process as illustrated in Figure 5.

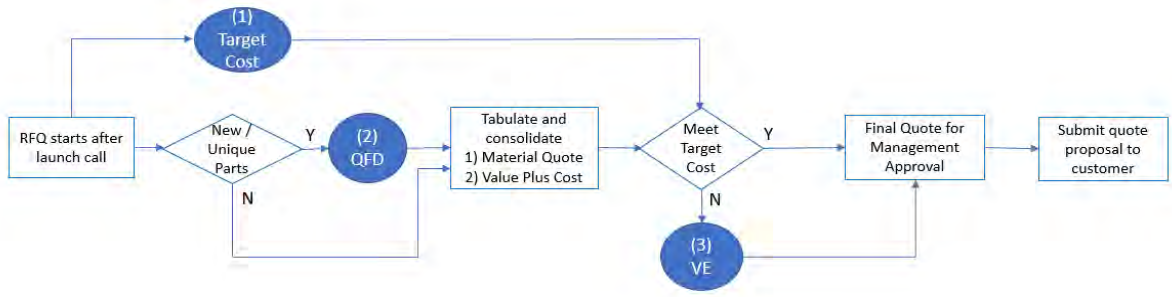


Figure 5: Simplified framework of New SA Quotation Process

Embedded Cases for New Quotation Process

Three embedded cases from the case company are presented to illustrate the application of the new framework and to assess its feasibility of resolving the key challenges.

Embedded Case 1

Customer A designed a hand-held device to help healthcare professionals to monitor patients' vitals remotely. Corporation A provided a quote proposal with a material cost of $132 to the Customer for the mentioned device. However, the quote was rejected by the customer, who requested the quote to be revised with a target material cost of $100. QFD was not applicable, as there was no new or unique

commodity involved. However, the customer was receptive to the idea of VE. Therefore, the Quotation team provided VE suggestions as follows:

<table>
<tr><th>No.</th><th>VE Activity</th><th>Simplified Steps Taken for VE</th></tr>
<tr><td>Step 1</td><td>Identify the gap between cost vs target.</td><td>(1) Original Material Cost = $132.
(2) Expected Material Cost = $100
(3) Value to cost down (Gap) = $32</td></tr>
<tr><td>Step 2</td><td>Identify and assess the commodity if VE is suitable.</td><td>1) Assess BOM contribution and identify high value contributors.
2) Verdict = To re-visit 25 parts identified for VE opportunity.
<table>
<tr><th></th><th></th><th></th><th colspan="2">High Value Contributors (>/=$1)</th></tr>
<tr><th>Commodity</th><th>No of Parts</th><th>Total</th><th>No. of Parts</th><th>Total</th></tr>
<tr><td>Electrical</td><td>119</td><td>$74</td><td>8</td><td>$67</td></tr>
<tr><td>Electro-Mechanical</td><td>20</td><td>$29</td><td>9</td><td>$26</td></tr>
<tr><td>Mechanical</td><td>29</td><td>$29</td><td>8</td><td>$15</td></tr>
<tr><td>Total</td><td>168</td><td>$132</td><td>25</td><td>$108</td></tr>
</table></td></tr>
<tr><td>Step 3</td><td>Work with suppliers to achieve the target.</td><td><u>Electrical & Electro-Mechanical initiative:</u>
Proposed changes to Antenna & Controller, substitute diode pack with single diode, cost reduction on high-end connectors, etc.
<u>Mechanical initiative:</u>
Remove NRE amortisation, propose cheaper equivalent grade raw material.</td></tr>
<tr><td>Step 4</td><td>Tabulate VE cost achieved and approval.</td><td>Potential Savings: $22.90
1) Electrical & Electro-Mechanical: $ 14.50
2) Mechanical: $ 8.40</td></tr>
</table>

Table 3: Proposed VE activities for Healthcare Handheld Device

The VE exercise, therefore, led to a savings of $22.90 (17.3%) and the business was awarded to Corporation A.

Embedded Case 2

Customer B, the product is an industrial outdoor router that is being manufactured by another EMS. The customer's target is a 15% reduction for the mechanicals, from the existing sales price. The plastic parts were unable to achieve the expected cost target due to an unrealistic existing price (i.e. raw material cost is 85% of the purchase price). The Quotation team decided to re-evaluate for an alternative solution to improve pricing competitiveness.

A target was first determined as follows, based on the desired profit margin of 5% of the expected selling price.

- Expected Selling Price = Target Cost (i.e. Materials Cost + Value Plus Cost) + Desired Profit Margin.
- $6.38 = Target Cost + Desired Profit Margin
- Target Cost (Materials) = $6.38 – $0.319 = <u>$6.061</u>

Again, QFD was not applicable, as there was no new or unique commodity involved. In addition, the Quotation team conducted a post mortem via a VE analysis on the plastics parts to assess its potential for improved cost.

No.	VE Activity	Simplified Steps Taken for VE
Step 1	Identify the gap between cost vs target.	Original Purchase Price = $7.50 Target Price = $6.38 Target Material Cost = $6.016 Value to Cost down = $7.50 - $6.016 = $ 1.484
Step 2	Identify and assess the commodity if VE is suitable.	Different aspects of VE were evaluated. The design could not be changed as a higher cost will be incurred due to new tooling required. Collaborated with raw material suppliers for an equivalent material grade.
Step 3	Work with suppliers to achieve the target.	Proposed change of resins to an equivalent material grade.

Step 4	Tabulate VE cost achieved and approval.	Potential Cost Down $: A – C = $7.50 - $6.13 = $1.37

		A	B		C	
Part Number	**Description**	**Existing Purchase Price (US$)**	**Target Price (US$)**	**Target Material Cost (US$)**	New Price base on VE Efforts (US$)	Remarks
CPN2	Base Cover	$5.30	$4.51	$4.28	$4.27	Quote base on alternative material: Lotte PC+10%GFF HN-3104
CPN3	Cover Lid	$2.20	$1.87	$1.78	$1.86	
	Total	$7.50	$6.38	$6.06	$6.13	

Table 4: Proposed VE activities for Industrial Outdoor Router

This analysis yielded potential savings of $1.37 (18.2%) with an alternative material proposal. However, due to customer decision, this project was not transferred to Corporation A even though a lower cost target was achieved.

Embedded Case 3

Customer C, a global leader in the field of optics and optoelectronics, requested a quote proposal for seven of their existing visualisation systems. Short lead-time was given to turnaround a quote of 1000+ parts. The main challenge was sourcing for new suppliers with the technical capability to produce the high precision optics lens. The entire process took over two months. Eventually, a single supplier that could meet customer's requirements was found. This case study was selected to evaluate the new quotation framework with the aim to discover a structural approach to handle a new commodity.

A further challenge was that the target price was not provided by the customer, which requires an internal target price to be developed. The steps involved included enquiring the current sales price of the diagnostic equipment, identifying past RFQs involving similar products and tapping on the historical pricing database to identify common components. Furthermore, the QFD method was adopted to ensure customer requirements were fully understood and prevent misinterpretation. An optics quote was obtained from the supplier at this stage and consolidated in the Costed BOM for final approval.

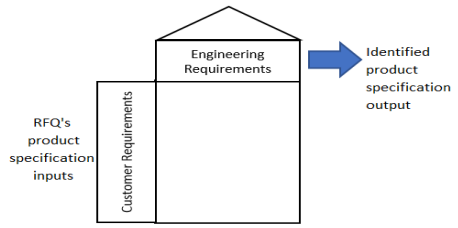
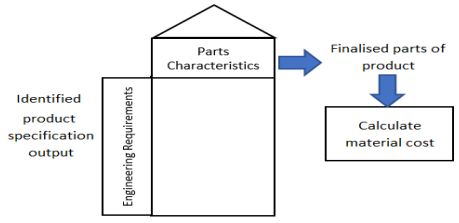
1st Phase: Product Planning Phase	Activities:
	(1) Optics requirements extracted from drawings and translated to product specifications by means of the QFD product planning phase. Collaborative discussion between customer, suppliers and Corporation A to ensure product requirements are clearly understood.
2nd Phase: Parts Deployment Phase	Activities:
	(2) The output for this phase is the material cost. In this case, the formal quotes from the optics suppliers are tabulated. Quotation team works with shortlisted suppliers to negotiate for the best pricing for the parts and tooling cost.
3rd Phase: Process Planning Phase	This responsibility falls under the Value Plus Department, which will work on this requirement.
4th Phase: Production Planning Phase	

Table 5: Illustration of using QFD tool for Medical Visualization System

On the other hand, there was little scope for the adoption of value engineering, as the product was classified as a Class II medical device, under the US Food & Drugs Administration (FDA) classification. For a Class II product, manufacturers must follow the customer's specifications exactly with no substitutions, to avoid a potential impact on health and safety. Nonetheless, through the QFD technique, a more systematic and structured approach was followed to ensure that customer's requirements are fully understood and met. Even so, misinterpretation of requirements for the optics parts led to several rounds of re-quotes, although these were minimized with QFD

Conclusion & Recommendation

The new framework provides a systematic flow by encompassing the various methodologies uncovered in the literature review such as TC, VE, QFD, and VSM. From three embedded cases, the new framework has demonstrated good potential in formulating RFQs that are competitive, accurate and profitable (Elgh, 2010; Ho and Lin, 2009) in the EMS industry. While these cases have exhibited positive outcomes from engaging the new framework, the principles developed in this framework are not currently being systematically applied among the thousands of RFQs in Corporation A. Hence, it is recommended that Corporation A adopts the new framework to guide the approach towards RFQs. The pre-requisites for its adoption include a sufficiently comprehensive RFQ documentation package, centralised repository to aid the derivation of internal target price and reasonable lead time to be catered for VE counter-proposals.

This study is not without its limitations, Firstly, target prices are not always available from customers and even if they are available, they may not be reliable. It is thus important to evaluate the provided cost target internally to avoid under-quoting. Secondly, for the VE counter-proposals, customers may not be fully receptive as changes incur time and cost due to the need for re-qualification. Thirdly, while an information technology/management approach to sharing pivotal quote parameters through a centralised repository system is a potential avenue through which coordination and information asymmetry issues could be avoided, this is out of scope in this study due to the complexity of implementation. Hence, future research could focus on resolving the challenges for cross-functional interfaces between functions involved in a bid process.

In conclusion, this research study has developed a systematic framework to formulate competitive, accurate and profitable EMS RFQs. This research contributes to the literature by proposing a new framework that integrates TC, QFD, and VE into a systemic step-by-step process to formulate SA RFQs. The implication for managers in the EMS industry is that the adoption of the new framework should lead to a reduction in the number of re-quotes, which would help to increase the quality of RFQs and ultimately improve customer satisfaction.

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ASSESSING THE MAGNITUDE OF DETOURS FACED BY CARGO FLIGHTS: AN EMPIRICAL ANALYSIS

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Introduction

Air cargo has grown fast over the recent decades (Kupfer et al., 2017) and has become important for various businesses (Leinbach et al., 2004) despite its strong adverse environment impact (Daley, 2010). Of course, air cargo still accounts for a marginal share of all the tonnes or ton-km of goods carried all over the world. However, its share expressed in value is significantly higher. For instance, Budd and Ison (2017) estimate air cargo accounts for only 51 million tonnes in 2014, but valued at over US$6.8 trillion. It is thus not surprising air cargo operations have received more and more attention from scholars (see Feng et al., 2015, for a review), although clearly less than passenger air transport (Kupfer et al., 2017). This also includes transport geography research and the statement made by Vowles (2006), according to which "An emerging area of investigation within the industry is that of air cargo and freight" remains topical. Air cargo transport geography studies have investigated various topics, including:

- The network geography of air cargo carriers (e.g., Bowen, 2004, Bowen, 2012, Walcott and Fan, 2017, Malighetti et al., 2019).
- The factors of air cargo flows (e.g., Hwang and Shiao, 2011, Lakew and Tok, 2015; Kupfer et al., 2017; Gong et al., 2018) and of airport choice (e.g., Gardiner and Ison, 2008).
- The symbiotic relationship between air cargo networks and specific economic sectors (e.g., Leinbach et al., 2004).
- Competition between main airports (e.g., Wong et al., 2016).
- Case studies focused on a specific cargo hub (e.g., Zhang, 2003).
- The time-geography dimension of cargo hubs (e.g., Kim and Park, 2012).

In contrast, the core geographical concept of "distance" in the air cargo industry has largely been neglected. As Rodrigue et al. (2013) stated, distance is "the most fundamental element of geography in general and transport geography in particular." At best, distance appears as a parameter among others in various research works (Matsumoto, 2004; Hwang and Shiao, 2011; O'Kelly, 2014; Wong et al., 2016; Gong et al., 2018). What is more, virtually all authors consider the distance flown as the shortest distance (named great-circle distance or orthodromic distance by the geographers). As it will be argued in the next section, distance flown in the real world is always longer than the shortest route. The magnitude of the detours is of importance, because longer detours usually involve higher operating costs (because of more fuel and workforce costs), less rotations (in a context where fleet ownership accounts for a significant fixed cost) and more emissions of greenhouse gases and of air pollutants due to increase in fuel burnt.

In this context, the aim of this paper is to assess the magnitude of detours experienced by air cargo flights. It is a by-product of a more general research that was focused on all commercial flights (Dobruszkes and Peeters, 2019). Before assessing the magnitude of detours, Section 2 summarises the factors of detours. Section 3 describes the data and methods used. Then Section 4 introduces the results. Section 5 discusses the implication of our findings while Section 6 concludes.

The factors of detours

In the real world, virtually all flights experience detours compared to the shortest route. This is because of various factors that are summarised in Table 1 (for a comprehensive review, see Dobruszkes, 2019). These factors relate to technical, natural, geopolitical and social constraints. In most cases, airlines do

not have leverage on these factors while in contrast, governments are usually responsible for geopolitical factors. At best airlines can replace older aircraft with newer models, which usually allow longer time to alternate airports, and thus straighter routes all other things being equal.

It is also worth noting that if nearly all factors of detours mean more fuel burnt and thus higher costs, there is one exception, namely the jet stream issue. Jet streams are four main air currents. Their altitude (9-12 km for the polar jets streams and 10-16 km for the subtropical ones), latitude, width (hundreds of kilometres) and intensity are such that they do interfere with flights. Jet streams flow eastbound and their location changes over time (both on a seasonal basis and in the shorter term). As far as they can, planes fly eastbound in a jet stream and avoid it if they are westbound. This the only case where a detour helps to lower the amount of fuel burnt.

Nature	Factor	Temporality	Impact on fuel burnt
Technical	Route design	Permanent	Increase
	Traffic density	Temporary or permanent	Increase
	Time to alternate airports	Permanent	Increase
Natural factors	Relief	Permanent	Increase
	Storms	Temporary	Increase
	Jet streams	Permanent but changing location	Decrease (tailwind) or increase (front wind)
	Cyclones	Temporary	Increase
	Volcanism	Temporary	Increase
Geopolitical	First air freedom	Permanent	Increase
	No-fly zones	Temporary or permanent	Increase
	War, terrorism	Temporary	Increase
Social	Strike	Temporary	Increase

Table 1. The factors of detours. Source: Dobruszkes (2019)

Assessing the magnitude of detours: Data and methods

Before explaining how to assess the magnitude of detours, it is worth noting that on nearly all maps, the shortest route is not a straight line. This is due to map projection issues. A map projection is a transformation of the globe (thus approximately a sphere or an ellipsoid) into a flat map, in which the Earth surface will be unevenly stretched and shrunken. This will alters shapes, distances and directions, especially when "large" portions of the earth are mapped (Robinson, 1988). As a result, the shortest route, which is actually a curve over the globe, has very little chance to become a straight line on a map (Figure 1). Fortunately, the azimuthal equidistant projection has the merit that any great circle (the line that divides the Earth is two equal volumes) passing through its centre will appear as a straight line on the map, with the correct direction and the right distance. Distances will be correct along the line, and the whole earth will be visible (in contrast with other equidistant projections, such as the gnomonic projection), although areas are not maintained and shapes are highly distorted at the edges of the map (Gilmartin, 1991). In all other cases — including the Mercator projection or its Internet variants that are used by most on-line flight trackers as well as by Google Maps until recently and by Baidu Maps — one cannot assess with one's own eyes the magnitude of detours experienced by commercial flights. As a result, it is fundamental that any measurement of distance in a geographical information system (GIS) has to take actual cartographic projections into account. In any other case, resulting distances could only be biased.

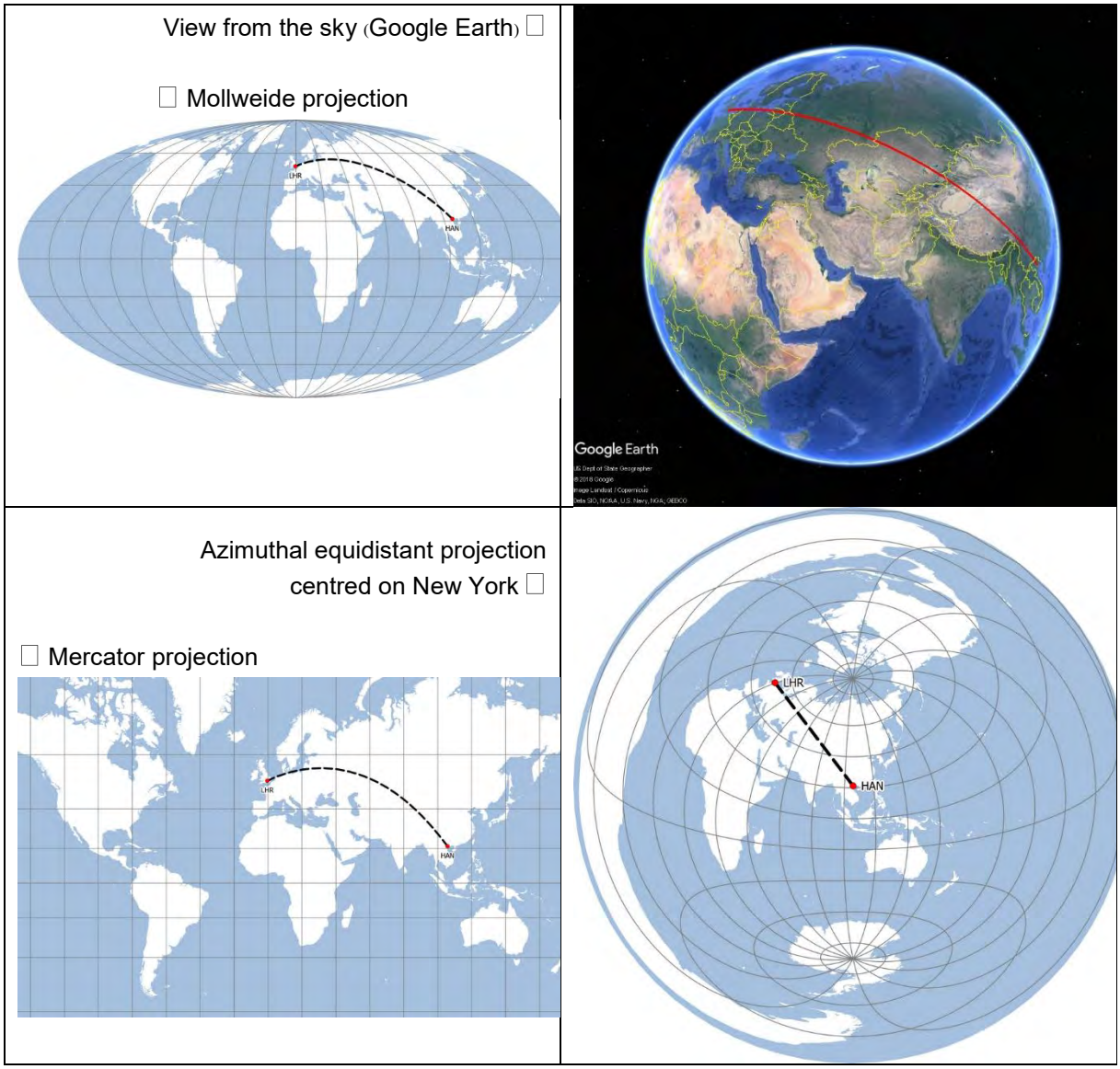

Figure 1: Mapping the shortest Hanoi–London route with various projections

To assess the magnitude of detours, we followed exactly the same methodology than in a previous paper in which we had considered a larger sample that included both passenger and cargo flights (see Dobruszkes and Peeters, 2019). One week of historical flight traces were bought from Flightradar. Flightradar data is based mostly on the so-called Automatic Dependent Surveillance-Broadcast technology (ADS-B), according to which aircraft locate themselves thanks to on-board GPS and satellites. Then, aircraft regularly transmit their position through their on-board ADS-B transponder, which is now set up in most commercial planes. A network of about 17,000 Flightradar ground receivers pick up the signal and feed both the real-time website and historical data. Because each receiver has a limited range (ranging from 250 to 450 km in all directions), covering the oceans is impossible, except close to land (including islands) equipped with receivers, if any. In certain areas, Flightradar also estimates the position of planes not equipped with ADS-B, thanks to the Multilateration (MLAT) method, between 3,000 and 10,000 feet. Flightradar is also fed by radar data in North America (including the US and Canadian

airspaces and part of the Pacific and Atlantic oceans), where data are thus also received from aircraft without ADS-B transponders.[2]

The time window of our data is from November 3 to 9, 2017, which included about one million flights made up of about 193 millions points. We had to clean this data. After investigations of the data, various visualisations and some preliminary computations, we could take various decisions about criteria to exclude non-relevant flights, namely:

- Incomplete flights, which are mostly flights that started before our time frame or that arrived after our time frame.
- Departure airport equalled the arrival airport.
- Diverted flight, considering they involve atypical itineraries in the context of unforeseen circumstances.
- Equipment and modes of transport other than planes (e.g., helicopters and balloons).
- Flight without flight code, which are mostly private and technical flights.
- Flights shorter than 75 km, because take-off and approach procedures then account for a large share of the distance flown.
- Aberrant distances.
- Planes that have never taken off.

This left us with a sample of 393,360 flights, which included both passenger and cargo flights. The next step was thus to isolate cargo flights. It is worth noting that air freight is carried in full cargo aircraft or on passenger or combi(nation) flights. Only full cargo flights are the scope of this paper. It is estimated than in 2014, they accounted for 56% of the total air cargo by tonne-km (Budd and Ison, 2017). Unfortunately, Flightradar data does not inform about the nature (passenger, cargo or mixed) of each flight. Furthermore, the aircraft code is too much general to detect full cargo aircraft (for instance, the B744 code means Boeing 747-400, but it could be a passenger, cargo or mixed configuration). Thankfully, the Flightradar data includes the airline's code of each flight. This involved that flights operated by full cargo airlines (such as DHL, Fedex, CargoLux and Kalitta Air) could be isolated. Some airlines that operate both passenger and cargo flights have two specific airline codes (e.g., SIA for Singapore Airlines vs. SQC for Singapore Airlines Cargo). But in other cases (e.g., Emirates Airlines and Ethiopian Airlines), there is no distinction between passenger and cargo activities. As a result, we could not identify all full cargo flights. The list nevertheless includes 49 airline codes (see Table 2), and the resulting number of flights is 12,287 (out of 393,360).[3]

Airline	Code	Flights
FedEx Express	FDX	4,232
UPS Airlines	UPS	2,995
European Air Transport Leipzig	BCS	915
Empire Airlines	CFS	328
Ameriflight	AMF	319
Cargolux	CLX	314
AirBridgeCargo	ABW	232
Lufthansa Cargo	GEC	210
Loong Air	CDC	194
ABX Air	ABX	191
Cargojet	CJT	188
Kalitta Air	CKS	157
Nippon Cargo Airlines	NCA	153

[2] See https://www.flightradar24.com/how-it-works for more details. One understands that despite its name, Flightradar is mostly not based on radars.

[3] Note that DHL does not appear high in this ranking because its operations are split among several subsidiaries, including European Air Transport Leipzig and AeroLogic.

Polar Air Cargo	PAC	152
AeroLogic	BOX	139
Mountain Air Cargo	MTN	124
Air Hong Kong	AHK	119
China Cargo Airlines	CKK	114
Air China Cargo	CAO	110
ASL Airlines Belgium (formerly TNT Airways)	TAY	108
Singapore Airlines Cargo	SQC	106
Avianca Cargo	TPA	91
MNG Airlines	MNB	83
Blue Dart Aviation	BDA	81
DHL Air UK	DHK	64
Southern Air	SOO	61
DHL International Aviation ME	DHX	57
Amerijet International	AJT	49
CargoLogicAir	CLU	43
Aloha Air Cargo	AAH	37
Cargolux Italia	ICV	35
ATRAN	VAS	33
Bluebird Nordic	BBD	33
CAL Cargo Air Lines	ICL	32
Martinair	MPH	30
Aviastar-TU	TUP	29
Air Cargo Carriers	SNC	28
Mas Air	MAA	22
EgyptAir Cargo	MSX	19
Sky Lease Cargo	KYE	15
Tasman Cargo Airlines	TMN	12
LATAM Cargo Colombia	LAE	9
LATAM Cargo Chile	LCO	9
Lynden Air Cargo	LYC	8
DHL de Guatemala	JOS	2
Northern Air Cargo	NAC	2
LATAM Cargo Brasil	LTG	1
West Atlantic UK	NPT	1
Maximus Air Cargo	MXM	1
Total		**12,287**

Table 2. The 49 freight airlines considered
and their number of flights within our dataset after cleaning (November 3 to 9, 2017)

The next step was comparing, for each flight, the shortest-route distance to the distance actually flown. In most cases, the shortest-route distance (reference distance) was found in the OAG Schedule database. For remaining flights, we computed it ourselves based on airport coordinates supplied by OpenFlights.[4]

As for the actual distance flown, it was then computed on a Postgresql/PostGIS (2.3) system. The positions were initially joined into 3D line strings, and then their lengths were calculated using the ST_LengthSpheroid() function provided by PostGIS, which in this case computes the length along the WGS 84 ellipsoid.[5] Taking the ellipsoid into account is crucial to avoid measuring the distance in a 2D projection (that is, via the inside of the Earth).

It is worth noting that the distance between two subsequent points, and thus the precision of itineraries flown and related distance computed, is not constant. As Figure 2 shows, flight paths are extrapolated in case of no coverage, which includes especially the oceans, most of Africa, inner China, Mongolia, Siberia, Greenland and Arctic Canada. In such cases, related portions of routes flown are long, straight

[4] See https://openflights.org/data.html

[5] ST_LengthSpheroid(geometry, 'SPHEROID["WGS 84",6378137,298.257223563]')

segments, instead of more precise, broken lines. Such long segments are likely shorter than the actual distance flown. This involves that because of the poorer knowledge of itineraries in several areas means, our computation of actual distance flown is shorter for part of the sample, and the lengthening of flights is then underestimated. This means the forthcoming estimation of the magnitude of the detour is a conservative one.

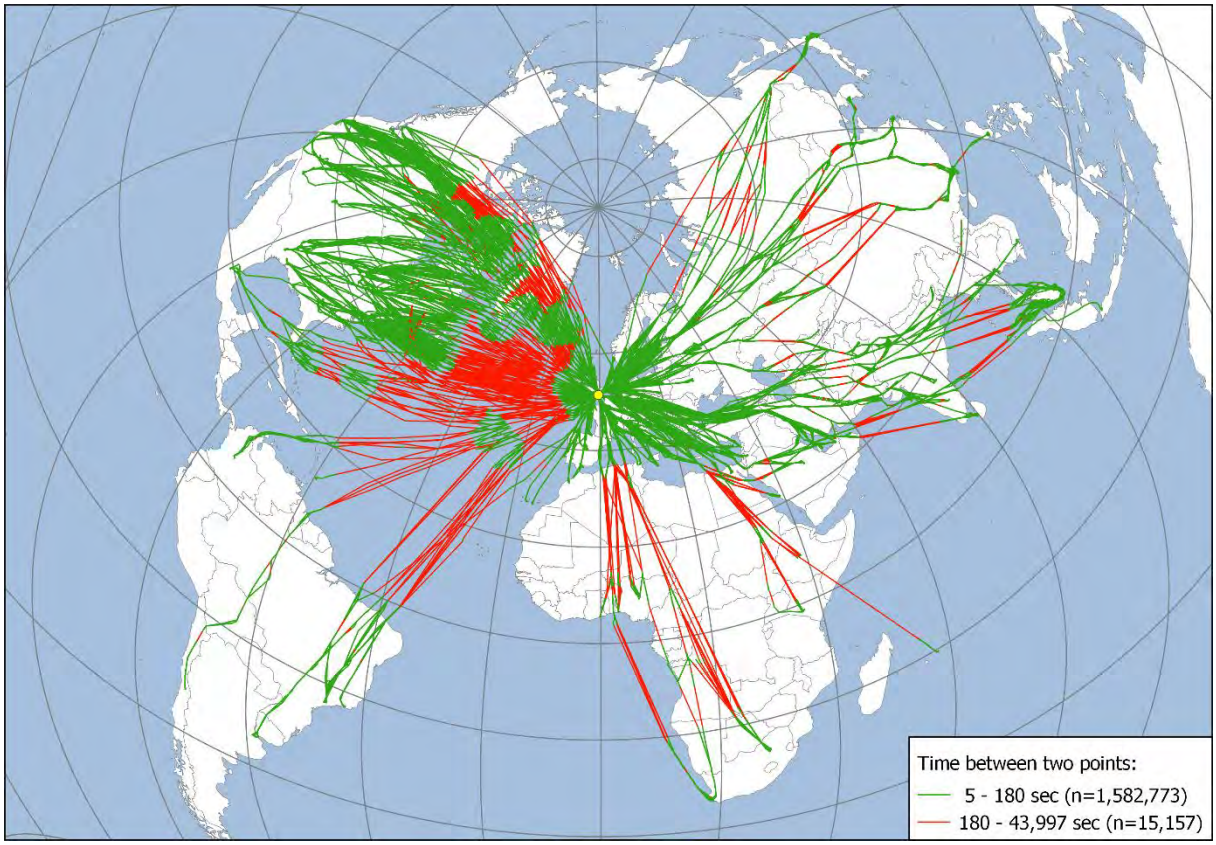

Figure 2. The uneven coverage of Flightradar through the distance between two subsequent points. Red lines highlight straight-line extrapolation (flights departed from London Heathrow, November 3 to 9, 2017).

The magnitude of detours faced by cargo flights

Table 3 gives the magnitude of detours within our sample and splits it by shortest-distance range. On the average, cargo flights face a 6.3-% detour, and shorter flights are more affected (+13%) than medium-haul and long-haul flights (+6% and +5%, respectively). Let recall that for longer flights, the magnitude of the detours is likely underestimated because of poor coverage over the oceans as well as in various developing countries and in inner, inhabited areas.

Beyond this reservation, Figure 3 confirms that shorter flights are proportionally more affected than longer flights

Having said that, given the distance split of cargo flights, medium- and long-haul flights still contribute to most of the extra distance flown (39% each), in contrast to short-haul flights (22%).

	All flights	Short haul	Medium haul	Long haul
Cumulative shortest distances (10^6 km)	25.70	2.69	10.46	12.55
Cumulative actual distances flown (10^6 km)	27.31	3.04	11.09	13.19

Cumulative lengthening (10^6 km)	1.61 +6.3%	0.35 +13.0%	0.63 +6.0%	0.63 +5.0%
Contribution to cumulative detours	100%	22%	39%	39%

Table 3: The magnitude of detours faced by cargo flights in absolute terms (n=12,287, November 3 to 9, 2017). Short haul: up to 1000 km; medium haul: 1001-4000 km; long haul: more than 4000 km (based on the shortest route).

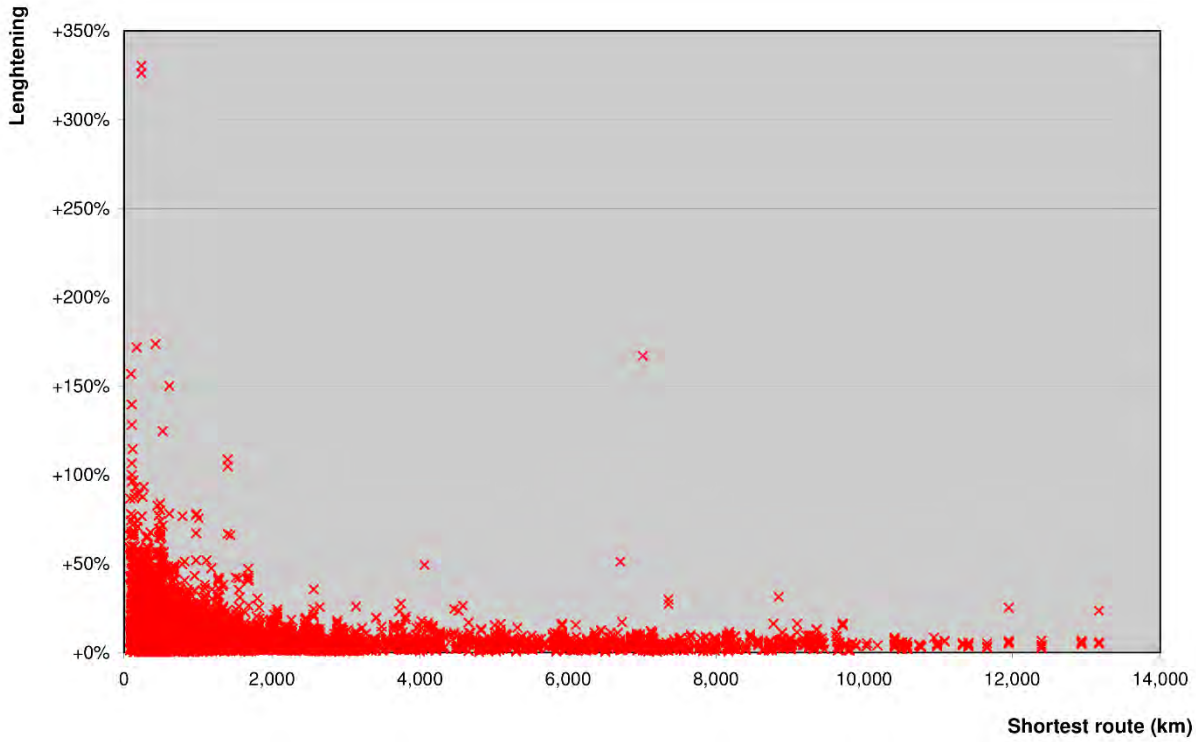

Figure 3. Detours vs. great-circle distance (one marker per flight, n=12,287, November 3 to 9, 2017)

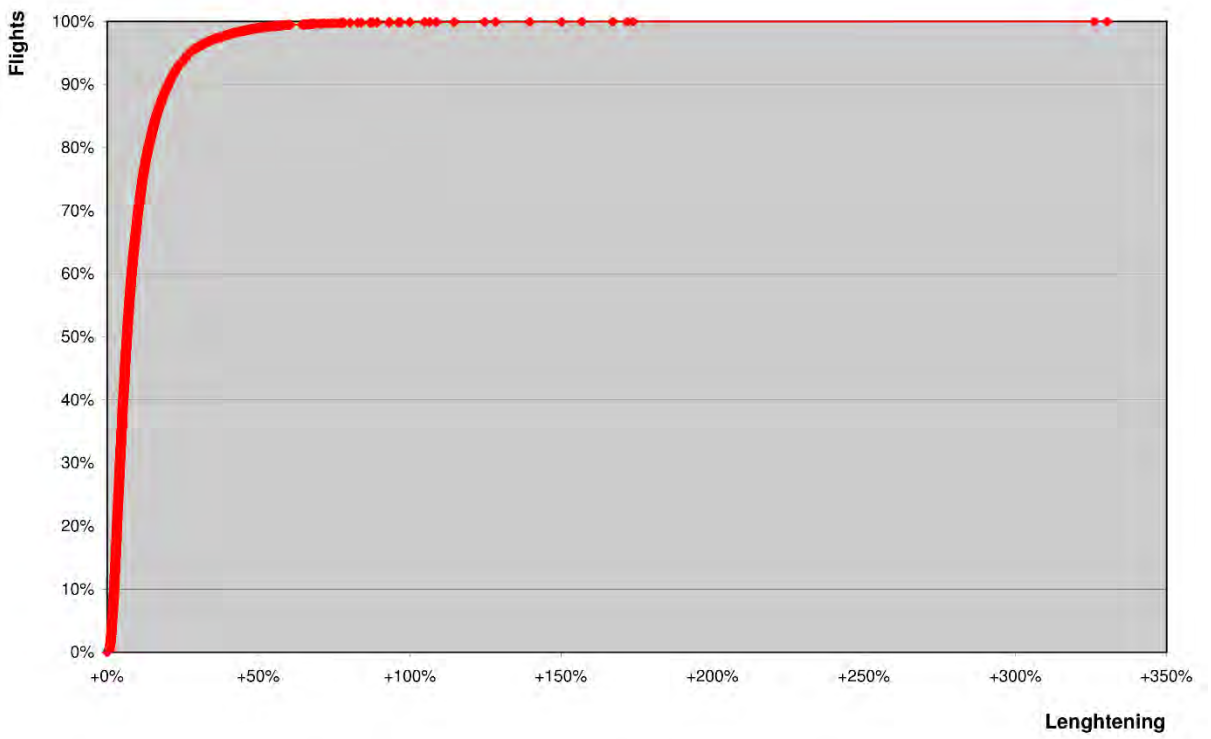

Figure 4. The distribution of detours faces by cargo flights (one marker per flight, n=12,287, November 3 to 9, 2017)

If the average detour seems rather low (+6.3%, see Table 3), Figure 4 shows actually shows a wide range of values, from nearly none detour to +330%. The median is +6.5%, which is thus close to the average, and standard deviation is +11.1%.

Finally, Table 4 shows the same results than Table 3 but for all flights (thus also including cargo flights that are part of Table 3). The comparison suggests cargo flights experience somewhat shorter detours. This was not expected, notably because cargo flights are partly operated by older planes. Older planes are usually more affected by the constraint of flying not too far away from diverting airports (based on the so-called ETOPS certification), because their technology does not allow really long diversion times like newer planes. This unexpected result may be due to the fact older aircraft do not have on-board ADS-B facility, so their position cannot be captured by FlightRadar.

	All flights	**Short haul**	**Medium haul**	**Long haul**
Cumulative shortest distances (10^6 km)	656.95	104.81	336.09	216.05
Cumulative actual distances flown (10^6 km)	706.82	119.79	360.67	226.36
Cumulative lengthening (10^6 km)	+49.87 +7.6%	+14.98 +14.3%	+24.58 +7.3%	+10.31 +4.8%
Contribution to cumulative detours	100%	30%	49%	21%

Table 4: The magnitude of detours faced by all flights in absolute terms (n=393,360, November 3 to 9, 2017).

Implications

The detours highlighted in the previous section have several implications.

On the economic side, detours of course increase fuel burnt (except in case of jet stream-related detours), less rotations and more working hours by crews. Given the significant impact of fuel on operational costs (Onghena et al., 2014), cargo airlines would definitely try to avoid detours. It could also that detours mean unfair competition. This occurs when a same route, one airline faces detours while another airline does not, provided that some airlines are banned over specific countries based on their registration country. Examples includes Qatar Airways banned from Saudi Arabia; Israeli airlines and flights from/to Israel banned from most Muslim countries; until recently, Taiwan-based airlines banned from China; etc. Finally, higher costs due to detours may have an impact on economic sectors that really count on aviation.

Detours also increase the environmental impacts of aviation, especially climate change and pollution. The actual contribution of aviation to climate change is not really known because of insufficient knowledge about the impact of aviation-induced cirrus effects and of high-altitude NO_x emissions (Lee et al., 2009), as well as the magnitude of impacts subject to both altitude and latitude of flights (Dahlmann et al., 2016). As for air pollution, it has long been believed that only landing and take-off cycles (LTOs) impact ground-level air quality. But has been recently suspected that pollutants emitted en route at higher altitudes could also affect air quality at ground level, even though this is still debated (Cameron et al., 2017; Lee et al., 2013). One may of course conclude from this that public authorities should do their best to lower detours, and thus improve the environment. However, this may decrease costs thus airfares, and thus increase traffic and its impacts (rebound effect).

Detours also challenge the monitoring of so-called horizontal flight efficiency by both national and international public bodies (e.g., Eurocontrol, 2014; FAA and Eurocontrol, 2014). Of course, shorter routes are usually better (exceptions are jet streams and also optimal vertical route that may constraint the horizontal route). But if detours are the consequences of technical limits or of natural factors, airlines and air traffic controls (ATCs) cannot interfere. And if detours are due to geopolitical constraints, public authorities may help, but in the meantime, airlines can only face the consequences.

Detours also have impacts for scholars. All kinds to rankings based on great-circle distances (e.g., ranking airlines by km flown or by tonne-km carried) are simply biased. In the same vein, any estimation of fuel burnt or of greenhouse gas emissions, interaction models and airlines' cost structure based on the shortest route are potentially affected too. Some authors have applied a corrective factor to the shortest-route distance (e.g., O'Kelly, 2014). However, given the spatial heterogeneity of detours (see Dobruszkes and Peeters, 2019), it is likely not correct to apply the same factor everywhere

Conclusions

While it is largely assumed commercial planes fly the shortest route, this paper demonstrates how much cargo flights (like passenger flights) face detours, which are imposed by a set of natural, technical, geopolitical and social factors. To our best knowledge, this is the first global assessment of the magnitude of detours, even though our estimation is conservative since the straight route was considered for portions of flights with no data. In addition, not all cargo flights could be captured due to data restrictions.

Detours affect airline costs and the environment, but it should be recalled that less detours would lower operating costs and thus make air cargo more attractive, which would increase the demand and eventually the impact on the environment.

Our research is in line with Ren and Li (2018), Burmester et al. (2018) and Li and Ryerson (2019), who have all highlighted the potential of recent big data sources for air transport. The interest in these data is beyond the sole distance issue. They make it possible to track cargo flights, which are excluded of various other datasets. For instance, OAG Schedules Analyser, which is very comprehensive for passenger flights, actually only includes a limited share of cargo flights; in particular, integrators (Fedex,

DHL, etc.) are not included in OAG data. Here flight trackers offer a great opportunity to investigate their network geography.

Finally, we would like to insist on the fact that the investigation of an apparently obvious topic –the distance flown by cargo flights– reveals how much the concept of distance still deserves attention. This poses questions for today's air transport geography. Air transport geographers have often engaged in advanced research and the use of sophisticated techniques. But surprisingly, research on the basics of aviation – including its very relationship with physical spaces – has remained underexplored. We hope this paper would encourage scholars to do the groundwork in this direction.

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BLOCKCHAIN TECHNOLOGY FOR THE ASEAN SINGLE WINDOW

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Background

The Association of Southeast Asian Nations (ASEAN) is an association of countries in Southeast Asia that aim for closer integration (Chiou, 2010). ASEAN was founded in 1967 with five countries, and now comprises of 10 members: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam (Shephard and Wilson, 2008). One of the measures for integration is the ASEAN Single Window (ASW) (Soesastro, 2008), which should be completed by 2025 (ASEAN, 2015).

The ASEAN Single Window is a computer network, in which each country's National Single Window (NSW) computer system is connected with the other countries' NSWs via a central service in the ASEAN Secretariat's central server in Jakarta (ASEAN Single Window Portal, 2018a).

Using a central server has several vulnerabilities. A central server with a central databse can fail, or the internet connection to the server can be instable or cut. While these problems can be overcome with Cloud Computing (Pugliatti, 2011), another serious problem remains: The system can be hacked, and data in the database manipulated, leading to the possibility of fraud.

Blockchain, on the other hand, does not use a central database but rather Distributed Ledger Technology (DLT). This renders the data "immutable", so that any data submitted to the database and confirmed cannot be altered retrospectively (Drescher, 2017).

This conceptual paper develops a use case for blockchain technology as the technology to be used for the ASW.

The ASEAN Single Window (ASW)

The ASW is the central system to which National Single Windows (NSWs) of the ASEAN member countries are connected. The purpose is to facilitate trade within ASEAN and integrate the member countries' customs systems and other organisations' computer systems involved in intra-ASEAN supply chains.

Each NSW connects relevant agencies and organisations in the public and private sectors that are concerned with logistics and supply chains. These include the customs departments, port authorities, shipping lines, customs brokers, freight forwarders, banks and certificate-issuing authorities, for example:

Figure 1: National Single Window (example Thailand)
Source: ASEAN Single Window Portal, 2018b

Implementation of the NSW streamlines logistics and supply chains by simplification of the processes. If a shipment arrives at the port, the shipping line has to send the ship's manifest to the NSW in advance. The port operator will confirm to the system when the vessel has arrived, and each container will be registered as received. The customs department is connected to the system, so will the importer's customs broker. Any required import licence will be mentioned in the import declaration by the customs broker, and the customs department can check easily whether the import licence is in place.

From a computer networking point of view, each of the organisations has a Local Area Network (LAN) in which client computers are connected to a server. There are different kinds of servers, for example mail servers, web servers or file servers. There are different ways - called topologies – the clients and the

servers can be connected, for example as a star, a ring or a bus topology (Clark et al., 1978). In any case, a LAN is a geographically restricted system, often within one building.

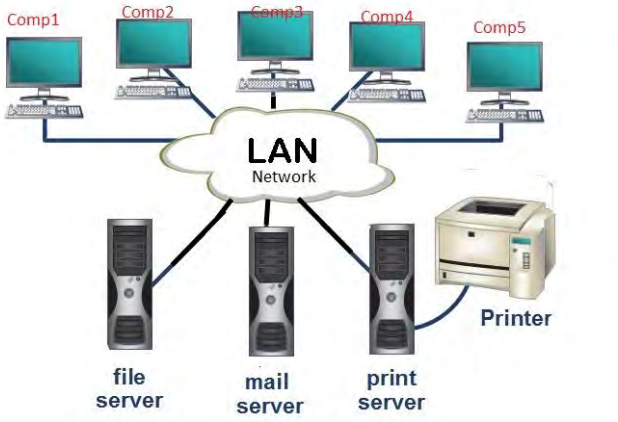

Figure 2: Local Area Network (LAN)
Source: Ammy 7 star (2019)

Each of the organisations has their own file server in which the files related to supply chains, including departure/arrival data or documents such as invoices and packing lists can be read or amended by the local clients (computers connected to the LAN), be it a local server or the cloud. This centralisation of control poses a security risk, as several examples in critical infrastructure control systems the US alone have been identified by Stamp et al. (2003) for example.

To connect all these organisations' systems to an NSW requires connecting the file servers via the internet. Whether the data on one organisation's server is accessible from each organisation directly or whether access is through a central server is not public knowledge; however, there is no guarantee that all organisations use the same database structure, so interfaces must be created. This is not an easy task; Thailand's 3rd National Logistics Plan 2017-2021 shows the completion of the development of NSW as a goal (NESDC, 2019). Once completed, the NSW transforms a fragmented system in to a "one-stop facility" (Basu Das, 2017).

Upon export of a shipment, any goods that receive tax privileges according to the ASEAN Free Trade Agremeent (AFTA) require a Certificate of Origin Form D, which certifies that the goods conform to the Rules of Origin. This certificate Form D is issued by the Ministry of Commerce's Foreign Trade Department and must accompany the shipment for import customs clearance at the importing country's customs office.

To illustrate, the following agencies are connected to the Thai NSW as of December 2016:

1. The Thai Customs Department	2. Department of Industrial Works
3. Department of Mineral Resources	4. Department of Disease Control
5. Royal Forest Department	6. The Board of Investment of Thailand
7. Department of Medical Sciences	8. Office of The National Broadcasting and Telecommunications Commission
9. Department of Primary Industries and Mines	10. Department of Mineral Fuels
11. Department of National Parks, Wildlife and Plant Conservation	12. Department of Land Transport
13. Marine Department	14. Rubber Authority of Thailand
15. Port Authority of Thailand	16. Industrial Estate Authority of Thailand
17. Electrical and Electronics Institute	18. Office of The Cane and Sugar Board
19. National Bureau of Agricultural Commodity and Food Standards	20. Department of Internal Trade
21. Excise Department	22. Thai Industrial Standards Institute
23. Food and Drug Administration	24. Office of Atoms for Peace
25. Department of Energy Business	26. Fine Arts Department

Table 1: 26 agencies are having the completed data linkage electronically for any kinds of goods or any types of documents in order to use for the customs formalities

1. Defense Industry Department	2. Department of Agriculture
3. Department of Fisheries	4. Department of Foreign trade
5. Department of Livestock Development	

Table 2: 5 agencies are having the data linkage electronically for some kinds of goods in order to use for the customs formalities

1. Department of Provincial Administration	2. The Thai Chamber of Commerce and Board of Trade of Thailand

Table 3: 2 agencies are having the data linkage electronically with paper-based documents in order to use for the customs formalities

Source for tables 1-3: The Thai Customs Department (2017)

According to Basu Das (2017) a problem with the implementation of the NSW in some ASEAN member countries is resistance to change by senior bureaucrats and operational staff who fear loss of power and other reasons ranging from "need for new job skills to extra earnings through unethical payment from traders in return of issuance of permits and licenses".

The NSWs of all the ASEAN member countries are being connected to one network:

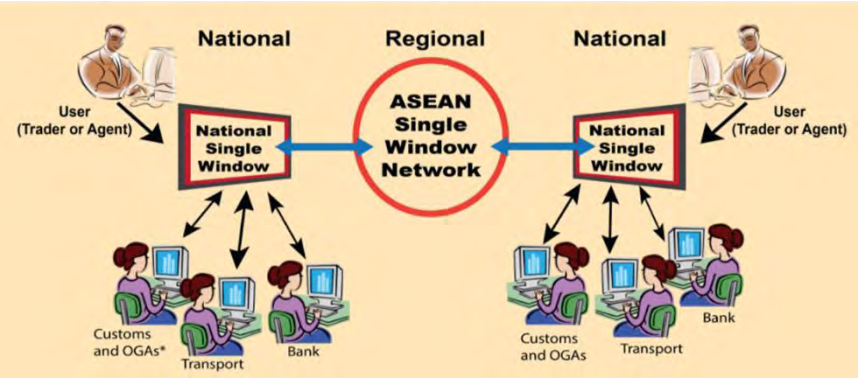

Figure 3: ASEAN Single Window
Source: ASEAN Single Window Portal (2018c)

If a shipment is sent from ASEAN member country A to ASEAN member B, all relevant data will be collected from all relevant organisations into the NSW of country A, then relayed to the ASW Gateway, and from there relayed to the NSW of country B, and then distributed to the organisations of country B. Some countries have now already implemented the "e-Form D" (Department of Foreign Trade, 2016), so that there is no need for a printed version of the Certificate to accompany the goods for customs clearance. An electronic copy is sent from the issuing authority via the NSW of the exporting country to the ASW and then on to the NSW of the importing country, where the Customs Department can access it.

Problem Statement

Many if not all organisations in the NSW of each ASEAN country use their own centralised network (i.e. a LAN). As the NSWs encompass many different kinds of organisations, private and public, the database systems all have to be integrated with each other, and coordinated. Some integration has not taken place, so that in practice staff retype data from printed documents into the system that requires it.

The idea of integrating not only all relevant organisations in each country to an NSW but then also to distribute this from the origin country of a shipment to the destination digitally via the ASW increases the efficiency of the supply chains very much. However, an implementation via different gateways and systems that may be compromised contains an unnecessary risk of data corruption – intended or unintended.

Seven ASEAN member states including Thailand and Malaysia are currently pilot-testing the e-Form D, in which the exporter applies for the Form D electronically, and it will then be sent via the ASW from the originating country's NSW to the destination country's NSW (Ibrahim et al., 2019). However, this document is created on a central server in the exporter's country, then sent to the NSW in their country, then sent to the ASW central server and from there to the destination country's central NSW server and then on to the customs department's central server. Intended or unintended modification or corruption of any data is possible at any of the transmissions, and there is no system that can guarantee with absolute certainty that the data arrives correctly as intended.

Blockchain Technology

Blockchain technology is an internet-based technology which does not use central file servers. The data is not stored on a single server or in the cloud – on several servers that mirror the data – but instead on many computers called nodes. Blockchain technology is a special case of Distributed Ledger Technology (DLT). In DLT, the data is shared across nodes in a network (Mills et al., 2016). In Blockchain Technology, the data is organised in blocks that are shared and that cannot be altered, making them immutable. All nodes on a particular blockchain will exchange data directly. This is known as a peer-to-peer (P2P) network as opposed to a Local Area Network (LAN) or a network of LANs.

Hashing and creating a chain

A block consists of data, a timestamp, its hash and the hash of the previous block. The hash is the result of an algorithm; the output of that algorithm is always the same if the input is the same. However, from the output it is impossible to deduce the input, making it a secure cryptographic tool. If a block contains the hash of the previous block and any data in the previous block is altered, the previous block's hash does not apply any more, a new hash is generated. However, the current block still shows the previous block's hash before the alteration, so the chain is interrupted. This means that no data in any block can be altered retrospectively without interruption of the chain.

Adding transactions to a chain

Each time a transaction happens, the node desiring to add that transaction to the blockchain requests confirmation from the other nodes which then will check whether the hashes all still connect. If any block in the chain since the start of that blockchain has been altered in the copy of the chain the requesting block has, the hashes will not match and the transaction will be rejected by the nodes. In the most well-known blockchain, the Bitcoin cryptocurrency blockchain, a simple majority of confirmations versus rejections is required to accept the transaction as valid. After validation, all nodes will be updated with the new data added.

Immutability

Since a transaction will only be added to the blockchain after a majority of the nodes confirms the integrity of the chain, no previous blocks can be altered. Since every node has a copy of the whole blockchain (or at least the hashes of each block), if any hacker were to change any data, they would have to hack into each node on the blockchain, or at least a majority of the validating nodes. This can easily go into the thousands or even millions (depending on the size of the blockchain) and while theoretically possible, it is considered not feasible by computer security experts (Srupsrisopa, 2019).

Transparency

Since every node has a copy of the whole blockchain, the blockchain is completely transparent. This means that if someone tries to alter the content of any one block, this amended block will be distributed to all other nodes and they will notice that the hashes do not match anymore, the blocks do not connect. So the alteration attempt is obvious to every node on the blockchain. This supports the immutability. Immutability and transparency go together.

However, the transparency of courses raises eyebrows in the business world, as companies do not want all other companies on the blockchain know the details of their business.

In practical terms, due to the sheer data volume, this researcher suggests not to copy all data to all nodes, but only the hashes. This way, every node can check whether the hashes still match and form a blockchain, but do not have the actual data unless they need it.

Permissions
There are different types of blockchains:

- Permissionless Blockchain. In a permissionless blockchain, all nodes have permission to read and write. Bitcoin is an example of a permissionless blockchain, everybody on the blockchain can buy or sell Bitcoins.
- Permissioned Blockchain. In a permissioned blockchain, only authorized nodes can write and add new blocks.

Public vs Private blockchains
Public blockchains can be accessed by any node on the internet, access to private blockchains is restricted to authorized nodes only.

Both public and private blockchains can be permissioned or permissionless; however, in case of a private permissioned blockchain, the question is whether a blockchain solution is required in the first place, as a centralised database can be used with the same result and is more efficient (Wüst and Gervais, 2018).

Smart Contracts
In blockchain terminology, smart contracts are short pieces of code that will execute automatically when conditions are met. This can be very useful in international supply chains if the origin and the destination country are members of a Free Trade Agreement (FTA). All ASEAN member countries are members of the ASEAN Free Trade Agreement (AFTA), which states that any goods made in a member country and having at least 40% of local content is considered eligible for exemption of import duties. The relevant line ministry in the originating country (in Thailand the Ministry of Commerce, in Malaysia the Ministry of International Trade and Industry, for example) will issue a confirmation to the producer of the goods that this product meets the requirement, and once this is confirmed, they will have to visit the office of the ministry each time they have a shipment, so that a "Certificate of Origin Form D" can be issued for each shipment.

<u>Development of a Conceptual Framework</u>
Wüst and Gervais (2018) suggest the following framework to determine whether a blockchain is the most appropriate technical solution to solve a problem:

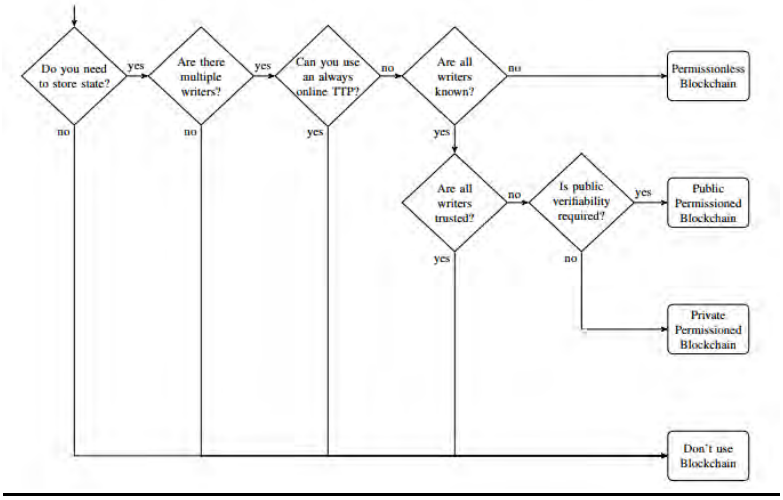

Figure 4: A flowchart to determine whether to use blockchain technology
Source: Wüst and Gervais (2018)

Following this flowchart, the data in the ASEAN Single Window certainly needs to be stored, there are multiple writers in each NSW. A "TTP" in the flowchart is a Trusted Third Party that can verify data. ASEAN does not have any single agency that could fulfil that role; each country's government will verify their own Certificates of Origin, for example, or each shipping line verifies their own Bills of Lading.

In the ASW, all writers will be known. Each organisation that is allowed to supply data to their NSW must be approved in advance anyway. A shipping line will provide legitimate vessel data, but an anonymous node cannot be allowed to do that. Only a licenced customs broker is allowed to submit a customs entry.

However, not all writers can be trusted. Fraud happens regularly; fake Certificates of Origin are submitted to customs offices to reduce import duties, invoice values are reduced in order to reduce import duties, or the nature of goods are changed in order to avoid requirements for import licences.

The question is whether public verifiability is required and a public permissioned blockchain should be used, or whether it is not required and a private permissioned blockchain should be used. Public verifiability has the advantage that any corruption, or suspected corruption, will be prevented.

On the other hand, there is a fear that if all shipment data is public available, any traders' company secrets will be known to their competitors, such as suppliers, customers, prices. However, the data on the blockchain can be secured with cryptographic primitives, for example with Public Key Infrastructure (PKI). With this technology, a writer digitally signs a data file with his private key and the recipient's public key, and only the recipient can open the file. This would solve the privacy concerns.

Using blockchain technology solves the problem of data corruption or alteration, intended or unintended, and ensure verified data is used by all participants in a blockchain. In the ASEAN Single Window with a high number of different kinds of organisations submitting data to be used by other organisations, the data will be first transmitted to their own country's NSW then to the ASW and then to the destination country's NSW and from there to the organisations needing the data, involves many transmissions and possible data corruption by error or by fraudulent intent, and provides interfaces for hackers. Data integrity is inherent to blockchain technology, so this problem can be solved with blockchain technology.

Conclusion

The ASEAN Single Window (ASW) provides all organisations involved in international supply chains within ASEAN with a tool to increase efficiency and reduce cost. However, using traditional networks and transmitting data between a number of networks from the origin of the data to the user of the data in another country is prone to errors and opens the opportunity for fraud.

This researcher recommends to use blockchain technology rather than connected central servers for implementation, as the immutability of blockchains ensures data integrity. Especially since each supply chain involves a multitude of organisations, a vast amount of data needs to be secured, which is a task much more difficult with central servers or even cloud technology than it is with blockchain technology. This reduction of data discrepancies to nil further increases efficiency in supply chain on top of the efficiencies gained by implementing the ASW.

In addition, with smart contracts, licences and certificates can be issued automatically and added to the blockchain, further increasing efficiency and reducing cost. Privacy or data confidentiality issues can be solved with PKI encryption.

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E-CUSTOMS EFFICIENCY AND FIRM PERFORMANCE IN VIETNAM

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Introduction

The development of Information Technology (IT) has contributed to and reformed many sectors, particularly e-government and e-customs. The adoption of IT customs services has dramatically changed the delivery from direct into indirect communication e.g. online communication (Anthonette, 2007). Regions such as USA and EU and the emerging Asian nations of Thailand, Singapore, Malaysia, Japan, and Korea have achieved various benefits from e-customs applications such as a reduction of time and financial costs for government agencies, enterprises and private citizens and an increase in transparency, convenience and consistency (Chan et al., 2008). However, there are a lot of challenges in e-customs with 50% partly-failed 50 and 35% completely-failed projects with only 15% being successful (Heeks, 2008). In the last few years, Vietnam has been known as one of the emerging developing economies in the world with significant GDP growth 6%-7% per year since 2000. However, Vietnam's logistics efficiency, as demonstrated by its ranking of 39th in the 2018 Logistics Performance Index (LPI) with a score of 3.16 out of 5.0, is still quite low compared to other countries in the ASEAN region (Arvis et al., 2018). Further, while the proportion of exports and imports keeps increasing (approximately US$426 billion in 2017 representing a 21% increase) Vietnam has less of a technological environment and faces many challenges when implementing e-customs (VGDC, 2017). Technological and legislative constraints, as well as finance and human resource constraints, can be the primary problems for Vietnam when modernizing customs (Urciuoli et al., 2013). Moreover, the essential role of SMEs is increasing not only in developed countries but also in developing nations, which is demonstrated by contribution rate in GDP, the number of SMEs participating in the economy and the amount of career opportunities which SMEs bring. This paper provides an empirical study investigating the current state of e-customs implementation in Vietnam and drivers and the barriers affecting same and their effect on firm performance.

Literature Review

Diffusion of Innovation (DOI) Theory

DOI theory was first introduced in 1962 to explain the processes of adoption and diffusion of innovations (Rogers, 2003). Rogers built this theory based on the attributes of an innovation and regarded the users' perception of these attributes as a major factor in determining whether the innovation will be adopted. DOI has been applied in a wide range of domains, such as agriculture and marketing, as well as in specialized IT applications, such as smart card technology, voice-mail, personal workstations, operating systems and e-government. In DOI theory, the concept of an innovation is defined as an idea, a practice, or an object that is perceived as new by an individual or other adoption unit while diffusion is defined as the process in which an innovation is communicated through certain channels over time among the members of a social system (ibid.). The diffusion of an innovation is a decision process and when individuals approach an innovation and become awareness of its existence, functions and features; they establish knowledge. This knowledge may fall into three categories. The first is 'awareness knowledge' which reflects existence of modernisation. The second type is 'how-to knowledge' to accentuate a rationale and urgency of innovation adoption. The final is 'principles knowledge' referring to the operational description of the innovation and how it works, but it is usually possible for an individual to adopt an innovation without it. According to DOI, there are five attributes of an innovation, namely relative advantage, complexity, compatibility, trialability and observability. Relative advantage is defined as the degree to which an innovation is perceived as better than the idea it supersedes; the more an innovation is perceived to be a relative advantage, the more likely it is to be adopted.

Hofstede's cultural dimensions

Hofstede (2011) determined that the collective awareness programme which leads to diversification between the members or between human groups has been perceived as the national culture. Five dimensions related to culture have been defined in Hofstede's framework. The first concept known as power distance refers to the extent to distribution of power between members of group or society. The second one is indicated as uncertainty Avoidance which involves the extent of scare felling of the members of group or society due to insecure condition. Moreover, dimension of individualism and collectivism classify the integration into groups of individuals. The fourth perception relates to masculinity and femininity which demonstrate assignment of genders in society. The final definition associated to long-term and short-term orientation that mentions about objectives of society looking forward to future. Despite the deficiencies of methodology in Hofstede's measures and concepts (Baskerville, 2003), 60% of literature has adopted Hofstede's cultural dimensions (Leidner and Kayworth, 2006) which means that the extent of influence and application of Hofstede's framework has been effective and significant. Further, Al-Hujran et al. (2011) proved that national culture got positive impact on citizen adoption of e-government services in Arab world. Consequently, we also chose Hofstede's cultural dimensions to evaluate culture as a factor impacting on e-customs implementation in Vietnam.

Institutional Theory

According to Grewal and Dharwadkar (2002), the significance of legitimacy which social stakeholders focus on can be the purpose behind institutional theory. Three dimensions of institutional theory including 'coercive, mimetic, and normative' explored in previous studies has been determined as the mechanisms which can enhance harmony of structure and process through changes of institution (DiMaggio and Powell ,1983). The stress on organisations caused by other ones who the organisations depend on as well as by expectations of social culture which can be aspects the organisations operate have been perceived as coercive isomorphism. The impact of politic and legitimacy can lead to these pressures for the organisations. In addition, administrative departments, clients and other key stakeholders can put the stress on the organisation when managing supply. Mimetic isomorphism stems from uncertainty engage to supply, which make the organizations imitate the successful experiences of other cases.

Strategic Profit Model in Logistics

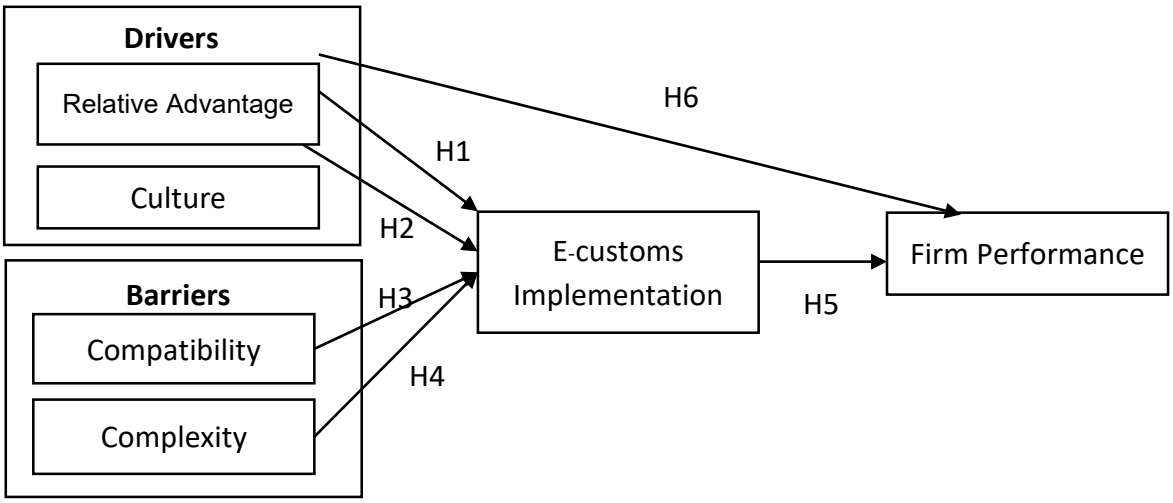
The goal of firms is to increase shareholder value. A specific way to measure that increase or decrease is to calculate the return on net worth (RONW). According to Lambert and Stock (1993), the

strategic profit model (SPM) was introduced to show how RONW is a function of three factors that can be controlled by management including (i) net profit, (ii) asset turnover and (iii) financial leverage. There are a number of studies discussing the benefits of e-customs such as reduction of burden of administrative document and requirement of data re-entry as well as fewer data errors; time savings; cost reductions; usefulness in risk management and advance clearance (Urciuoli et al., 2013). These advantages of e-customs have influence on decreasing general overhead management or administrative costs, reducing inventory costs as well as freight and indirect labour warehousing costs.

Conceptual Framework

We combine elements from DOI and institutional theory and Hofstede's dimensions for our empirical study and group drivers and barriers for e-customs systems from previous studies according to characteristics of DOI theory. Moreover, the connection between national culture and citizen adoption of e-government services found that culture has positive influence (Al-Hujran et al., 2011). Our conceptual framework shown in Figure 1comprises three main parts. The first part consists of the enablers with positive impact and barriers with negative influence on e-customs in relation to the attributions of DOI theory. The second part comprises firm performance which can be analysed and clarify the correlation between e-customs and business performance of SMEs basing on institutional theory. The third section examines the impact of relative advantages to firm performance with the strategic profit model support.

Figure 1: Conceptual Framework



Methodology

This research applied several analytical techniques. Firstly, to review the literature we synthesised information that illustrates analysing, conciliating, summarising and presenting data and information systematically. Secondly, a questionnaire survey study was conducted to examine the proposed model using confirmatory factory analysis (CFA) and structural equation modelling (SEM). The primary objective of multivariate analysis was to attempt to explain and predict the influence of factors on e-customs implementation in Vietnam as well as the relationship between e-customs and business performance. The SEM software used for this study was SPSS/AMOS version 24.

Survey data collection

The questionnaire survey was carried-out during in 2018 and distributed to customs staff in five provincial, interprovincial and municipal departments of customs including Hanoi, Hai Phong, Ho Chi Minh city, Binh Duong and Dong Nai. These customs departments mange a number of imported and exported goods. 860 questionnaires were distributed to customs officials; of which 758 were returned and 702 valid responses were collected to use in analysis. The survey questions were designed based on DOI theory of by Rogers (2003) and Hofstede's (2011) dimensions as applied in the e-government domain and on preliminary information obtained from documents relating to the pilot implementation of e-customs in Vietnam. The content of the instrument was also derived from the literature review on e-government and e-customs.

Table 1: Drivers and Barriers in e-customs implementation

Drivers (Enablers)	Relative advantages (Usefulness)	Time saving (RA1)
		Cost-savings (RA2)
		Reduction of requirement of data re-entry and few data errors (RA3)
		Reduction of burden of administrative documents (RA4)
		Convenience 24/7 system (RA5)
		Risk management (RA6)
		Advance clearance (RA7)
	Culture: - Uncertain avoidance (CUL1-3) - Power distance (CUL4-6) - Collectivism/ Individual (CUL7-9) - Masculine/ Feminine (CUL 10,11) - Long-term/ Short-term orientation (CUL12)	
Barriers (Inhibitors)	Ease of use (EOU)	Data loss over Internet (EOU1); Complicated and difficult to use e-customs software (EOU2)
	Compatibility (Technical constraints)	Adequate IT skills and technological equipment (COMPAT1); Interoperability of technology (COMPAT2); Confidentiality (COMPAT3); International standards among nations (COMPAT4); Redesigning or upgrade e-customs system (COMPAT5)

Research hypotheses:

H1: Relative advantage positively affects e-customs implementation, i.e. $\beta>0$;
H2: National culture positively affects e-customs implementation, i.e. $\beta>0$;
H3: Complexity negatively affects e-customs implementation, i.e. $\beta<0$;
H4: Ease of use negatively affects e-customs implementation, i.e. $\beta<0$;
H5: E-customs positively affects firm performance, i.e. $\beta>0$;

H6: Relative advantage positively affects firm performance, i.e. β>0

Findings

Reliability and validity

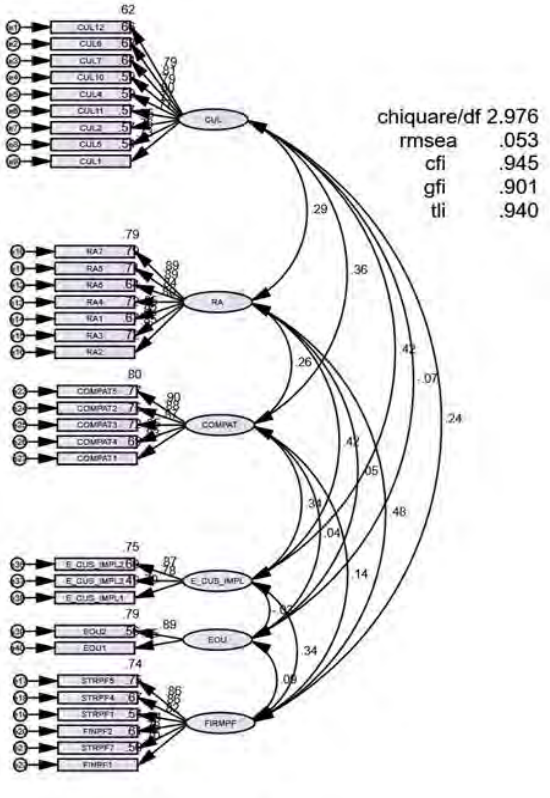
We applied Hair et al.'s (2018) assessment of the reflective outer model includes evaluating indicators' reliability, internal consistency reliability and convergent and discriminant validity. Cronbach's alpha reliability coefficients for all latent variables. Cronbach's alpha coefficient was calculated for each latent variable using SPSS 24 and all coefficients calculated were greater than the suggested 0.70 cut-off value. However, the Culture construct the item-total statistics table revealed that CUL3, CUL8 and CUL9 had corrected item-total correlations of less than 0.3. MacKenzie et al. (2011) strongly recommend deleting problematics items provided that the essential aspects of the construct domain are captured by the remaining items. After deleting these three items the Culture construct showed a reliability coefficient 0.931.

Indicator reliability through standardized loadings (standardised regression weights using AMOS terminology), internal consistency reliability via CR and Convergent validity via AVE all exceed the 0.5 rule of thumb. Construct reliabilities ranged from 0.804 to 0.948 and demonstrate adequate reliability as these exceeded 0.7. Since both exceed recommended thresholds the model exhibits unidimensional, reliability and convergent validity. Discriminant validity was examined by comparing the square root of the AVE for each latent variable and its correlations with the other latent variables, and these were also satisfied.

Table 2: CFA Goodness-of-fit Statistics

Chi-square (?2)		Guidelines
	Chi-square = 1336.318	
	Degrees of freedom = 449	
	p-value ~ 0	
Absolute Fit Measures		
	Goodness-of-fit (GFI)= 0.901	> 0.95 great; > 0.9 traditional; > 0.8 sometimes permissible (Joreskog, 1969; Bogozzl, 1981; Brown and Cudeck, 1993)
	Root mean square error of approximation (RMSEA)= 0.053	< 0.07 (Hair et al. 2010)
	90 percent confidence interval for RMSEA= (0.050; 0.056)	
	Root mean square residual (RMR)= 0.027	
	Normed chi-square= 2.976	<2: good; from 2 to 5 acceptable (Hair et al. 2010)
Incremental Fit Indices		
	Normed fit index (NFI)= 0.920	
	Comparative fit index (CFI)= 0.945	>0.90 (Hair et al. 2010)
	Relative fit index (RFI)= 0.912	
Parsimony Fit Indices		
	Adjusted goodness-of-fit index (AGFI)= 0.883	
	Parsimony normed fit index (PNFI)= 0.766	

Figure 2: CFA results



Confirmatory Factor Analysis (CFA) Results

For the CFA we focused on the key goodness-of-fit (GOF) values of the χ2 statistic, CFI, and RMSEA. Table 2 and Figure 2 above show selected fit statistics from the CFA output. The overall model χ2 is 1336.318 with 449 degrees of freedom. The p-value associated with this result is less than 0.0001. This p-value is highly significant using a threshold of 0.05. Thus, the χ2 goodness of fit statistic can satisfy criteria and indicate that the observed covariance matrix matches the estimated covariance matrix within

sampling variance. The value of RMSEA, an absolute fit index, is 0.053. This value is below the 0.07 upper guideline for a model with 32 measured variables and a sample size of 702. The normed χ2 is 2.976. This measure is the chi-square value dived by the degrees of freedom. This value between 2.0 and 5.0 is considered acceptable (Hair et al., 2018). Moving to the incremental fit indices, CFI is the one most widely used and this model has a value of 0.945, which, like RMSEA, exceeds the CFI guideline of greater than .90 for a model of this complexity and sample size. The other incremental fit indices also exceed suggested cut-off values. Although this model is not compared to other models, the parsimony index of AGFI has a value (0.855), which reflects good model fit. In conclusion, the CFA results suggest this measurement model provides a reasonably good fit and thus it is suitable to proceed to further examination of the model results.

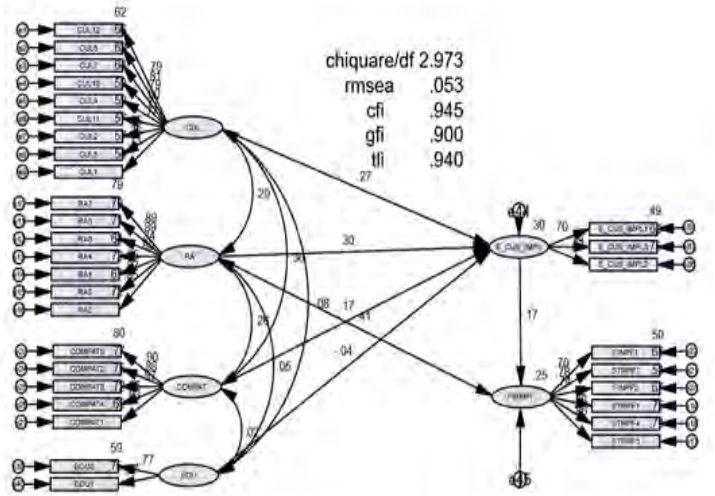
Structural Equation Modelling (SEM) Results

The structural model shown in the path diagram was then estimated and assessed. Table 3 and Figure 3 show the overall fit statistics from the testing SEM model. The χ2 is 1344.012 with 452 degrees of freedom ($\square < 0.05$) and the normed chi-square is 2.973. The model CFI is 0.945 with a RMSEA of 0.053 and 90% confidence interval of 0.050 to 0.056. GFI archives 0.90 matching with cutoff value. Therefore, all measures are within a range that would be associated with good fit.

Table 3 Goodness-of-fit of SEM

GOF Index	Structural Model
χ2 (chi-square)	1344.012
Degrees of freedom	452
Probability	0.00
GFI	0.90
RMSEA	0.053
Confidence interval of RMSEA	(0.050; 0.056)
RMR	0.028
Normed chi-square	2.973
NFI	0.920
CFI	0.945
TLI	0.940
RFI	0.912
AGFI	0.883
PNFI	0.770

Figure 3: Standardised Path Estimates for Structure Model



Discussion and Conclusions

Table 4 shows the estimated unstandardised and standardised structural path estimates. All but one structural path estimate (H4) are significant and in the expected direction. The exception is the estimate between EOU and E_CUS_IMPL because the p-value of 0.364 > 0.05. Therefore, although the estimate is in the hypothesized direction, it is not supported. Overall, however, five of six estimates are consistent with the hypotheses, these results support the theorical model with a caveat for one path that is not supported.

Table 4: Structural Parameter Estimates for SEM

Structural Relationship	Unstandardised Parameter Estimate	Standard Error	p-value	Standardised Parameter Estimate
H1: CUL → E_CUS_IMPL	0.253	0.040	***	0.27
H2: RA → E_CUS_IMPL	0.332	0.045	***	0.30
H3: COMPATEOU → E_CUS_IMPL	0.158	0.038	***	0.17
H4: EOU → E_CUS_IMPL	**-0.039**	**0.043**	**0.364**	**-0.037**
H5: E_CUS_IMPL → FIRMPF	0.143	0.039	***	0.169
H6: RA → FIRMPF	0.380	0.039	***	0.406

*** $p < 0.001$

Following is a discussion of the six hypotheses pertaining to the structural relationships presented above.

H1: National Culture (CUL) positively affects E-customs Implementation

This hypothesis is supported with a standardised positive coefficient of 0.27. Five dimensions of culture including uncertain avoidance, power distance, collectivism/ individual, masculine/ feminine and long-term/ short-term orientation were applied in this study. The results support for the positive relationship between national culture dimensions and e-customs implementation in Vietnam and culture plays as a significant factor of e-customs implementation. There are some differences compared with the previous researchs related to culture and innovation or e-government. Firstly, other studies indicate that uncertain acceptance, low power distance and individualism encourage innovation and e-government (Al-Hujran et al., 2011). In other words, this paper declares that uncertain avoidance and collectivism as Vietnam also have positive impact on e-customs. Secondly, Vietnam is known as a high power distance country (Hofstede, 2011), however, with the aim of integration and international trade improvement, this perspective is changing in Vietnam from high to low power distance between policy makers and business. Thirdly, this reseach also agrees with literature reviews that masculine and long-term orientation societies will be more innovate in innovation/ e-government (Al-Hujran et al., 2011). Vietnam as a short-term orientation society (Hofstede, 2011) becomes and old theme as this emerging country is switching to long-term orientation. In term of five dimensions, uncertain avoidance, power distance and masculine show significant influence (Al-Hujran et al., 2011).

H2: Relative Advantage (RA) positively indicates E-customs Implementation

This hypothesis is supported with a standardised positive coefficient of 0.30 and relative advantage is evaluated as the most important factor in this research. This study supports evidence in previous studies discussing about the benefits of e-customs as follows (Urciuoli et al., 2013):

Reduced burden of administrative documents: By adoption of e-documents and e-records, e-customs is likely to decrease the pressure of administrative documents.

Reduced requirement of data re-entry and fewer data errors: The information and data in public administration results have been shared and exchanged in electronic system, which declines necessity for data re-entry as well as data errors made. Moreover, technical processing can be saved time and costs.

Time savings: E-customs can reduce time of accessing data, inspecting and clearance goods, which supports business to implement customs procedures quicker compared with traditional customs. Further, governmental agencies can develop communication and coordination among themselves by using e-customs. Exchanging information, for example examination results, approval of clearance, quarantine verifications and recommendation documents could be supported conveniently by using EDI system, which helps business as well as individuals who do customs declaration save time and costs because they do not have to move and visit a number of state agencies.

Cost reductions: One of the drivers of e-customs is cost saving through the modernisation of customs system by computerisation (Urciuoli et al., 2013). The administrative costs regarding paperwork, faxes and phone calls of enterprises and public organisations can be reduced because of adoption ICTs in customs.

Usefulness in risk management: Biljan and Trajkov (2012) argue that risk management in the customs sector concerns indicating individuals, goods and means of transport which have to be investigated. Modernisation of customs system can support authorities to succeed in faster clearance while minimising risks of non-compliance or illicit trade. Further, exchanging electronic data alloes pre-arrival or pre-departure data used in automatic systems verify different shipments with high risk potential and where more inspections can be conducted.

H3 and H4: Compatibility (COMPAT) negatively affects E-customs Implementation and Ease of Use (EOU) negatively affects E-customs Implementation

H3 is supported with a standardised positive coefficient of 0.17 while the hypothesis H4 is not supported as the p-value cannot satisfy the criteria below 0.05, although this factor has a standardised negative coefficient of -0.04. Technological obstacles such as inadequate infrastructure, IT skills, confidentiality, difficulties in using and upgrading software have been discussed in the literature as primary barriers in developing countries like Vietnam (Goossenaerts et al., 2009). In contrast, our study suggests that both compatibility (COMPAT) and ease of use (EOU) of technology are not challenges for e-customs in Vietnam. In particular, the compatibility of a customs system becomes a driver for e-customs efficiency. The Vietnamese government has identified the ICT sector as a primary one that contributes to national growth. With the aim of achieving a sustainable economy and international integration, all Ministries and local governments were instructed to promote IT adoption and development through Resolution No.26/NQ-CP promulgated by the Prime Minister in April 2015 (Nguyen and Trang, 2017).

H5: E-customs implemetation positively affects Firm Performance (FIRMPF)

H5 is supported with a standardised positive coefficient of 0.17. E-customs implementation affects positively both sides of firm performance including financial and strategic performance with indicators as following: profit, growth rate; paperless, customer satisfaction and employees satisfaction. The number of customs departments implementing e-customs increased from 2 in September 2009 to 13 in 2010, to 21 in 2012, to 34/34 customs departments and 171/171 customs branches since 2015. Over this same period, the proportion of customs declaration forms that were submitted electronically rose from over 6 million customs declaration forms in 2015 to nearly 11 million in 2017. In terms of turnover value, the proportion of exports and imports being declared electronically rather than through traditional customs increased sharply from 2009 and reached a value of US$25.1 billion in 2017, a 21% increase from 2016 (VGDC, 2017).

H6: Relative Advantage positively affects Firm Performance (FIRMPF)

H6 is supported with a standardised positive coefficient of 0.40, which proves that relative advantages of e-customs system influences significantly on firm performance because this factor is related directly to saving costs and convenience of business (Lambert and Stock, 1993).

Conclusions

This study was conducted using concepts of culture and DOI theory. The outcomes of this study point out the relationship between culture and e-customs as well as drivers and barriers affecting e-customs implementation in Vietnam. Particularly, relative advantage and culture are two significant factors influencing on e-customs adoption. Some perspectives of cultural dimensions are changing when applying innovation in e-government and e-customs in case study in Vietnam, for instance, switching to less power distance between government staffs and business and rolling to long-term orientation with public service as e-customs. Further, technical and technological constrains are not inhibitors with emerging countries as Vietnam due to dramatically development of IT and government's investment in this industry. Finally, the development of e-customs implementation in general, and factors of relative advantages of e-customs systems in particular, positively affect for performance.

As with all studies there are some limitations. Firstly, this paper just focuses on the single perspective of customs officials. To gain comprehensive understanding, further research with both businesses and customs staff should be carried out. Secondly, the results of SEM show that e-customs implementation has 30% explanation based on factors of culture and DOI while firm performance has 25% explanation

from relative advantage and e-customs implementation. Further research should consider how other factors may affect e-customs implementation in Vietnam. Finally, this study only looks at Vietnam. Further studies should extend this work to other developing countries, especially in the ASEAN region, to determine if there is external validity to these findings.

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EVALUATION OF FACTORS AFFECTING AIR CARGO TERMINAL OPERATIONAL PERFORMANCE

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1. Introduction

In the age of increasing in air travel, the availability of appropriate airport capacity is a significant constriction on the future air travel demand, for both passenger and cargo. With the inadequate capacity in both airside and landside areas, the air cargo industry continues to face challenges of sustainability, profitability, and customer satisfaction (IATA, 2018). As the world of air cargo is rapidly changing, it is becoming an important factor supporting the current global trade system. Boeing (2016) projected that over the next 20 years, the world's air cargo traffic would continue to grow. Competitive air cargo transport generates advantages and is one of the key players to drive the economy of many countries, including Thailand. However, in equivalent, the air cargo industry has been slow to adjust to an increasingly electronic world that demands more transparency, speed, and efficiency. In addition, the customer's behavior is also changed to be more sensitive and demanding.

Air cargo is now becoming one of the serious issues in Thailand's aviation industry. The demand for air cargo operations is increasing; however, irregularities are still occurring from operation practices and processes at airports. This needs to improve for a better performance to cope with the future demand. Thailand is now also facing this rapid change. The ability to adapt to the transformation is still inferior in terms of performance. This determines how Thailand can improve cargo terminal performance efficiency in order to cope with demand and maintain the sustainability.

Air cargo transport involves a sequences of services from origins via hubs to destinations to move cargo through a shipper, a forwarder, a road transporter (or trucker), an airline (or carrier), and a consignee (Derigs et al., 2009). Certainly, authorities such as aviation security agencies, customs, airports or quarantine departments are also involved apart from the business logistics chain. The shipper desires the commodity to be sent at a low cost and at the required service level. The forwarder performs as the "middle man" between the shipper and the airlines. The road transporter provides the ground transportation services before and after air transport. The airline by its cargo terminal at airports receives, stores, transfers, tracks, loads and unloads cargo, and assigns and manages capacity. Ground handler provide ramp transport and aircraft loading/unloading. The consignee receives the shipment (Kasilingam, 2003) as present in figure 1.

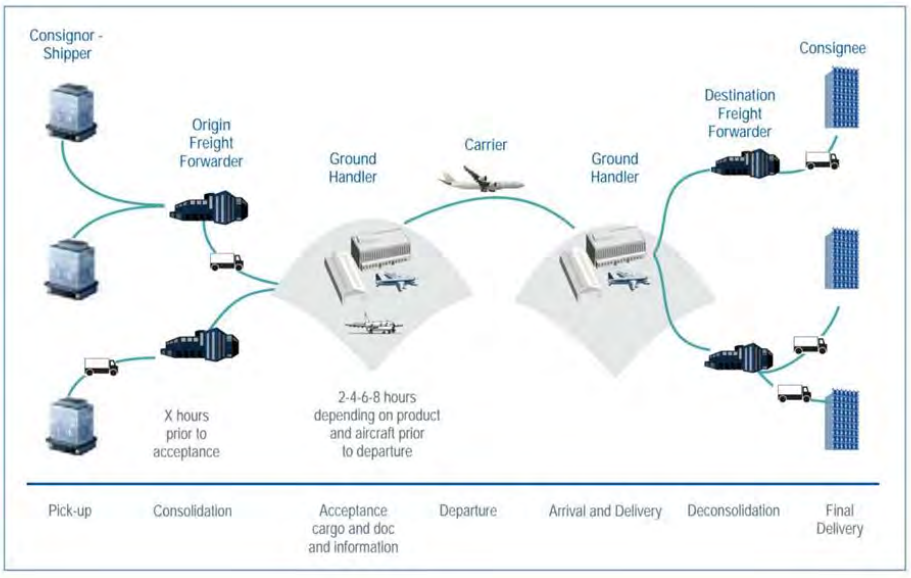

Figure 1: Physical Handling Flow (IATA, 2017)

The present demand for world air cargo has come into an era of uncertainty growth due to several unpleasant turmoil in countries. Trade war between USA and China, air sky closure in Pakistan, Japan and S. Korea counter-barrier, Honk Kong continuing strike and the latest taxation obstruction from USA to EU have been impacting to air cargo transportation seriously. The turmoil lead to unhealthy less air cargo bringing to forwarders to compete each other for transporting shipments. Forwarders can simply pinpoint the comparative strengths and weaknesses of the service factors that affect air cargo service choice. Their awareness toward airline's service factors differ, and these differences are the main factors that determine the choice and the competitiveness of specific airline. This paper, therefore, evaluate the significant factors affecting air cargo terminal operational performance in order to increase operational performance and customers' satisfaction.

2. Literature review

For the literature review, this study considers two perspectives which are air cargo terminal's operation performance and factors selection process.

Air cargo terminal operation performance

Before cargo is moved to the aircraft for departure, it is delivered to the airport via air cargo terminal by trucks and then unloaded for inspection, information verification, sorting, and packing. This process involves decision problems on manpower planning and scheduling, cargo processing, and truck arrival, as well as on unloading management for air cargo terminal operations, all of which are interdependent. There are several handling processes enforced by authorities, airline requirements and The International Aviation Transport Association (IATA). However, air cargo operation has been studied at a minor stage in airport researches and some papers put air cargo as a secondary part especially in air cargo terminal services. The typical air cargo terminal has four major activities of transit, sorting, storage and cargo information handling processes (Hu & Huang, 2011). Although, efficient air cargo terminal operations are critical for improving service performance to users and few studies have focused on air cargo terminal performance (Lin, Ling, & Han, 2005). Ohashi et al. (2005) applied numbers of runways, hours of loading/unloading, time for customs clearance, cargo throughput and air cargo processing time on a study of choice of air cargo transhipment airport: an application to air cargo traffic to/from Northeast Asia. Researchers were interested in different perspectives. Factors are at their own concentration and dispersed in different subjects. Table 1 shows the list of factors from previous researches for this study.

Table 1: the list of factors from previous research

Reference	Focus
Lau and Zhao (2006)	Cargo routing Scheduling
Yan et al. (2008)	Manpower Requirement Work time table
Rong and Grunow (2009)	Manpower Requirement Personal shift
Ou et al. (2010)	Truck Scheduling
Xu et al. (2014)	Cargo Routing Scheduling
Rodbundith et al. (2018)	Electronic import goods declaration Cargo security (facilities, operations) Cargo terminal area (sq. m.) Available tracking and tracing service
Suwanwong et al. (2019)	Minimum connecting time Short-shipped cargo

According to the table, the researcheresmainly focus on the manpower and scheduling in order to minimizing the cost in the past. However, as today is the era of disruption, customers are more demanding and increasing their expectoration. The focus might have been changed from the past. Rodbundith et al. (2018) and Suwanwong et al. (2019) mainly discussed on the service level agreement. This research, therefore, concentrates on the factors that effect to air cargo terminal performance and customer's satisfaction and combine factors from previous researches to changed circumstances for this research.

Factors selection method

Factor selection among a set of alternatives along with numerous contradictory criteria is a multiple criteria decision making (MCDM) problem. The objective of this research is to select the most appropriate factors among alternatives for significant factors affecting air cargo terminal operational performance. MCDM methods support decision makers solve complex decision problems involving conflicting criteria in a systematic and consistent way. Mardani, Zavadskas, Khalifah, Jusoh, and Nor (2016) show that use of MCDM methods has significant growth in the field of transportation systems.

MCDM includes many methods such as AHP, TOPSIS, PROMETHEE, SAW, and the newest method - Best-Worst Methods. Between these methods, only TOPSIS and AHP were found to be used most in air transport study. Marvelous efforts have been consumed and noteworthy advances have been completed towards the development of several MCDM methods for solving different types of decision problems Yeh, Deng, and Pan (1999); Triantaphyllou (2000). In spite of this, there is no generally accepted approach for the general MCDM problem (Yeh, Deng, & Chang, 2000), and the proof of the decision outcome remains generally an open issue. The outcome is quite regularly reliant on the method used.

There are many ways and methods to evaluate factor selection. Therefore, to select the suitable method, it is depending on the research objective and data collection. This research utilizes two MCDM methods, Best-Worst Method to define the weights of criteria and VIKOR to rank alternatives and select the best alternative. Best-Worst Method (which is developed based on AHP model) is used to define the weights in the hierarchy of criteria. VIKOR as a compromise ranking method are used for ranking and selection process in order to be assured in selecting the best alternative. Another reason for using these methods is their successful applications to the MCDM problems in the literature.

Best-Worst Method is the latest MCDM technique proposed by Rezaei (2015), which is based on pairwise comparisons to acquire the weights of alternatives and criteria respective to several criteria. It reduces the number of pairwise comparison by only executing reference comparison which means that experts are only required to define the preference of best criterion over other criteria and the preference of all criteria over the worst criterion, using on a 1-9 scale. By removing secondary comparisons this method is much more efficient and easier to obtain weights in an MCDM problem. This method had been used in a variety of contexts such as supplier selection (Rezaei, Nispeling, Sarkis, & Tavasszy, 2016), sustainable supply chain (Sadaghiani, Ahmad, Rezaei, & Tavasszy, 2015), energy efficiency of buildings (Parmarth Gupta, Anand, & Gupta, 2017), urban sewage treatment technologies sustainability assessment (Ren, Liang, & Chan, 2017), and measuring university-industry PhD projects efficiency (Salimi & Rezaei, 2016).

The literature on VIKOR and Fuzzy VIKOR methods is reviewed by Yazdani and Graeml (2014) for a total of 198 papers with 9 main application areas from 2002 to 2014, by Gul, Celik, Aydin, Gumus, and Guneri (2016) for a total of 343 papers with 13 main application areas from 1998 to 2015 and by Mardani, Zavadskas, Govindan, Amat Senin, and Jusoh (2016) for a total of 176 papers with 15 main application areas from 2004 to 2015. Uludag and Deveci (2013) applied Fuzzy VIKOR and Fuzzy TOPSIS methods to a potential city airport location selection problem by assessing thirty-four sub-criteria under nine main criteria (geographical specifications, climatic conditions, infrastructure conditions, costs, transportation, the possibility of extension, legal restrictions and regulations, potential demand, environmental and social effects) for five location alternatives. Milosevic and Naunovic (2013) adopted VIKOR for determining the most suitable location for a sanitary landfill facility from three alternatives by evaluating thirty-two sub-criteria under five main criteria (hydrogeological criteria, meteorological criteria, spatial criteria, socio-political criteria, and legal and economic criteria) and use fuzzy AHP for determining

weighting coefficients of the evaluation criteria. Liu, You, Chen, and Fan (2014) proposed an extended VIKOR method based on the interval 2-tuple linguistic variables to select the best disposal site for municipal solid waste among four alternatives considering four criteria (adjacent land use, climate, road access, and cost). Mokhtarian, Sadi-Nezhad, and Makui (2014) proposed Interval Valued Fuzzy VIKOR as a reliable method to select an appropriate location for digging some pits for municipal wet waste landfill. Pankaj Gupta, Mehlawat, and Grover (2016) proposed an extended VIKOR method using trapezoidal intuitionistic fuzzy numbers and apply it to the plant location selection problem with six criteria (skilled workers, expansion possibility, availability of acquirement material, investment cost, transport facilities, and climate) and three location alternatives. Hariz, Dönmez, and Sennaroglu (2017) completed Geographical Information Systems (GIS) analysis to classify feasible incinerator locations based on economic, environmental and social criteria and then use AHP, VIKOR and PROMETHEE methods to select the best location for a central healthcare waste incinerator.

The provided information indicates that there have been very few studies of factor selection for a freight forwarder's perspectives in the journal papers, therefore, presented MCDM problem and significant factors for evaluating factors is considered as the main contribution of this research to the literature.

3. Methodology

Factor weighting using Best-Worst Method (BWM)

Multi-criteria decision-making (MCDM) is a significant branch of decision-making concept. As mentioned in Chapter 2, the latest MCDM method is Best-worst method was selected for this research. The step of BWM was describe below (Razaei, 2015);

Step 1: Build the set of decision criteria. In this step, the criteria ($C_1, C_2,...,C_n$) that should be used are considered. This step is done by factor screening process at the very beginning of the phase. The structure of the criteria can be built as the hierarchy level as shown in Figure 3.

Step 2: Select the best criteria (most important) and the worst criteria (least important). In this step, the decision-makers identify each criteria and decide the most- and least important among the criteria. There are no comparison process in this step

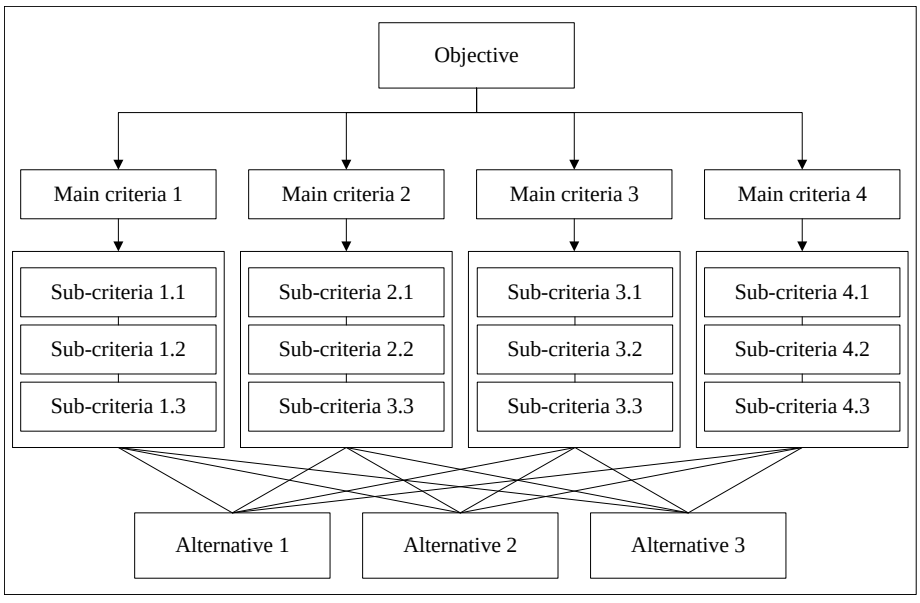

Figure 3 Criteria structure Source: Organized by Author

Step 3: Determine the preference of best criteria over all other criteria using the number between 1 and 9, as shown in Table 5.1. The value of 1,3,5,7,9 characterize equal importance, weak importance, essential importance, demonstrated importance, and extreme importance, respectively; while the value

2,4,6, and 8 are used to compromise between the values. The result of Best-to-Others vector would be:

$$A_B = (a_{B1}, a_{B2}, \dots, a_{Bn})$$

Where a_{Bj} represent the preference of the best criteria B over criterion j. It is clear that $a_{BB} = 1$

Table 2 The fundamental scale of absolute numbers

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another: its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

Source: Saaty (2008)

Step 4: Determine the preference of all criteria over the worst criteria using the number between 1 and 9, as shown in Table 2. The result of Best-to-Others vector would be:

$$A_w = (a_{1w}, a_{2w}, \dots, a_{nw})$$

Where a_{jw} represent the preference of the criterion j over the worst criteria W. It is clear that $a_{WW} = 1$

Step 5: Find the optimal weights $(W_1^*, W_2^*, \dots, W_n^*)$. The optimal weight for the criteria is the one where, for each pair of W_B/W_j and W_j/W_w, the $W_B/W_j = a_{Bj}$ and $W_j/W_w = a_{jw}$. The next step is to satisfy these condition for all. The solution, where the maximum absolute difference $\left|\frac{W_B}{W_j} - a_{Bj}\right|$ and $\left|\frac{W_j}{W_w} - a_{jw}\right|$ for all j is minimized, should be made. Considering the non-negativity and sum condition for the weights, the following problem is resulted;

$$\begin{aligned}
&\text{Min } \xi \\
&\text{s.t.} \\
&\left|\frac{W_B}{W_j} - a_{Bj}\right| \le \xi, \text{ for all j} \\
&\left|\frac{W_j}{W_w} - a_{jw}\right| \le \xi, \text{ for all j} \\
&\textstyle\sum_j W_j = 1 \\
&W_j \ge 0, \text{ for all j} \qquad (1)
\end{aligned}$$

Solving problem (1), the optimal weights $(W_1^*, W_2^*, \dots, W_n^*)$ and ξ* are obtained.

The last step is to test the consistency through calculation, modifying it if necessary to get an acceptable consistency. Table 2 shows the order of the consistency index table according to study of Razaei, (2015) which is used to calculate Equation (2). The consistency ratio for Best-Worst Method using ξ and the corresponding consistency index, as follow;

$$\text{Consistency Ratio} = \frac{\xi^*}{Consistency\ Index} \qquad (2)$$

Table 3 Consistency Index (CI) table

□□□	1	2	3	4	5	6	7	8	9
CI	0.00	0.44	1.00	1.63	2.30	3.00	3.73	4.47	5.23

Source: Razaei, (2015)

4. Case study

In according to air cargo terminal performance, there are several criteria that air cargo terminal has to improve in order to increase the customer satisfaction and operational efficiency. As mentioned that there is very limited research focus on air cargo performance, the factors from the previous research are very few. This research, therefore, requested experts and users in air cargo terminals to provide the significant factors for evaluating air cargo terminal performance. Table 3 is the list of the factors.

Table 4 List of the factors

Factors	Sources
Short-shipped cargo	Suwanwong et al. (2019)
Minimum connecting time	
Electronic import goods declaration	Rodbundith et al. (2018)
Cargo security (facilities, operations)	
Cargo terminal area (sq. m.)	
Available tracking and tracing service	
Cargo handling capacity (metric tons) per annum	
Cut off Time	Expert interview
Transit/Transfer Time	

□ Short-shipped cargo

Short-shipped cargo is the left over cargo. The increasing amount of short-shipped cargo reflects poor management of the airline, which affects its overall reputation. The defects occurring with the airline's ground operations not only influence the airlines but also the cargo shippers and consignees. One main reason is that air cargo is time-sensitive: longer delivery time and short-shipped irregularity are unsatisfactory for the shipment owners. Short-shipped cargo as a key factor leads to increased waiting times, which reduce the overall air cargo terminal performance (Suwanwong et al., 2019).

□ Minimum connecting time

Minimum connecting time for air cargo is different from the one for air passengers. As there is no standard for the minimum connecting time, it usually depends on airports and airlines. A small-size airport has shorter minimum connecting time than a large-size airport. According to Suwanwong et al. (2019), based on interviews with experts of Thai Airways International (TG), approximately 6–12h are the minimum connecting time if a transshipment is involved and/or the cargo needs to be towed to other terminals.

□ Electronic import goods declaration

Electronic import goods declaration is a part of E-freight and E-AWB project of IATA. This an industry-wide program involving carriers, freight forwarders, ground handlers, shippers, customs brokers and customs authorities that aim to build an end-to-end paperless transportation. All import goods is declared electronically to customs. This allows shipper or its freight forwarder to perform customs clearance 24/7 and fasten the clearance process with customs instead of traditional AWB and other document required by especially import country-customs. Air cargo terminal acts on behalf of carriers shall be enable to deal with electronic import goods declaration with customs efficiently.

- Cargo security (facilities, operations)

  Supply chain security is an increasingly important and complex element in air cargo operations and workflows as governments and organizations pursue a network and layered approach to security regulations, program requirement and technologies. The international Civil Aviation Organization (ICAO) is one of two primary international organizations provide standards, recommended practices and guidance material for countries and stated in the field of air cargo security. The other primary organization in this field is the World Customs Organization. Both organizations control the application of security screening and controls upstream in the air cargo supply chain including cargo facilities and operations. Cargo security is fully monitored and controlled at state and international levels. Air cargo terminals must obey regulations enforced by nations' civil aviation authorities.

- Cargo terminal area (sq. m.)

  Several parties such as Boeing or IATA forecast growing air cargo transport each year. With limited area of cargo terminal, the performance and service quality are at risk to handle increasing cargo tonnages. Cargo terminal operator are well-aware of this significant criteria to their future expansion to cope with growing demand from carriers. Impromptu future expansion may have defected cargo terminal performance and revenue from limited cargo terminal area to accept more cargo tonnages from new customer airlines.

- Available tracking and tracing service

  FSU: The cargo-IMP Status Update. This message is used to notify/update interested parties especially shippers, freight forwarders and consignees with a (change of) status of a specified consignment as recorded in the system of a handling cargo terminal. Usually, the system is connected with airline website to allow interested parties to track and trace their current consignment's delivering status. This tracking and tracing service is mandatory required from airlines to shippers, freight forwarders and consignees.

- Cargo handling capacity (metric tons) per annum

  Available cargo handling capacity per year is a significant indicator of cargo terminals to carriers to select. The buffer between maximum handling capacity and utilized capacity is always compared to acknowledge the availability for ensuring airlines' cargo handled properly. Tight or nearly utilized capacity is at risk to airlines for overcapacity of cargo terminal which may decide to embargo to handle cargo. In that case, this severely impacts to airlines to carry less cargo and lose revenue at the end. Consequently, airlines always require to know cargo terminal's handling capacity prior selecting cargo terminal.

- Cut off Time

  To transport cargo by air, time is matter. Normally, export cargo is directly delivered by freight forwarders from factories after production to cargo terminal. There are several conditions such as traffic, trucking quality or road infrastructure may delay consignment delivery to airports. Shorter cut off time to accept cargo from freight forwarders are preferable to them. Cargo terminal is necessary to handle cargo faster to ensure that airlines especially passenger airlines are punctual to their departure time. The proper cut off time is significant to be specific between cargo terminal, airlines and shipper freight forwarders.

- Transit/Transfer Time

  Boonekamp and Burghouwt (2017) and Kim and Park (2012) use one transshipment as their maximum number. Those studies maintain that if the number of transshipments is greater than one, customers will change to another route. According to Suwanwong et al. (2019), to support that assumption, industry experts are interviewed to determine the preferred number of transits/transshipments. Without considering the airfreight transport fee, they confirm that direct flights are most preferable, and one transit/transshipment is at an acceptable level.

After conducting the experts' group discussion for factor selection process, in this step, a structured interview was applied in order for determining the weight and significance of each variable. The survey is conducted and delivered to the experts in the in the management level who came from related aviation industry such as air cargo terminal operation, airline, and freight forwarders. Below is the step of the method to calculate the weight of each criterion.

Step 1: Determine a set of criteria; this step consider the criteria that should be used which already done by the group discussion. Nine variables were selected for this step

Step 2: Determine the best (the most important criteria) and the worst criteria (the least important criteria); in this step, the decision makers decided the criteria without any comparison. Table 5 show the results that the most important criteria is Short-shipped cargo and the least important criteria is Cargo terminal area (sq. m.)

Table 5 Determine the best and worst criteria

Criteria	Rank
Short-shipped cargo	Best
Cargo terminal area (sq. m.)	Worst

The next step is to construct Best-Worst method to investigate the weights and priority of each variable. The analysis was made on a scale from 1 to 9. Table 6 presents the final weights of each criteria. Among the 9 criteria, the experts decided that Short-shipped cargo was the most important variable. The result shows the weight of Short-shipped cargo to be 0.236. The experts agreed that the Short-shipped cargo is main criteria that effect to the air cargo terminal performance. In addition, the consistency ratio (CR) was all smaller than 0.1; therefore, the results were considered to be reliable.

Table 6 Factor weighting summary

Criteria	Weight	Rank
Short-shipped cargo	0.236	1
Minimum connecting time	0.143	3
Electronic import goods declaration	0.14	4
Cargo security (facilities, operations)	0.167	2
Cargo terminal area (sq. m.)	0.011	9
Available tracking and tracing service	0.112	5
Cargo handling capacity (metric tons) per annum	0.101	6
Cut off Time	0.056	7
Transit/Transfer Time	0.034	8

5. Discussion and Recommendation

In according to Table 6, to enable cargo terminal operational performance, the operators shall seriously look into these first three factors to enhance handling performance. Short-shipped cargo, cut-off time and transit/transfer time are respectively significant to all relevant stakeholders especially cargo terminal operators. Short-shipped cargo defects cargo not flown as booked meaning that airlines may be decreased on-time-performance to shippers and consignees who are able to select other airlines in next shipments while many alternatives of airlines available in the market. Carrying airlines may face claims from shippers as well for any irregularities from short-shipped cargo such as broken or missing pieces. Proper handling service is necessary to be well-performed by cargo terminal operators to airlines. Short-shipper cargo must be avoid in order to upstream their operational performance.

Secondly, as mentioned earlier, time is matter to air cargo transport to please shippers. To transport products by air is lesser carrying capacity while more expensive logistics cost, shippers will ship their goods by air when goods is very important to arrive at the desired time to destinations and shorter time is preferably significant. Shorter cut-off time is helpful to shippers to have times to transport just finished goods from manufacturers to airports. This is the nature of air cargo after its production

process. If cargo terminal operator agrees on shorter cut-off time meaning that their in-house handling process must be faster and more efficient to deliver to aircraft side on time.

Thirdly, transit/transfer time, there are several airlines nowadays. Small to medium airlines are operating with smaller network comparing to well-known airlines. Hubs and spokes are usually a strategy for airlines. Also, low cost carriers are now fly point to point. Airline home base is rarely no longer be only their hub but using other airports are secondary hubs. The old fashion airline tactic is changing to widen their network. Trucking service is linked into airline network. This means that more and more transit/transfer cargo are connecting hourly, daily, weekly. To quickly transfer cargo from airline to other airlines or transit from this flight to other flights are more important to transport cargo to destinations. Airlines concentrates more on connecting cargo to shipper's desired destinations. Quick transit/transfer time is subject and pinpoint to cargo terminal performance as a key topic to select cargo terminals to serve their flights. Therefore, cargo terminal is mandatory to review their handling procedure to fasten airline transit/transfer time.

As the top three factors are somehow relevant to timing required by airlines. Cargo terminal shall seriously look into these three factors in order to satisfy airlines, shippers, freight forwarders and consignees. The question is how to handle cargo with nil irregularity and faster in cargo terminal custody. This is important to cargo terminal to gain higher standard of their operational performance in all area of handling activities. Redundant, duplicated or repeated activities must be terminated and improved to serve related stakeholders in the airport.

Reference

As by request.

EXPLORING CONSUMER LOYALTY BEHAVIOUR TOWARDS VIETNAMESE STRATEGIC RETAIL GROUPS

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Introduction

In academia and business an important and meaningful question considered by most researchers and business practitioners relates to which factors affect customer loyalty. Customer loyalty has been much researched in terms of which factors affect it and has been considered a vital priority of marketing. Customer loyalty is defined as "a deeply held commitment to re-buy, re-patronize a preferred product or service consistently in the future, thereby causing repetitive same-brand or same brand-set purchasing, despite situational influences and marketing efforts having the potential to cause switching behavior" (Oliver, 1997:392). In addition, the relationship between customer satisfaction and customer loyalty as well as which factors affecting customer loyalty have still unceasingly debated between scholars. However, these factors have not been researched to any great degree as they relate to strategic industrial sector groups. Further, while most studies relating to customer loyalty in the retail grocery sector have separately explored customer loyalty through specific factors such as brand image, social responsibility, switching cost, there is little research on examining different factors that simultaneously affect customer loyalty.

Based on strategic theories used in specific industries, different strategic groups might have different factors affecting customer loyalty. Leask and Parker (2006) define a strategic group as a group of corporations that employ the same or similar strategies in a specific industry. The term strategic group seeks to identify configurations based on observing firms' behaviour and then explaining differential performance. Similar characteristics for such group will likely relate to cost structure, formal organization, control systems, management rewards and punishment. Such groups are important for retail logistics and supply chain management (SCM) as different strategic positions of grocery retailers will shape their retail supply chains and replenishment and fulfilment activities.

This paper is going to investigate consumer loyalty behaviour towards Vietnamese strategic retail groups. As Vietnam's increased growth is rapidly changing consumer buying power, and hence expectations of product offerings and service as well as consumer loyalty behaviour are also changing. The findings provide practical insights into this integrative phenomena for academic researchers and business and strategic decision makers when looking at customer loyalty in grocery retail, especially regarding applied business strategies for sustainable success. The structure of this paper is as follows. After this introduction, the literature review method is presented, followed by thematic findings. Then, research methodology will be briefly demonstrated, a discussion of these findings will be presented in detail, ended by conclusion of the research.

Review Method

Literature review plays a vital role in the development of any research area. It summarises and establishes connections between previous works, demonstrates different streams and results which can help researchers identify research gaps and provides opportunities for proposing research directions (Martins and Pato, 2019). According to Webster and Watson (2002:xv-xvi), "a high quality review is complete and focuses on concepts". In academic research, a systematic literature review approach is used. According to Tranfield et al. (2003), a systematic literature review (SLR) bases on a clearly formulated question, identifies relevant studies, appraises their quality and summarizes the evidence by use of explicit methodology; it thus uses a concept-centric approach (Webster and Watson, 2002). The SLR approach starts from searching a keyword representing a researched topic; it can reduce the bias when all reviewed documents represent the objectivity. Applying the SLR approach tothis study and based on the main objectives of the research, we developed three *a priori* themes to explore this topic:

strategic groups, customer perceived value and satisfaction, and customer loyalty. Reading materials used based on reliable online databases and books related to retailing sector. From main keywords, many sub-themes had been found; new sub-theme keywords such as customer perceived value, customer satisfaction, service quality, in-store logistics, and customer behaviour were explored fully. This process was applied thoroughly in order to meet the research objectives and all highly-related papers were synthesised for analysis.

Thematic Findings from the Review

Strategic Groups

There are several concerning studies retailing strategy (Grant and Fernie, 2019). Researchers have tried to form retail firms' strategic types and explored the linkage between strategic choice and firms' performance (McGree and Petersen, 2000). Based on the strategic options of Porter, some scholars have also considered a business strategy in retail markets in terms of low cost, differentiation and focus strategies (Helms et al., 1992;). The options chosen depended on price leadership orientation, merchandise differentiation or product market approach such as productivity improvement, penetration, market development and diversification. Hawes and Crittenden (1984) investigated strategy in retail industry at a functional level and found the different performance between different strategic groups which were formed by firms' scope and resource allocation. For small retailers, strategies might only be based on product specialisation or customisation and customer service perspectives (Covin and Covin, 1990) and firms can differentiate themselves from others via functional levels of strategies. There are two theories including resource-based view (RBV) theory and industrial organisation (IO) theory which can be used to explain the nature of how strategic groups are constituted. RBV argues that firms with differences in resources and capabilities are a foundation of different firms' performance (Solesvik and Westhead, 2010). In other words, the key difference amongst firms is their resources and how it is used, deployed, allocated by firms. In IO theory a structure-conduct-performance (SCP) framework has investigated how the structure of an industry (all factors generate the market competitiveness) influences the conduct (the behaviours/strategies used) and firms' performance. Both RBV and IO theory have shaped and provided a good tool for strategic management researchers compare and contrast groups of firms (Leask and Parker, 2006). In a retail industry, the different strategic positions of grocery retailers will shape their retail supply chains and replenishment/fulfilment activities.

Customer Perceived Value and Satisfaction

Regarding customer perceived value, it has recently received significant attention in the marketing field because it has a crucial role in predicting purchase behaviour and contributes to firms' strategy-adjustment (Chang and Wang, 2011). The concept behind "perceived value" is the relationship between benefits and sacrifices, this term is assessed in terms of comparing between many firms leading to the whole picture of "how buyers choose a certain product or supplier over others" (Hanninen and Karjaluoto, 2017: 606). I.e., perceived value is the overall assessment of customers toward the products or services offered by suppliers based on what they received directly, in that brand image, store attributes are also considered. A number of measurements have been developed in order to measure "perceived value" as a unidimensional measure with a limited number of items that represent a perception of value (Eggert and Ulaga, 2002). However, the determinants of perceived value are different among consumers and thus measurements can lack validity.

Kotler and Keller (2009:789) defined customer satisfaction as "a person's feeling of pleasure or disappointment that results from comparing a product's perceived performance or outcome with his/her expectations". Therefore, the level of customer satisfaction depends on the gap between expectation and perceived performance. It is also a good indicator of firms' future performance, a crucial dimension to long-term business success. In looking at customer satisfaction, firms can recognise their strengths and weaknesses; if firms can fulfil their customer needs, they will receive customer satisfaction in return and vice versa. In literature, there are two approaches of customer satisfaction that are highly accepted. There is some research on which factors might affect customer satisfaction. According to Fornell et al. (1996), three antecedents which are perceived value, perceived quality and customer expectation have

been revealed. Service quality has a strong positive effect on customer satisfaction and loyalty, especially in retail (Sivadas and Baker-Prewitt, 2000).

Customer Loyalty

Customer loyalty is defined by many researchers in different ways. However, they all have two dimensions, which are: customers repeatedly purchase a good or service; and having favourable attitudes toward a good or service offered by companies (Athavale et al., 2015). Customer loyalty is defined as "a deeply held commitment to re-buy, re-patronise a preferred product or service consistently in the future, thereby causing repetitive same-brand or same brand-set purchasing, despite situational influences and marketing efforts having the potential to cause switching behaviour" (Oliver, 1997:392). Many firms compete fiercely to get more customers and price is one of the factors influencing customer loyalty; however, competitive pricing might not guarantee customer loyalty in the long-term. From the beginning, Oliver (1997) classified loyalty in four steps which are cognitive, affective, conative and action. The study from Sivadas and Baker-Prewitt (2000:78) in a retail store setting found a strong support for the model, in that "cognitive loyalty is a significant predictor of affective loyalty; affective loyalty is a strong predictor of conative loyalty and conative loyalty significantly affects action loyalty". However, in some cases, consumers repeatedly purchase but it cannot be seen as loyalty due to situational effects such as low price, constant promotion programmes and proximity (Hartmann and Ibanez, 2007). Therefore, many researchers have indicated that behavioural approach was not sufficient to explain customer loyalty. Attitudinal loyalty relates to customers' psychological and sensation orientation, they have a positive feeling about retailers and are willing to introduce others to buy products or services from the retailers, reflect a positive word-of-mouth communication (Kursunluoglu, 2014).

Hoffman and Lowitt (2008) found that 70 percent of US consumers demonstrated their faithfulness to their favourite retailers, but in the case of properly enticed programmes offered by rivals, 85 percent of these so-called loyal customers are willing to switch immediately. Researchers have investigated the structural linkage between customer loyalty and its predictors. It has attracted great interest from academics and practitioners. Service quality has been considered as the key driver of loyalty; however, some researchers have also proved that customer satisfaction is a weak indicator in terms of customer loyalty (Prentice, 2014). From these studies, customers were happy and highly satisfied with products or services offered, but they did not return and repeatedly purchase (Barber et al., 2010). In addition, Prentice (2014) confirms that, depending on the industry which firms are serving, service quality might not always generate customer satisfaction and loyalty; via the research he proved that there are some dimensions of service quality (model presented above) expressing negative effects on customers' favourable behaviour. Therefore, the relationship between these factors is still being debated, and there is little homogeneity over the operationalisation of the construct of loyalty amongst researchers. "Relational trust and value are the strongest determinants of loyalty rather than satisfaction" and service quality was also found as an antecedent of customer loyalty" (Kursunluoglu, 2014:532). Other studies have investigated customer loyalty and they considered service quality, satisfaction, perceived value, price, brand image, and identity as antecedents of loyalty and found that customer satisfaction does not equate to customer loyalty (Kumar et al., 2013). Such findings continue to be debated.

Resulting Research Gaps

1. The relationship between customer satisfaction and customer loyalty, factors influencing satisfaction, customer perceived value as well as which factors affecting customer loyalty are still being debated between scholars.
2. Previous research has not investigated factors affecting customer loyalty in different strategic groups, rather they have examined specific industries and generalised for the whole industry. Based on strategic theories in a specific industry, different strategic groups might have different factors affecting customer loyalty. This means that the differences between strategic groups in the same industry have been ignored and no research has been linked to strategic terms. Therefore, this research is required as it brings up the idea of "strategic groups" in customer loyalty research.

Research Objectives based on the foregoing gaps

1. Provide insights into the Vietnamese retail industry; classifying all current supermarket firms in Vietnam into their proper strategic groups.
2. Investigate factors directly affecting customer loyalty, customer satisfaction and customer perceived value in Vietnamese supermarkets.

Related Research Questions

RQ1: How many strategic supermarket groups in Vietnam?

RQ2: Which factors directly affect customer loyalty, customer satisfaction and customer perceived value in the Vietnamese supermarket sector?

Research Methodology

The qualitative research includes semi-structured expert interviews, which will help the researcher identify "strategic groups" within the Vietnamese supermarkets in order to facilitate the subsequent comparison of groups; semi-structure interviewing consumers will also help the researcher justify and validate her proposed research framework, with constructs added after interviewing if required. At each step, core questions were created based on the main objectives of this research, the research requires to interview supermarket consumers and experts who can most likely offer valuable information. Based on the differences and the research purpose, a non-probability method which includes purposive expert sampling was chosen. According to Sekaran and Bougie (2011) purposive sampling is the method where respondents are selected based on a variety of criteria which can include their relevance, their specialist knowledge of the research topic or the willingness to participate in the research. It means that after understanding the purpose of the research, the researcher will identify a predetermined target group. In addition, back to back translation is a good technique which has been widely applied by researchers to test the accuracy of translations in order to avoid mistakes occurring during the translation process, particularly in cross-cultural research.

Discussion of Findings

The Vietnamese Retail Industry and Competitive Environment

In Vietnam, supermarkets have impressed with large realignment from being regarded as unprofessional to professional and have reached international standards about how supermarkets should be formed and served. Supermarkets used to sell some normal consumer products with average quality. However, they have covered different kinds of grocery items and diversified their categories, serving different segments with large scale and being rewarded by building retail brand names in the long-term. In the past decade, the incredible development of retailing formats and competition between firms in order to gain market share have led to a colourful and varied retailing landscape. In particular, the market is currently undergoing many mergers and acquisition activities between firms, and fierce competition with the entry of many strong foreign retailers. The traditional market itself has a certain role in the Vietnamese community, due to the fierce competition from other retailing formats, the traditional markets have gradually changed the way they work in the big cities with more civilization, and they have arranged their activities, as well as selling many items associated with the traditional consumption culture of Vietnamese people. Besides that, as a result of globalisation, many people have been changing their consumption styles and begun to prefer products with foreign brand names. The population is also getting used to the term "fast food". In general, many retail stores have established complex formats serving consumers not only with grocery products but also fresh food, entertainment, fashion and so forth, followed by the integration of advertising and media industries with names such as Cresent Mall, Aeon Mall, Vivo City and so forth. Most of them have a modern and professional look and enjoy comprehensively professional logistics services.

Regarding supermarket sector, Vietnamese supermarkets have been developed through three stages. At the first phase, supermarkets served many main daily consumption needs such as flip-flops, household utensils, pet food, flowers, electronic items, food, grocery products, bakery, clothing, television and furniture. Typically, Maximax, Coopmart and BigC supermarket, they all still have a certain position and some of them are holding court and becoming leaders with huge market share in the consumer goods market. They can be considered as enjoying similar popularity to that of Walmart in the

United State. The second stage has marked the emergence of specialised supermarkets with specific products or functions, with many wholesale formats being established and indirectly competing with supermarkets in the first stage (Metro or Aeon). The third stage (for about the last six or seven years) is the current situation where supermarkets are serving the multi-segments such as daily food, groceries, entertainment and its services, drugstores, beauty parlours, barber shop, fashion and so forth. These formats have attracted consumers from different groups, especially at the weekend, when people enjoy a day shopping and using the other comprehensive services offered nearby. With this format, supermarkets have integrated with many other retailers, alliances with famous-drink and food brand names, pulling other retail groups to operate in the same areas in order to cross-serve their consumers. It can be said that "everything people need to enjoy their days, they have it in here". The idea of gathering possible services needed by consumers in the same place is a great improvement in the Vietnamese retailing industry. There are many services and products offered for children as well, such as ground play, English centres for both children and adults. This also is a reason that retailers can attract more family consumer groups. Besides that, some banks have located in this supermarket format as well in order to facilitate their customers during the shopping process or other personal requirements. Accordingly, the advertising industry also follows and penetrates to these multi-purpose supermarkets. The whole integrated provision of services has led to greater efficiency of the supermarkets which can replace other supermarket formats in the future. However, compared to the UK supermarkets, other integrated establishments such as gas stations, car washes, bill-paying service and repair shops have not appeared in Vietnam.

Regarding the competitive environment, strong and full development is the current nature of Vietnamese supermarkets in the last five years. With the supermarket format, strategic groups are clearly separated but the development is still not synchronised. Differences and variety of functions are also a factor that can facilitate grouping a client-group flow. For instance, with daily shopping for groceries, Vietnamese consumers usually choose Coopmart and Big C; shopping with entertainment services, consumers choose a multi-functional supermarket. Besides that, wholesale supermarkets are still competing with other strategic groups to some extent, the main competitive point is to focus on selling foreign products and specialised items with large quantities, and in return consumers can enjoy reasonable prices. The level of competition and attractiveness between strategic groups is different. Therefore, competitive forces at each strategic group will be different. However, the summarised analysis that follows can demonstrate a five forces review affecting the retailing industry: consumers have a high power; suppliers have a low power compared to supermarkets themselves; and there is a significant threat of substitution; the Vietnamese retail market is identified as fragmented, competition is high; the threat of new entrants is high. Besides that, there is competition between different strategic groups and within groups, groups located near each other in the strategic group map usually attract more consumers from other groups by using marketing with good promotion and services offered, concentrating on specialised products. For instance, that Lotte and Aeon offer multi-functional products and services leads other supermarkets to mimic these improvements and apply to their business model. Therefore, fierce and ceaseless competition between supermarkets is happening. The term "ecosystem-strategic supermarkets" or "Supermarket Ecosystem" can be used in this situation. In that, supermarkets are much more than large grocery stores, they also offer various business integrations and are operating as commercial centres. Services offered attached to supermarkets have been considered as one of the main factors that can attract more consumers. This business format has been becoming very popular in Vietnam.

Strategic Group Mapping

Checking similar points between supermarkets in many ways such as from the products and services offered, degree of specialisation, company structure, prices, targeted segmentations, firm size, brand name building, expanding strategies, the ways of competition or alliance can facilitate strategic group mapping process. There are 12 main supermarkets in Vietnam, located across the country. Based on Porter, Vietnamese supermarkets can be grouped into five different strategic groups, based on recommendation from an expert in retailing from Vietnam, as follows:

1. **Group 1: Specialised daily consumer goods**: firms in this group have covered a wide geographical area across the country, the business focus to serve consumers with their basic daily consumption of food, grocery products, and household utensils. Typical of this group are Coopmart and BigC.
2. **Group 2: Multipurpose premium supermarkets**: operating under ecosystem-strategic format but choose to locate at prime locations and luxury areas, focus on a group of rich people living at newly created cities, luxury apartments, especially concentrating only on retail sales rather than wholesale. Typical of this group is Lotte.
3. **Group 3: Premium supermarket chains with convenience stores**: the characteristics of this group are high quality products such as fresh meats and organic vegetables without chemical pesticides; products with clear origin, especially fruits. They also offer daily consumer goods but with premium quality and cover a huge geographical area in a main city with flexible stores allocated, especially, a majority of their customers being people who live in new urban segments and areas. Besides that, they have expanded markets with a huge amount of convenience stores in urban areas in order to attract more customers, compared to GROUP 1, GROUP 3 is considered as a "premium" group with premium price charging. Typical of this group is Vinmart.
4. **Group 4: Group of Multipurpose supermarkets**: operating under ecosystem-strategic format including Aeon mall, Vivo city, Cresent mall or wholesale format as Metro. These groups often locate in crowded areas but far away from the central area.
5. **Group 5**: Other supermarkets

It can be noted that "ecosystem supermarkets or malls" in Vietnam might be different from the concept in western areas, malls in Vietnam are characterised by a form of large battlefield. Many stalls and areas in the whole supermarkets or a mall are not owned by supermarket owners. They are from different small retailers who sign a partnership contract or even just rent a space for their business. There is a good linkage between many retailers; they compete with each other or even with supermarkets themselves. Besides that, when supermarkets integrate with other attached businesses, they create a favourable business environment to avoid fierce competition. For example, at the food court, there is a limitation on the number of country-specific restaurants and variety of choices of food from different countries. These stores will be asked to move out if they cannot achieve a business with good profits. In another scenario, the supermarket owner will give a chance for potential and good firms moving in. In general, the decision of which firms can move in and integrate with the supermarket business is very selective. Supermarkets itself have more power than other small retailers and always choose "win-win" strategies. The mall and multifunctional supermarkets also compete fiercely and threaten to take over market share from other strategic groups; the form of ecosystem in supermarkets is significantly successful in Vietnam.

Many main points collected from the expert interview, including the current situation in the Vietnamese retail industry, and specifically the supermarket sector; the comments on competitive business environment; the suggested techniques to group firms to strategic groups, then applying these techniques in practice, the case in Vietnamese supermarket sector. Via this interview, the brief picture about the Vietnamese retailing industry, particularly the supermarket sector was presented. In the end, the expert commented, noticed and discussed some further factors which might affect customer loyalty, apart from the one presented at the literature review part.

Analysis for consumer interviewing: Customer loyalty perception

There were 21 interviews conducted and 35 questions asked based on the objective of the research which is to investigate consumer loyalty behaviour towards Vietnamese strategic retail groups. This qualitative interview revealed all possible factors that might affect customer loyalty. Many respondents choose to shop at supermarkets because of its advantages such as clean and fresh atmosphere, trustworthy and diverse goods as well as its types, a variety of delicious and fresh food, not worrying about bargains because clearly presented prices, good returns policies, nice and polite attitude of in-store staff, safe household utensils offered, clearly stated origin, an eye-catchingly display, easy to find, especially, the comfortable feelings of whether purchasing or not after checking without worrying annoyed anyone; home-delivery service offered. As consumers explained, products from supermarkets seem to have a higher quality compared to the one at traditional markets.

Considering factors affecting customer satisfaction, a majority of respondents emphasised the importance of good customer services, friendly well-trained in-store staff, product quality, excellent in-store logistics and promotion programmes, a supermarket brand name and firm image. In general, when consumers perceive high-value reception when shopping, they will be more satisfied. Some respondents considered about where supermarkets' brand names are coming from, including domestic and foreign brand name. They demonstrated that foreign supermarkets give them a reliable feeling. It generates a positive effect in the purchase decision.

Loyalty behaviours can be linked with many factors such as convenience in terms of location, customer service, retail brand experience, service quality offered, clean toilets provided and origins of products, the quality of products, prices, no scandal occurred, nice corporate image and store image, habit, super-friendly well-trained and supportive in-store staffs, nice store atmosphere. Many respondents emphasized the most crucial factor if firms want to keep consumers loyal to them is in-store staff's behaviours; if staff express disrespectful behaviour and seem not to be supportive, they might move to other retailers even though the original supermarket satisfies all their needs.

Respondents also explained that if there are new supermarkets built which are far away from their houses compared to the currently chosen one and many suitable attached services around that area, in the case other factors match their needs, they will move to the new supermarkets and use other services offered. For example, even the new supermarkets are slightly far, but it is located near other services such as spa/ beauty salon, cinema, book stores, consumers might re-consider their choices and choose new supermarkets. Besides that, some respondents said that they will lose trust in supermarkets which do not have a positive corporate social responsibility, in the case they have alternative choices, they might move to new supermarkets.

Although some consumers do not care about CSR, if supermarkets treat their employees nicer, employees might be happy and give consumers a better service. Some serious situation such as business from supermarket seriously affect a natural environment and cause pollution and damage people's living environment, all respondents will commit not to shop at that supermarket anymore. All respondents expressed their disappointed behaviour to firms who do not pay taxes, but some of them still choose to shop at these supermarkets due to its indirect effect to them. Further, when mentioning a brand name experience, logo and brand identity should be considered; 100% of the respondents admitted that the colour and how the logo of specific brand name is designed are also considered as the crucial factors to decide the first impression of consumers about a specific brand.

50% of respondents explained that store image is a crucial factor, in the case that other factors match or exceed their expectations they might feel annoyed and unpleasant if bad store image provided such as cramped and dirty in-store atmosphere, illogically allocated shelves as well as products, unfriendly, irresponsible and unsupportive in-store staff. They all argued that they cannot be satisfied with supermarkets in such circumstances and emphasised that to be loyal with a specific supermarket brand name, they have considered many factors, and store image seems to be an important factor. However, the rest explained that store image seems not to significantly affect their choices, they argued that being a supermarket, at least store image should be above average in order to make it work and compete with others. The researcher also asked consumers "Are you loyal to a supermarket brand name or their specific store?" and 57% of the respondents admitted that they are loyal to a specific store of a supermarket brand name. Surprisingly, all of these consumers mentioned convenient store accessibility in which it is located near their houses or its convenient locations.

A majority of respondents stated that bonus points or discounts slightly stimulate their purchase decision if product quality remains unchanged. If other supermarkets which are further from consumers' houses offer an attractive promotion, consumers tend to move to that supermarket to experience discounted shopping, but all participants supposed that they will not change supermarkets which they are currently loyal to. In the case, supermarkets offer good promotion programmes, but their employees show disrespect to consumers or behave in unsupportive ways, respondents will commit not to go to that supermarket for shopping as well. Switching costs positively affect customer loyalty as well, as consumers consider high switching costs; they are more likely to be loyal to their current supermarkets. The qualitative research also revealed that alternative attractiveness negatively affects customer loyalty and also confirms many factors affecting customer loyalty, apart from factors investigated in the literature review, trust and habit were also considered as factors influencing customer loyalty.

Conclusions

This paper's contribution is theoretical understanding of grocery retail in a rapidly changing emerging nation and provides guidance for the various retail groups to set-out their respective strategies and establish competitive advantage. In addition, the findings of this research can result in a conceptual framework that could be used to test in the future. A practical contribution would be strategic group mapping and consumers' loyal behaviours, which allows practitioners to understand more about Vietnamese supermarkets and these issues should not be ignored by academic researchers and practitioners from other industries. A limitation of this paper is that the question of which level the involved factors affecting customer loyalty/customer satisfaction and customer perceived value is still under-researched. Therefore, future research should implement a quantitative research based on the results of this study to fully explore and understand relationships between factors mentioned.

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HUMANITARIAN SUPPLY CHAINS: MANAGING RISKS IN DISASTER MANAGEMENT CYCLE

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Introduction

There has been an increase in the number of recorded natural disasters and climate change will only continue to fuel the occurrences of natural disasters in the years to come (Agarwal and Singh, 2018). Humanitarian logistics play an integral role in disaster relief operations and it is important that countries respond swiftly when disasters strike to allow beneficiaries to receive aid and relief supplies as soon as possible. When a country is faced with disaster, it is paramount for the country to provide aid efficiently and in the most cost-effective way.

Humanitarian supply chain encompasses "the flow of services, supplies, information and finances between donors, beneficiaries, suppliers and different unit of humanitarian organisations, in order to provide physical aid to beneficiaries" (Agarwal and Singh, 2018, p. 100). As with commercial business supply chains, there are also risks in humanitarian supply chains. In the humanitarian context, risk is "the combined susceptibility and vulnerability of the community to potential damage caused by a particular hazard within a specified future time period (Guzman, 2004, p. 7). According to Daultani *et al.* (2005), it is important that risks are managed so that business supply chain operations remain efficient, smooth and organised. Hence, similarly for humanitarian supply chains, it is vital that risks are managed well to increase efficiency and productivity in humanitarian relief efforts. Besides that, managing risks will also help to increase competitiveness and credibility in the humanitarian sector, which will in turn lead to greater fundraising potential (Mizushima *et al.*, 2008). While risks cannot be eliminated, it is possible to manage risks to minimise the adverse impacts these risks bring. This is crucial as disasters not only bring about adverse economic, physical and environmental impacts, they also threaten the sustainable development goals of the affected country (Guzman, 2004).

The Disaster Management Cycle (DMC) plays a crucial role in humanitarian supply chains. By identifying potential risks in the DMC and managing them, it aids relevant stakeholders in informed decision-making to achieve the managerial objective of humanitarian logistics, which is to provide critical relief supplies to alleviate human suffering and deprivation. Stakeholders will also be more prepared to provide the necessary and appropriate response when the need arises.

Objectives of this Study

The goal of this project is to find out the risks associated with humanitarian supply chains, or more specifically, the DMC, and study possible ways to manage these risks.

The research questions of the study are as follows: (1) What are the types of risks involved in the DMC? (2) How can the risks in the DMC be managed?

The first objective of the study is to find out and identify the risks involved in the four phases of the DMC, namely mitigation phase, preparedness phase, response phase and recovery phase. Risks associated with commercial business supply chains will also be compared with these risks. The second objective of the study is to classify the risks in a risk matrix according to their likelihood and consequence, and study how these risks can be managed.

Literature Review

A literature review was carried out to gain a better understanding of humanitarian supply chain and risks in the DMC, as well as the studies which have been carried out. The review is broken down into three main sections – supply chain risks, risk management in the DMC and strategies to manage risks.

Supply Chain Risks

Jahre (2017) classifies supply chain risks into two main categories – micro risks and macro risks. Micro risks are normal risks associated with demand, supply, manufacture and infrastructure. On the other hand, macro risks, which are also known as abnormal risks, are usually disruption risks. The nature of humanitarian supply chains (they are carried out in disaster-prone areas) means that humanitarian organisations are more likely to experience macro risks, though micro risks do exist as well. In fact, there is a positive correlation between the two categories of risks. Micro risks are more evident in areas with high macro risks as efforts are in place to prepare for and respond to disasters (Jahre, 2017). Thus, it is important that both micro and macro risks are managed well. Furthermore, it is suggested in McLachin *et al.* (2009) that SCRM is especially crucial in the humanitarian context as supply chain disruptions can lead to or play a role in humanitarian crises. Most relief and recovery efforts in humanitarian crises are also often subjected to risks (McLachin *et al.*, 2009).

Risk Management in the DMC

The rapid development of the global economy and our socio-economic system have increased the damage from natural disasters. Thus, it is crucial that there is proper risk management to minimise these damages. The integrated natural disaster risk management (INDRM) was introduced as a strategy to improve disaster prevention and mitigation. The INDRM has three main objectives. It aims to address the gaps between the different phases of the DMC, enhance the capacity and capability of the local population "to prevent, mitigate, prepare and respond to the occurrence of disasters" as well as promote high collaboration and cooperation between key players in disaster reduction and response (Zhang *et al*, 2006, p. 7).

Zhang *et al.* (2006) found that risk is interconnected with four elements, namely hazard, exposure, vulnerability as well as emergency response and recovery capability. Hence, in order to manage risks from natural disasters, there is a need to lower the hazard and level of vulnerability of the general population, minimise the risk of hazard to the population (i.e. exposure) and improve emergency response and recovery capability. Zhang *et al.* (2006) also suggested that risk management should encompass the phases of the DMC, be it in the pre-disaster stage, post-disaster stage or when disaster occurs.

There are several countermeasures of INDRM, and these are broken down into two categories – risk control and risk finance (Zhang *et al.,* 2006). Risk avoidance/prevention and mitigation belong to the "risk control" category, while risk transfer and risk acceptance come under the "risk finance" category. Despite this categorisation, one similarity among these measures is that they should be performed at the pre-disaster stage. Figure 1 shows the countermeasures of the INDRM.

Figure 1: Countermeasures of the INDRM (Zhang *et al.*, 2006)

Figure 2 illustrates how risk management should encompass the DMC and provides a summary of the countermeasures and implementation process for the INDRM.

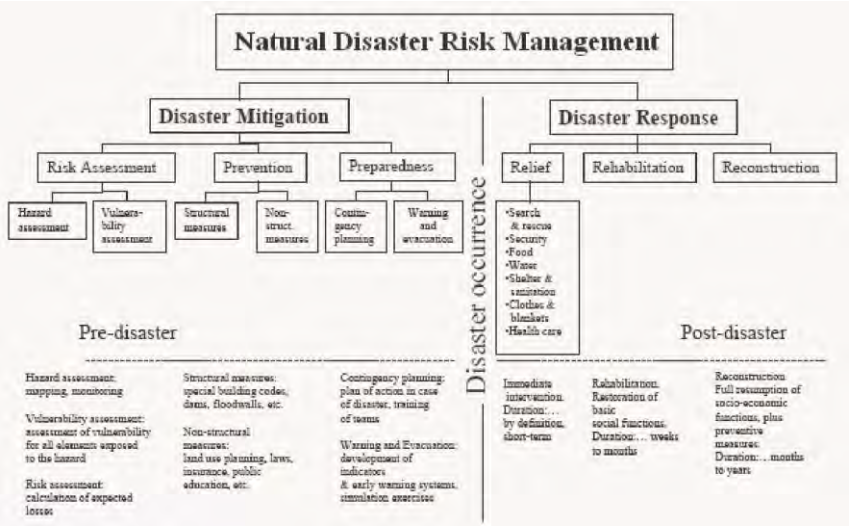

Figure 2: Countermeasures and Implementation Process for INDRM (Zhang *et al.*, 2006)

Viagi *et al.* (2016) also agree with Zhang *et al.* (2006) that risk management should encompass the DMC and proposed a humanitarian supply chain model integrated with risk management.

According to Viagi *et al.* (2016), there should be some transition between the response phase and the recovery phase as the changes between these phases have an impact on the general characteristics of humanitarian aid. This was one of the reasons cited for the proposal of a model integrated with risk management. The other reason cited was that risk management should occur at every phase of the DMC. Viagi *et al.* (2016) view that risk management should aim to reduce the effects of disasters or accidents through measures such as risk identification, preparation of mobilisation plans and evacuation. This may also include detailing the risks and probability a disaster may occur and ensuring that efforts are in place to reduce response time and enhance the productivity and efficiency of rescue teams.

In relation to the above, the representation of the DMC was re-written in the following sequence: preparedness, response, transition, recovery and mitigation. Components of the supply chain risk management framework, including risk context and risk driers, risk management influencers, decision makers, risk management response as well as performance outcomes, were incorporated and integrated into the model as well. Figure 3 shows the new proposed model.

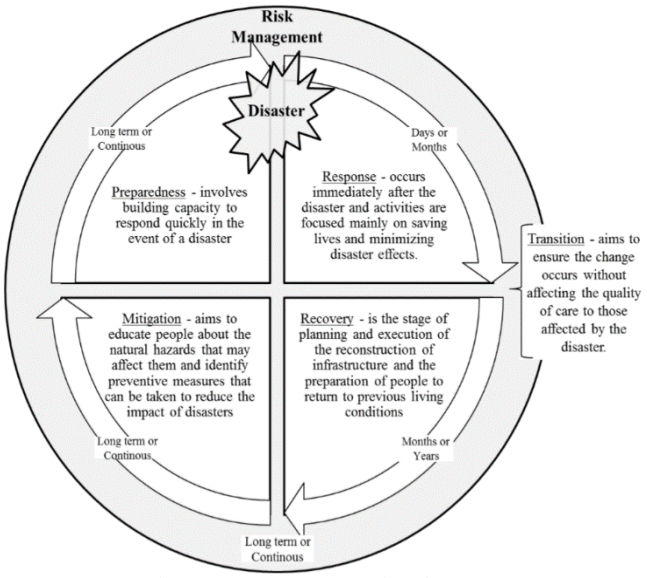

Figure 3: Proposed Model showing integration of Risk Management and Disaster Management Cycle (Viagi *et al.*, 2016)

Viagi *et al.* (2016) found that integrating risk management into the DMC will enable humanitarian organisations to have a better management of humanitarian activities. As every individual is aware of his or her responsibilities and the importance of what needs to be done, this allows personnel to work more efficiently and effectively while maximising available resources (Viagi *et al.*, 2016). This is especially important in humanitarian supply chains as lead time is short and resources available are sometimes very scarce.

Strategies to Manage Risks

Adopting SCRM strategies

Strategies in SCRM are often used in commercial business supply chains. Jahre (2017) identified some of these strategies which can be adapted and used in humanitarian supply chains. A framework for humanitarian risk mitigation strategies was developed to show the link between micro risks and macro risks as well as the strategies identified to mitigate the risks. The framework is seen in Figure 4.

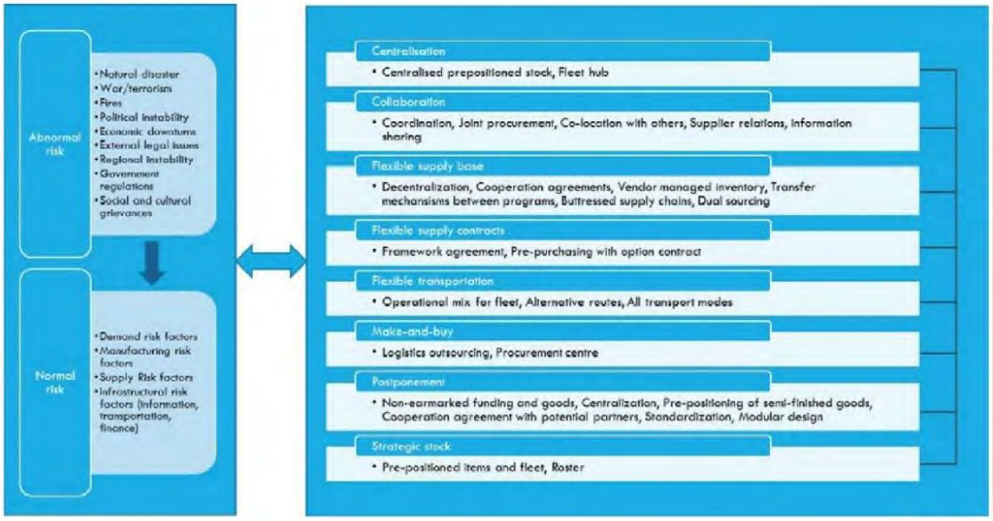

Figure 4: Framework for Humanitarian Risk Mitigation Strategies (Jahre, 2017)

As illustrated by the connecting lines in Figure 4, the strategies need not be used in isolation, they can be employed as a combination of strategies as long as the specific risks are addressed. (Jahre, 2017)

also found that certain strategies like revenue management and dynamic assortment plans are not suitable for use in humanitarian supply chains. This is due to the differences in the nature of commercial business supply chains and humanitarian supply chains. The former is more profit-driven, while the latter is needs-driven and does not view profits as a main goal.

In addition, Jahre (2017) analysed the strategies adopted by various humanitarian organisations, such as the International Federation Red Cross and Red Crescent and United Nations World Food Programme. From these strategies and out of those identified in Figure 1, it was found that the more common strategies adopted are strategic stock, postponement, collaboration, flexible transportation as well as flexible supply base.

Adopting INDRM Strategies

The INDRM strategies proposed by Zhang *et al.* (2006) include ensuring that there are adequate support mechanisms and resources, as well as implementing disaster risk management process top-down such that the local community is aware of what is done at a national level. More importantly, it was emphasised that multi-level and multi-dimensional coordination and cooperation occur at many levels and there must be significant collaboration amongst the various stakeholders to effectively manage disaster reduction and response.

Adopting Supply Chain Resilience

Supply chains are becoming increasingly complicated and it is inevitable that business organisations face external threats and vulnerabilities which can lead to financial losses. Thus, it is instrumental that supply chains are resilient so that an organisation's vulnerability to risks is minimised. According to Scholten *et al.* (2014), apparent from traditional risk management strategies like risk assessment and continuity planning, resilience is another approach which can be adopted as "supply chain resilience can deal with unforeseeable disruptions and events". This supply chain resilience framework is then operationalised and applied to disaster management processes as the latter is often unstable with disruptions in material, product and information flow. Furthermore, disasters will have negative impacts on businesses and their resources if not managed properly.

There are four elements of supply chain resilience, namely supply chain re-engineering, collaboration, agility and risk awareness/ knowledge management. Scholten *et al.* (2014) showed how these elements are relevant and evident in humanitarian supply chains. For instance, numerous stakeholders are involved in a single humanitarian supply chain and it is improbable a single player can manage processes efficiently and effectively. Thus, this highlights the importance of collaboration and cooperation amongst the various stakeholders in humanitarian supply chains to ensure effective risk management and achieve a successful relief operation when disasters occur. The fact that disaster management processes have very short lead times (or in fact almost zero lead time) also exemplifies the importance of agile processes.

In addition, Scholten *et al.* (2014) identified critical capabilities that are needed to develop supply chain resilience in each phase of the DMC and they developed a framework to illustrate this. The framework is shown in Figure 5.

Phase/ Process (2nd Order Categories)		Supply Chain Resilience Capabilities (2nd Order Categories)				
		Horizontal & Vertical Collaboration	*Supply Chain (Re-) engineering*	*Agility*	*Risk Awareness*	*Knowledge Management*
Mitigation	Establish a cross-functional planning team	√	√		√	√
	Analyse supply chain capabilities and hazards	√			√	√
	Develop and communicate plan for preparedness, response and recovery	√	√		√	√
	Agree measurements and metrics for preparedness, response and recovery	√	√		√	√
	Develop continuous improvement and supply chain risk mitigation plans	√	(√)		√	√
Preparedness	Implement preparedness plan: Translate strategic agreements into operational matters	√	(√)	(√)		√
	Evaluate based on measurements and metrics	√		(√)		√
	Establish routines through training and simulation	√	√	(√)		√
Response	Implement response plan, measurements and metrics	√	(√)	√		√
	Evaluate direction and control	√		(√)		(√)
	Evaluate communications throughout the supply chain	√		(√)		(√)
	Evaluate supply chain disruption outreach	√	(√)	√		(√)
Recovery	Review and implement recovery plans	√	(√)			√
	Ensure continuity of risk and resilience management	√			√	
	Maintain employee support	√			√	
	Resume operations	√		(√)		√

(√) = possibly required
√ = required

Figure 5: Framework for Building Supply Chain Resilience (Scholten *et al.*, 2014)

The study also used Hurricane Katrina as a case study to prove the importance of building supply chain resilience. In the case study, it was found that disaster plans were still at the developing stage when the hurricane hit and no agency was found to be responsible for any hurricane protection in New Orleans (Scholten *et al.*, 2014). There was evidently a lack of supply chain resilience built in the mitigation phase and this impacted other phases when disaster struck.

Summary

To sum up, the literature sources reviewed suggested that there has to be risk management in every phase of the DMC in order to maximise efficiency of work teams and reduce time and wastage of resources. Additionally, collaboration and cooperation amongst stakeholders in the DMC is crucial to ensure effective risk management.

However, there are some missing gaps in the literature sources that this project will aim to address. Firstly, Viagi *et al.* (2016) explained the importance of managing risks in humanitarian supply chains and therefore justifies the need for risks in the DMC to be managed. However, the literature does not explore how the risks in the DMC can be managed, which will be addressed in this project. Next, while Jahre (2017) showed how SCRM strategies used in commercial business supply chains can be adapted to the humanitarian context, it does not show how a specific strategy can help to manage a certain risk, be it micro or macro risk. In addition, Scholten *et al.* (2014) identified the respective strategic capability which

can help individual processes in each phase of the DMC, but it did not explain much in detail. Lastly, while Zhang *et al.* (2006) provided countermeasures based on the pre-disaster and post-disaster stages, the strategies recommended were not in relation to any specific risk. Instead, they were proposed based on the general idea of natural disaster risk management. Hence, this project will seek to address these gaps, where specific risk management strategies will be identified to manage risks in the respective phases of the DMC.

Methodology

The two main research designs in research are quantitative research design and qualitative research design. This section presents the study methodology to achieve the research objectives of this study.

Research Design

The project will adopt elements of quantitative and qualitative research designs with the use of web-based questionnaires. Web-based questionnaire is a convenient way of collecting and gathering the necessary data relevant to the project. It allows respondents to complete the questionnaire at their own pace and they may give more accurate answers as well.

The questionnaire will consist of both close-ended and open-ended questions. Respondents will provide their inputs by checking the appropriate boxes in the closed-ended questions and answer the open-ended ones in their own words. This questionnaire will target the key players and stakeholders in the humanitarian supply chain. They include non-governmental organisations (NGOs), government, military, logistics companies, among others.

Data Collection

Both primary and secondary data will be collected for this study. Primary data will come in the form of web-based questionnaires.

The questionnaire will seek to collect both quantitative and qualitative data to provide valuable insights and recommendations for this project. The questionnaire will attempt to obtain the following information:

a) Respondent's role in the DMC (i.e. government, NGO, military, etc)
b) Respondent's participant in the DMC (i.e. preparedness phase, mitigation phase, response phase and/or recovery phase)
c) Risks faced in the respective phases of the DMC
d) Ranking of each risk on the Likert scale of 1-7 based on likelihood and consequence
e) Possible ways to manage these risks

Next, secondary data will consist of archival reports and publications on humanitarian supply chains as well as notable case studies. When necessary, data from trusted sources such as the United Nations Statistics and United Nations World Food Programme will also be used.

Proposed Analysis

Data collected from the web-based questionnaires have to be processed and transformed into useful information for the study. This section will explain how data will be analysed.

Data from Questionnaire

Qualitative and quantitative data collected from the questionnaire will be examined. Where appropriate and relevant, data will be analysed using graphical techniques. Graphical outputs such as pie charts or bar charts will be generated using Microsoft Excel to present the data.

However, it may not be appropriate for all qualitative data to be presented visually. Thus, data may then be categorised and grouped accordingly to facilitate analysis at the later stage. Additionally, data collected from questions based on the Likert scale can be presented using measures of central tendency, such as mean and mode.

Process Mapping

Process mapping is the use of a process flow diagram to show the product and information flow in a supply chain. By mapping these processes, it allows the user to better understand how the system works. As an introductory, the same technique is used to uncover the flow of a humanitarian supply chain.

Figure 6 shows the flow of a typical humanitarian supply chain, adapted from Chandraprakaikul (2010) and Viagi *et al.* (2016). It must be noted that though it is a process map, the flows and processes between each stakeholder in the supply chain are dynamic and recursive. There is also no single flow that fits all operations. Ultimately, the supply chain flow of a humanitarian relief operation is dependent on the context, such as the country where the humanitarian operation is taking place as well as the conditions and constraints at the time of operation.

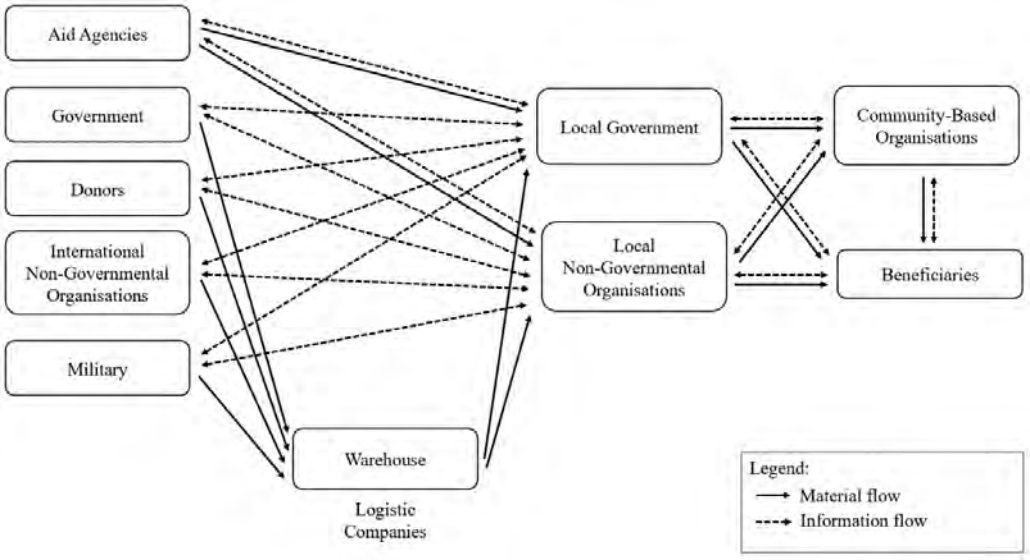

Figure 6: Humanitarian Supply Chain Flow (Chandraprakaikul, 2010; Viagi *et al.*, 2016)

Impact Analysis

A risk impact analysis is the process of analysing the likelihood and consequences of risk events if they are realised, and results of the analysis are typically used to establish importance ranking. An impact analysis is needed and relevant to the DMC as well.

According to Samvedi *et al.* (2013), one important element of risk management is identifying and assessing the risk. After identifying the risks in the respective phases of the DMC, the risks have to be evaluated. A risk score matrix will be used to quantify the identified risks. Thereafter, the risk will be assessed and grouped into different zones based on the likelihood of occurrence of the risk (i.e. frequency) as well as the consequence of the risk (i.e. severity). This will be done for each phase of the DMC.

By conducting a risk analysis, it allows one to assess the identified risks and better understand the frequency and severity of a particular risk. Additionally, the matrix enables stakeholders to prioritise the risks as it aids in spotting the urgency and importance of the various risks (Abdel-Basset *et al.*, 2019). This is particularly important in the humanitarian context. The resources available in each country is finite and there must be an appropriate allocation of resources to manage these risks. Hence, the matrix will also enable the prioritisation of the various risks identified and aid in the resource allocation.

Preliminary Findings

This project is currently underway as we are still working on this project and are in the midst of data collection. Nonetheless, we have made some preliminary findings with regards to Research Questions 1 and 2.

Research Question 1

We have based the risk categorisation on Jahre (2017), a recent paper written in the humanitarian supply chain risk management context. There are five types of risks involved in the DMC. They are demand risk, supply risk, manufacture risk, infrastructure risk and disruption risk. Demand risk is the risk associated with disruptions arising from demand volatility; supply risk is the risk associated with disruptions arising from obstruction of product flow; manufacture risk is the risk associated with the disturbance of internal operations; infrastructure risk is the risk associated with infrastructure facilities, while disruption risk is the risk associated with man-made or natural disasters. As mentioned earlier, humanitarian organisations do face both micro and macro risks, which encompasses the five types of risks. However, the extent to which an organisation faces a particular risk depends on the its participation in the DMC (response phase, recovery phase, mitigation phase and preparedness phase).

Research Question 2

We found that several SCRM strategies from Jahre (2017) could be adapted in the humanitarian context to manage risks in the DMC. Some supply chain resilience capabilities identified in Scholten et al. (2014) could also be adopted to manage the risks in the DMC. These strategies are as follows:

- Having a mobile logistics hub (assuming the chosen location is safe and accessible)
- Having a centralised propositioned stock
- Having a joint or bulk procurement system
- Having a flexible supply base
- Logistics outsourcing – use of a third-party logistics provider
- Horizontal collaboration and coordination amongst players involved in the same phase of the DMC
- Vertical collaboration and coordination amongst players involved in the different phases of the DMC
- Preposition vehicles and having a fleet management program
- Having flexible transportation with an operational mix of vehicles and transport mode, depending on location and accessibility of disaster site
- Risk awareness

One finding from the data collection thus far is that for a particular risk, different strategies may be used to manage that risk as it depends on the nature of phase where the risk occurs. Nevertheless, it is agreed that collaboration and coordination amongst players, be it horizontal collaboration and coordination amongst players in the same phase of the DMC or vertical collaboration and coordination amongst players involved in the different phases of the DMC, is required to manage risks in the four phases of the DMC.

Conclusion

In summary, given that there are adverse consequences of risks when they are not managed well, it is vital that humanitarian organisations, regardless of their participation and role in the DMC, take steps to manage these risks. Moreover, a study conducted by the United Nations Development Programme in 2012 stated that "every dollar spent reducing people's vulnerability to disasters saves around seven dollars in economic losses" (United Nations Development Programme, 2012, p. 1). Thus, while there may be short-term financial outflows to manage risks in the DMC, it is still crucial that such steps are taken to minimise further outflows in the long term.

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IMPROVING LOGISTICS SERVICE QUALITY IN THAI RETAILING

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Introduction

It is well-established that logistics and supply chain management (SCM) activities provide time and place utility for customers. Meeting and satisfying customer requirements are critical performance outputs related to logistics and SCM activities and as a result logistics and SCM performance measurements (PMs) have emerged as major factors enabling firms to obtain a competitive advantage through increased organisational effectiveness, better realisation of organisational goals (such as enhanced competitiveness, better customer care and profitability) through the delivery of superior customer value (Grant, 2012).

This notion is particularly important in the retail sector where the consumer is the end customer who will use or consume the product or service offered. As a result, the consumer is also involved in some retail logistical and supply chain activities and hence should form part of the retail PM process. That involvement is undergoing rapid change with increased online retailing, which itself has different elements of PMs. The provision of appropriate PMs in a consumer setting can be linked to consumer service quality research in the marketing, but which has also been take up by many researchers in the logistics and SCM domains, including this paper's authors, as logistics service quality (LSQ). Popular manifestations of LSQ performance measures include on-shelf availability in traditional retail and order fulfilment in online retail.

This topic has been discussed over the years (e.g. Editorial, 1994 and Grant, 2004a) but in many cases LSQ remains far from perfect both in traditional (Grant and Fernie, 2019) and online retail (Grant et al., 2017a). Further, while much of this research has focussed on western developed economies little research has been undertaken on these concepts in eastern developing economies such as Thailand. It is thus not well-known what the state of the art and improvement opportunities are for LSQ and PM in Thai retailing. This paper discusses a new research project to investigate and improve LSQ and PMs in Thai retailing and answers a call for more research in this country and the entire Asian region (Chen, 2015). It first synthesises the background to these concepts, then outlines emerging research objectives for a planned course of empirical research to address them.

Background

Changes in Retail since the 1980s

Retail stores are the final logistical link to consumers in 'bricks & mortar' (B&M) retail supply chains. The retail sector has been transformed over the last four decades and two good examples are the UK and Thailand. In the UK grocery retailers such as Tesco and Sainsbury's led this transformation by integrating primary and secondary distribution through centralisation processes to reduce lead times and inventory. Non-grocery retailers in clothing and electronics followed driven by importing container loads of products as a result of the outsourcing phenomenon where developing nations in Asia, especially Thailand, become producers for the world (Grant, 2014). In Thailand the retail chain has been characterised by an evolution of bargaining power from wholesalers after World War II through producers and suppliers and retailers to world-class, international retailers today such as Big C (Casino), 7-eleven, Carrefour and Tesco Lotus. The emergence of these international retailers consolidated strengths of modern trade in the retail supply chain as these European retailers transposed their standard operating procedures and logistics performance requirements on it. Thai traditional retail chains still exist but their importance has diminished considerably with consumers preferring to buy from the international retailers (Tosomboon, 2000).

The PMs of goods on-shelf, i.e. in-store availability, directly relates to enhanced consumer accessibility, increased store and brand loyalty, and product extensions evidenced by some grocery retailers providing banking and mobile phone services under their corporate brand umbrellas Availability is thus important to provide consumer satisfaction and ongoing, loyal relationships (Grant, 2014). However, consumers have also increased expectations about where and when they can find products,

which in turn drove the development of different PMs for upstream retail operations to ensure stock-outs were minimised (Grant, 2012).

The introduction of online retailing over the last two decades has challenged traditional retail supply chains and distribution systems in the west and is seriously disrupting the traditional business models of the modern international trade retailers in Thailand. Traditional retailing activities are based on the concept of 'bricks & mortar' (B&M) single-channel distribution systems. However, alternative channels for retail sales were introduced with the rise of online shopping and retailers are differentiating themselves depending on their adopted approach to retail logistics such as 'pure players', i.e. retailers that do not have an up-front store presence and only sell products via the internet (Grant et al., 2017b). More recently, retailers are moving towards a concept of 'omnichannel' distribution to satisfy the growing needs of diversified shopping preferences and seamless customer experience. Omnichannel distribution integrates marketing and operational activities across channels with merged frontend and backend systems (ibid.). Consumers now appear to be taking control over the retail chain and are now the members with the most bargaining power in both the west and Thailand, demanding free delivery and returns and convenience for delivery or pick-up. Thus, retail supply chains must now meet consumer expectations and requirements instead of the retailers themselves.

The manifestation of good logistics service quality (LSQ) is therefore either through good product availability in-store or online fulfilment. Both these outcomes are important to provide consumer service and satisfaction and help develop ongoing and loyal relationships as part of a total customer service experience for consumers (Fernie and Grant, 2019).

In-store Retailing

Physical retail stores are the final B&M logistical link to consumers in retail supply chains and retailers tend to focus on logistics and SCM activities that bring products to store but pay less attention to in-store logistics processes (Grant and Fernie, 2019). Almost fifteen years ago Corsten and Gruen (2003) argued that in-store product availability was the new battleground in the fast-moving consumer goods industry sector. Availability for in-store processes involve not only physical on-shelf replenishment but also human resource (Trautrims et al., 2012) and managerial tasks such as ordering, shelf space planning and in-store consumer service (Kotzab and Teller, 2005).

Corsten and Gruen (2003) advocated an integrated approach based on process responsiveness, operation accuracy and incentive alignment to address causes of stock-outs. These PMs relate to assortment planning and space allocation; ordering systems, inventory control and store flow replenishment. Three suggestions for operational accuracy include inventory level accuracy, the ability to measure and identify on-shelf availability and incentive alignment to schedule staff for improved shelf filling. Efficient Consumer Response (ECR) UK and IGD (formerly the Institute of Grocery Distribution) are the outlets through which members in the UK grocery supply chains address availability/ stock-out problems. ECR Europe represents the EU and proposed seven 'levers' to improve availability. These include measurement levers which need managerial attention (levers 1 and 2); replenishment and in store execution, namely merchandising (levers 3 and 4); inventory accuracy (lever 5); promotional management and ordering systems (levels 6 and 7). These levers have subsequently formed the basis of the ECR UK/ IGD availability agenda (Fernie and Grant, 2008).

Another issue relates to whether increasing availability and reducing stock-outs, increases profits or whether increases in other logistical costs related to increased stockholding and transport negates them. Trautrims et al. (2009) investigated category performance factors regarding availability, profitability, and consumer propensity towards substitution and loyalty in conjunction with a major UK retailer and one of its major soft drink suppliers. They found that retailer decisions to increase availability are influenced by product category, stock keeping unit and store and consumer behaviour.

The same situations exist in the non-grocery retail sector with fashion clothing being one of the worst examples. The UK's House of Fraser, who went into administration in 2018, experienced poor availability due to inefficient location of products in crowded stock rooms and staff time taken to get products ready for sale in-store. Reprocessing or 'repro' stock, merchandise left in other in-store locations such as in changing rooms or on other displays, exacerbates in-store replenishment problems in fashion retail. All

these factors contributed to an overall availability level of 71% across House of Fraser's stores compared to availability levels in the mid-90% range for the grocery sector (Fernie and Grant, 2014).

It is clear from this stream of research that availability, as a component of customer service, underlies trade-offs between achievable additional sales from higher availability and relevant and applicable costs. The costs for improving availability depends on the methods used, but an increase in stock and attention to in-store availability on-shelf makes it extremely costly to obtain 100% availability. A consumer's reaction to a stock-out, where they face additional transaction, substitution and opportunity costs, strongly relates to product characteristics and the buying situation and will therefore be unique for every purchasing decision. However, the outcomes of greater product availability and less stock-outs include better consumer service and satisfaction and improved logistical productivity that should increase revenue and reduce costs (Grant and Fernie, 2019).

Online Retailing

Consumers' ability to purchase online using a variety of devices such as smartphones, tablets and remote kiosks has fundamentally changed retail shopping in the last decade. Initial LSQ considerations were built on the physical distribution service quality (PDSQ) construct in B&M retail settings and PMs were defined according to dimensions of product availability, timeliness and quality of delivery, order status information and order condition (Grant, 2012). The literature has debated these traditional PDSQ elements, primarily related to business-to-business or B2B contexts, in light of online shopping and examined to what extent they can be translated ot adopted for assessing LSQ in a business-to-consumer or B2C online shopping environment. Similarly, online retailers focus on product availability in their fulfilment centre (FC) or warehouse and outsource final delivery to parcel carriers of logistics service providers (LSPs). Xing and Grant (2006) developed and later tested (Xing et al., 2010) an online service quality or fulfilment model from the consumer's perspective derived from the original service quality model of Parasuraman et al. (1985) discussed in the next section.

This e-PDSQ model found four important consumer criteria expectations of the online fulfilment experience: availability, timeliness, condition and return. Availability refers to inventory capability; i.e. having inventory readily sourced to fulfil consumer orders. Consumers will turn away if products they want are out-of-stock and another website selling similar products is only a click away. Alternative offerings for substitution may be useful to retain consumers if used properly. Further, availability also considers how a consumer can track and trace and order; this relates to a perceived control over delivery of their orders makes them more eager to know when to expect arrival of orders.

Timeliness measures order cycle performance which for a consumer is the time elapsed between placing and receiving an order including how many choices the consumer has over the fulfilment date and time window, how quickly the consumer receives the order and whether the retailer's actual performance matches its promise when the order is confirmed. Reliable, on time and quick delivery is of importance to consumers as they are more likely to return products that arrive late and this has an important bearing on repeat purchase and the profitability of the retailer. Offering consumers more choice while they are in the online buying process can be a critical part of the service experience as a retailer's ability to meet a consumer's schedule is often a key factor in making a sale.

Condition is the form and composition of the delivered order and is about the accuracy and quality of the order. Damaged or faulty products will result in returned or even cancelled orders. The condition of products directly affects consumers' perception of online LSQ. Finally, return is about how many consumer channel options there are to return products, how promptly online retailers collect or replace products and how the retailer deals with damaged, unwanted or faulty products. Return requires processes available to handle products from the point of receipt or consumption to the retailer or supplier for possible repair, resale, recycling, etc. The first two criteria are visible to a consumer through the ordering platform however the last two criteria are below a consumer's line of visibility and are the responsibility of the retailer and/or LSP providing fulfilment. The nature of these four criteria suggest that a consumer's online purchasing behaviour tends to be more like a business-to-business logistics buyer instead of exhibiting usual hedonistic consumer behaviour patterns.

The e-PDSQ concept needs to be complemented by considerations of wider service quality elements related to the online shopping experience. For example, do websites facilitate efficient and effective

shopping, purchasing, and delivery of products and services? These are the critical elements affecting customers' perception of service quality and satisfaction (Xing et al., 2010). Nevertheless, previous research also lacks consensus on order fulfilment and logistics customer service factors especially in the context of omnichannel distribution with integrated supply chain and distribution operations across all channels (Murfield et al., 2017).

Many retailers and LSPs offering grocery delivery fulfilment use a rigid methodology based on fixed delivery schedules and delivery time windows with few scheduling choices provided during final online checkout, which is based on a static model using a set of assumptions about what demand might be for a given territory (Xing et al., 2011). Hence, 'online shopping cart abandonment' occurs frequently at the checkout payment point when consumers realize they are not going to get the product when they want it. Online shopping for non-grocery products requires less logistical effort. Catalogue mail order retailers have had long experience of delivering a broad range of merchandise to home.

Consumers in the Retail Supply Chain

Customer service is a crucial business element for any firm who can use it to differentiate itself from its rivals feature and obtain a competitive advantage and enhance profitability. Customer profitability has been shown to increase over time due to increased customer purchases and reduced costs from economies of service to them. Also, a reduction in customer defections by 5% may increase a firm's profits anywhere from 25% to 85% over their tenure with them (Grant, 2012). Grant (2004b) found that elements of logistics customer service fall into one of three categories: pre-order or pre-transaction, order service and quality or transaction, and post-transaction, which has two distinct element groupings of relationship service and relationship quality. Logistics and SCM activities do not include any form of tangible 'product' and hence may be considered services as they exhibit fundamental characteristics of services such as intangibility, inconsistency, an inability to 'inventory' a service, and inseparability between service production and consumption.

Satisfied customers represent the outcome of a firm's successful customer service policy. Satisfaction is a customer's fulfilment response to an order or transaction and is based on a judgment that a product or service feature, or the product or service itself, has provided or is providing a pleasurable level of consumption-related fulfilment, including levels of under- or over-fulfilment (Oliver, 1997). The dominant paradigm in satisfaction theory is the expectancy-disconfirmation paradigm that has its roots in social and applied psychology and is the basis of the seminal service quality (SQ) model developed by Parasuraman et al. (1985) based on the consumer's perspective.

This paradigm contains two fundamental constructs: a preliminary expectation of a product or service's performance and a perceived comparison of that performance afterwards that yields a perceived confirmation or a perceived positive or negative 'disconfirmation' of expectations. Positive perceptions over time will lead to customers developing long-term relationships with retailers and their LSPs. However, consumers nowadays can make purchases online using a variety of devices such as smartphones, tablets and remote kiosks, which has fundamentally changed retail shopping and driven almost unrealistic expectations for instantaneous fulfilment. Such changes in expectations can impact selection of appropriate PMs. Various solutions have been posited for attended or unattended deliveries to home, collection boxes or pick-up points (representing omnichannel fulfilment options) that all have their own unique and distinct PMs (Fernie and Grant, 2019).

Customers will accept some variation in SQ due to external environmental conditions and will then moderate their short-term expectations in line with this situation. Long-term expectations may also be modified depending on the cause *which leads to customers having a 'zone of tolerance' between what SQ level they expect and what is adequate or feasible given these external environmental conditions. However, customers will not tolerate service failure.*

There are five reactions to in-store service failure (Corsten and Gruen, 2003). *Consumers will* buy at another store (store switching), delay ordering or purchasing at the same store (postpone), not purchase at all (lost sale), substitute the same brand (different size or type) or substitute for another brand (brand switching). Percentages related to these reactions have not significantly changed in fifty years, around 65% of consumers adopt one of the first three reactions, thus not buying in that store on that occasion if

a stock-out occurs (Grant, 2012). The opportunity costs of a stockout have been estimated to be a 17% decrease in profit compared to profit with no stockout (Anderson et al., 2006).

In online retailing, *where there is a sense of immediacy,* failures are due to delivery, website design, customer service (which includes recovery), payment, security, and other issues such as inadvertent customer error or lack of personalised information at the website. About 55% of consumers who encounter an online failure choose to complain and only 43% are satisfied with a retailer's recovery efforts. More importantly, 65% of consumers will change their future behaviour with 37% never purchasing again from a website (Grant et al, 2017a). Over 31% of all online delivery and service appointments fail and the main factor is a lack of notification or communication of arrival times, which is a key tenet in Xing and Grant's (2006) e-PDSQ model. This suggests consumers perceive online recovery strategies and processes to be inadequate or inequitable relative to any failures experienced and provide evidence that e-commerce service providers are not adequately learning from or recovering from service failures. The actual costs of online failure are difficult to determine but were estimated to cost retailers, LSPs and consumers a collective £1.6 billion a year in the UK related to customer service, consumer's time, fulfilment, and of making a redelivery (Grant et al., 2017a).

Retail and Logistics in Thailand

As noted above, research about these issues is sparse in Asia generally and Thailand particularly. However, some research has investigated food retailing and logistics in several Southeast Asian countries (Stephens et al., 2016), SME e-commerce in Malaysia (Saputra et al., 2018); PMs (Banomyong and Supatn, 2011), retailer-supplier relationships (Banomyong and Salam, 2002; Salam and Banomyong, 2003), and customer service and experience (Tivasuradei and Pham, 2019) in Thailand; and LSQ (Grant et al., 2017c) and grocery retail strategies (Nguyen et al., 2018) in Vietnam.

Euromonitor International (2019) noted that Thailand's economy continued to show gains in 2018, with improved consumer confidence, an increase in disposable income and low unemployment which supports growth in retailing despite many consumers remaining cautious about non-essential spending. Retail sales were US $164 billion by Thailand's 70 million population. It was also noted that internet retailing continued to see dynamic growth in 2017-2018 as Thai consumers were using the internet for more than 10 hours a day on average and were spending around half this time shopping online; online sales were over US $2.7 billion or almost 2% of total sales. As a result, internet retailing is projected to have a strong influence in the retail sector which could result in slightly slower growth in the number of store outlets, although many retailers want to expand into less saturated, secondary areas to benefit from demand. As Thai disposable incomes increase and consumers become more demanding, retailers are having to find new ways to remain relevant. For example, Central Group invested THB 350 million in revamping and rebranding its department stores to keep shoppers in its stores for longer, i.e. the concept of experiential or entertainment retail. There have also been changes in Thai internet retailing; Shopee Mall launched in 2017 and rose to second place behind Lazada in rankings by the end of 2018.

These trends impact logistical and supply chain systems as well. Most of Thailand's retail space is in the Bangkok Metropolitan Region (BMR) and total supply is around 5 million sq. m., most of which is in shopping malls, with over 44% of this space in the suburbs shown in Figure 1 as land is less expensive and investment increases in mass transit have made travelling more convenient (Krungsri Bank, 2019a). Further, regulations have restricted developers from building new shopping malls in central Bangkok and instead they renovated existing malls to become more modern and incorporate luxury shops such as the 0.232 million sq. m. EmQuartier mall owned by The Mall Group, who are in second place of retail supply ownership (8%) to Central Group (18%). Warehouse space in Thailand comprises a little over 6 million sq. m., of which 77% is general purpose operated by about 700 firms. Most of these are in the Eastern Economic Corridor (EEC) which includes Samutprakan, Chonburi and Chachoengsao. The remaining 23% is comprised of chilled and frozen storage for retail and seafood export (about 180 firms) and grain silos for cereal crops and grain (about 30 firms). Occupancy of general warehousing is about 84% with flat demand despite increased demand for traditional and internet retail (Krungsri Bank, 2019b). Most retail warehousing is north of Bangkok around Ayutthaya. Finally, road freight comprises 81% of Thailand's commercial transport with annual expenditures of about THB 750 billion (Krungsri Bank, 2019b).

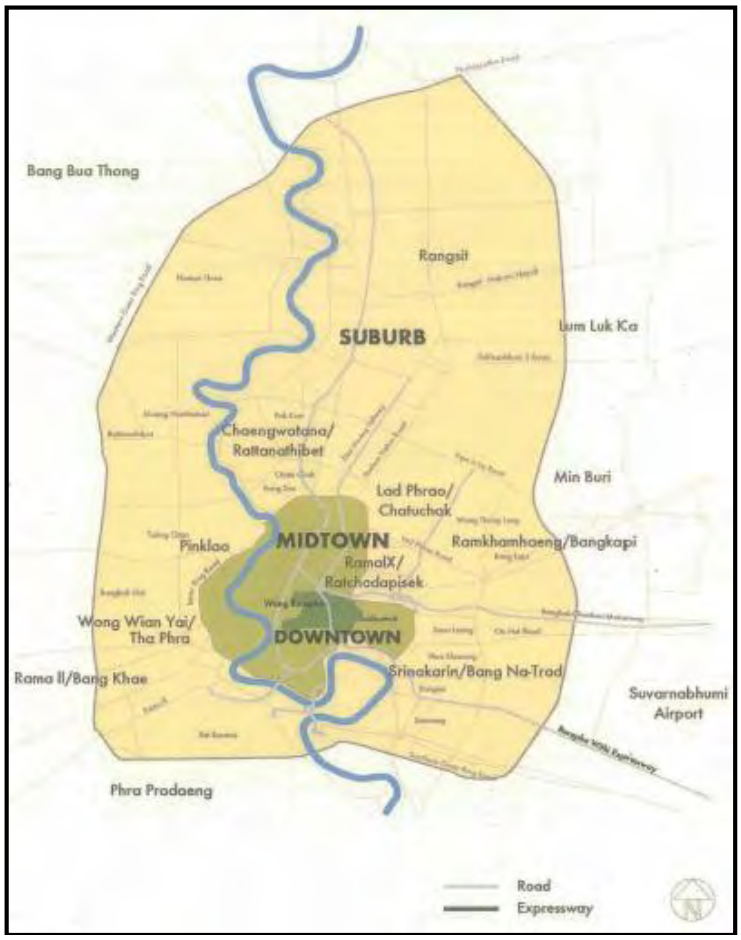

Figure 1: Bangkok Retail Map (Source: Krungsri Bank, 2019a)

Research Objectives and Planned Empirical Research

The following research objectives have emerged from foregoing and will inform the future empirical research in this project:

Retailers

1. What is the current state of LSQ practices and PMs in the Thai retail sector from their perspective; i.e. what are the key strengths, weaknesses and challenges for the sector both in-store and online?
2. How will they adapt their LSQ practices and PMs to meet these issues and do any of them have any specific action plans for 2020 onwards?
3. What do they perceive are their customers' expectations of retail LSQ both in-store and online now and going forward?
4. How do they currently meet these expectations both in-store and online and how will they adapt going forward to ensure they continue to meet them?

Consumers

1. What is the current state of LSQ practices and PMs in the Thai retail sector from their perspective; i.e. what are the key strengths, weaknesses and challenges for the sector both in-store and online?
2. How do consumers believe retailers can adapt their LSQ practices and PMs to meet these issues?
3. What are consumers' expectations for retail LSQ both in-store and online now and going forward?

4. How do they perceive retailers are currently meeting these expectations both in-store and online and how do they perceive retailers will adapt going forward to ensure these expectations continue to be met?

LSPs

1. What is the current state of LSP LSQ practices and PMs in the Thai retail sector from the perspective of retailers, consumers and LSPs; i.e. what are the key strengths, weaknesses and challenges for the sector both in-store and online?
2. What do LSPs perceive are retailers and customers' expectations of LSP LSQ practices and PMs both in-store and online now and going forward?
3. How do retailers and consumers perceive LSPs are currently meeting their expectations both in-store and online and how do they perceive LSPs will adapt going forward to ensure these expectations continue to be met?
4. How do LSPs perceive they are currently meeting retailer and consumer expectations both in-store and online and how do they perceive LSPs will they adapt going forward to ensure these expectations continue to be met?

The empirical research planned will utilise a mixed-method approach comprised of exploratory, qualitative research interviews to explain the theoretical concepts and generate constructs in the context of Thailand, and quantitative research surveys to test such concepts and constructs and provide generalisable findings.

Conclusions

This paper has discussed the rationale behind a new research project to investigate and improve LSQ and PMs in Thai retailing. It first synthesised the background to these concepts and then outlined emerging research objectives to pursue the above planned course of research to address them. This paper is conceptual and thus a limitation is a lack of empirical study at this project outset stage.

Acknowledgements

The authors would like to acknowledge and thank the Bangkok Bank and Thammasat University in Bangkok, Thailand for awarding funding to support this research project through a 2019 Bualuang ASEAN Chair Professorship.

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INVENTORY MANAGEMENT SYSTEM FOR A HIGH MIX, LOW VOLUME MANUFACTURING ENVIRONMENT

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Introduction

In today's dynamic market conditions, manufacturers are expected to become more flexible and responsive in meeting demand for customised product specifications and quality requirements (Manyika, 2012). Product mix is becoming more complex and diverse, driving more companies to operate in a high-mix low-volume (HMLV) manufacturing environment. To meet targeted service levels and buffer against uncertainties, manufacturers may commit too much financial resources into holding excess inventory.

At the same time, more competency is also required in planning for inventory that is used in an uncertain manufacturing environment, where demand and supply are becoming less predictable. This may result in companies not being able to stock up on materials in time due to uncertain demand and unforeseen long lead times.

As depicted graphically in Figure 1, the problem in this context is that stock-outs and excess inventory can both happen concurrently. Hence, the challenge is in ensuring that the right quantities and right types of inventory can be made available at the right time to fulfil customer's demand promptly.

Figure 1: Excess inventory and stock-outs can happen concurrently

Our client's company is a provider of defence communication solutions that are fully optimized for individual customers. It offers a wide range of services, where it not only designs its own products, but also manufactures build-to-print microwave modules and components that are used in dedicated special areas such as intelligence, defence and satellite systems. Thus, the environment it operates in is HMLV in nature, where the products assembled may vary in lot sizes, production processes and applications. It can transform assembly lines and change product requirements in a matter of hours, causing its planners to face numerous challenges when planning for the facility's inventory.

The company utilises the build-to-order approach, which is essentially a pull system, where it will only purchase inventory for confirmed orders. Once confirmed orders are received, planners will analyse the Bill of Materials (BOM) and execute Materials Requirements Planning (MRP). Inventory will then be purchased at very high levels that can fulfil all the orders received, even if the total number of units in an order are scheduled for staggered deliveries over a few years. Hence, there is no reorder point set because they are deemed unnecessary since all the inventory required to build an order is purchased all at once. Reorders will only be made if inventory level becomes insufficient in fulfilling scheduled orders. There is also no consistent approach used in determining the quantity to order.

The original inventory management practices had been effective during the initial years of setting up the manufacturing business because it was easier to manage the inventory of fewer products. However, a more robust inventory management system is due because the number of products and the value of its inventory have increased substantially over the past few years. The original practices were observed to expose the company to many problems that led to delayed deliveries. Furthermore, the management of the company has put in place strategic plans to expand the manufacturing business for the next decade. It is, therefore, important to ensure continued operating profits by improving the current inventory management practices.

Research Methodology

Four research objectives corresponding to the four research questions were then developed:

- Identify the costs associated with managing inventory.
- Apply inventory classification tools to improve application of inventory models.
- Develop an optimal inventory management system to reduce inventory costs and improve customer service levels.
- Evaluate at least two similar inventory management policies and compare its costs as an objective appraisal.

Utilising the literature scan, our approach is to utilise Six-Sigma (DMAIC) methodology and tools to analyse the data collected and provide initiatives to improve customer satisfaction level for XYZ Singapore Service Centre.

Primary data is important because they are first-hand data that are gathered for the specific research problem at hand, using procedures that apply to the research problem best (Hox & Boeije, 2005). To facilitate this study, the necessary primary data will be obtained through personal field observations, surveys, interviews and discussions with staff of the company. Table 1 describes the collected primary data, its method of collection and its purpose in this study.

Description of collected primary data	Method of collection	Purpose	Participants involved
Summary of problems stemming from lack of a good inventory system	Personal field observations, interview and discussion	To establish problem statements that gave rise to research objectives and thus, the beginning of this study	3 planners, 2 senior managers
Monthly wages of staff who facilitated the flow of materials from order processing to storage and the time they spent on this process	Surveys	To determine the costs of placing a new order	3 purchasers, 3 store personnel, 7 incoming quality inspectors
Causes that led to high costs of inventory	Brainstorming session (discussion)	To break down high inventory cost into its major components and causes	3 planners
Material attrition rate	Survey	Incorporated into classification model to improve its applicability	3 engineers that operate surface mount technology (SMT) machines

Table 1: Description of collected primary data, its method of collection and its purpose in the study

In-house secondary data sources could provide these includes the following data:

- Description and type of SKU

- Unit price
- Lead time in days

These data will be used in the calculation of holding costs, and in models such as ABC analysis, economic order quantity and reorder point that will be proposed as solutions to reduce inventory costs.

Results

Costs associated with managing inventory

After conducting the brainstorming session, all sub-causes were categorised into four major cost factors. They are presented in the Fishbone diagram as seen in Figure 2. It is hereby established that overstocking, shortage, reordering and storage costs are the four major costs associated with managing inventory in the company. Through this analysis, it is also understood there is a need to reduce the four major contributing cost factors by developing an optimal inventory management system.

ABC/Pareto Analysis

After conducting the ABC analysis, the below findings were observed and plotted in Figure 3.

10% of the inventory items accounted for 80% of the total annual consumption value
20% of the inventory items accounted for 15% of the total annual consumption value
70% of the inventory items accounted for 5% of the total annual consumption value
The above findings indicated that every inventory item should not be controlled to the same extent because they are of different monetary value or importance to the company. Resources can be more efficiently utilized by focusing them on the top 10% (Class A) of the inventory items that are deemed to be the most valuable. Class B can be less tightly controlled as compared to Class A but should not be overlooked as they might potentially become Class A's SKUs. For the bottom 70% of items in Class C, they require less control and monitoring as compared to Class B and C. However, it does not mean that they are not essential to fulfilling customers' demand as any shortages can still cause a delay in completing production orders.

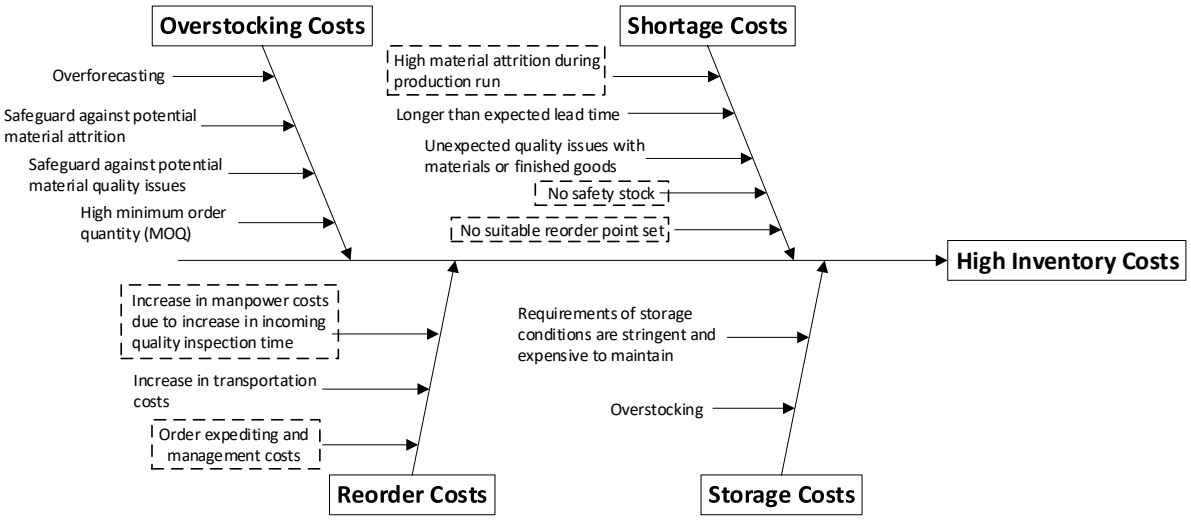

Figure 2: Fishbone diagram identifying all cost components of high inventory costs

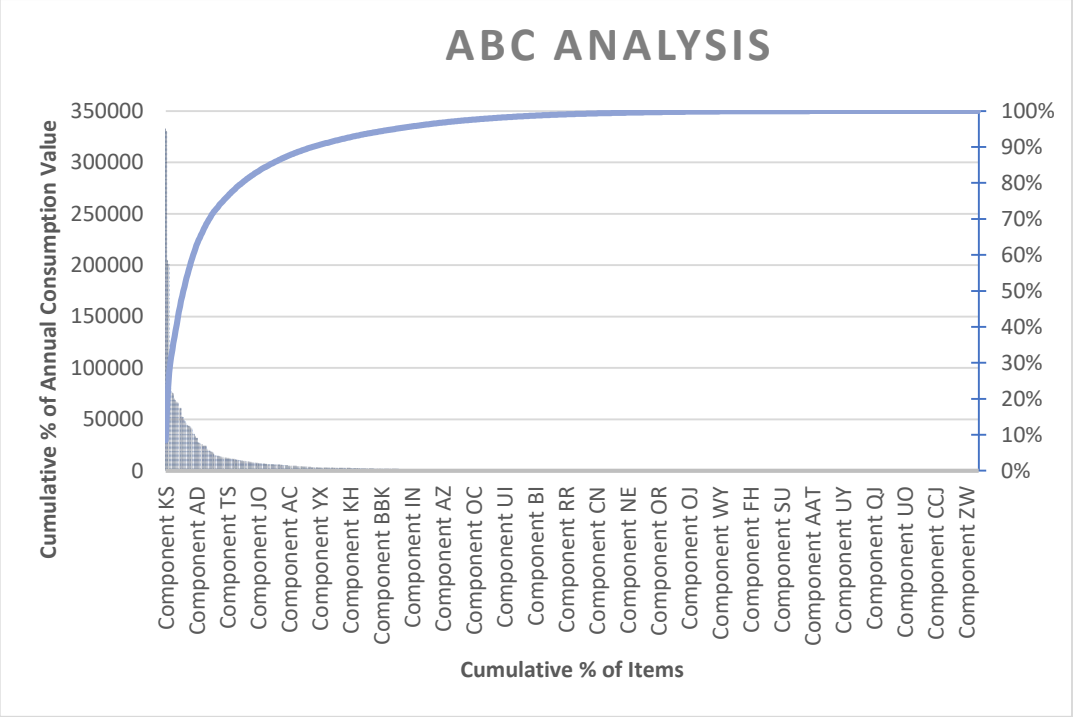

Figure 3: Results of the ABC analysis

HML Classification

After compiling the collected attrition data, it is presented in Figure 4, where the most commonly observed attrition rate is between 19% to 22%, with the lowest at 2% and the highest at 36%. We will later investigate if attrition rates, especially those that are the most common, has any relationship with consumption value.

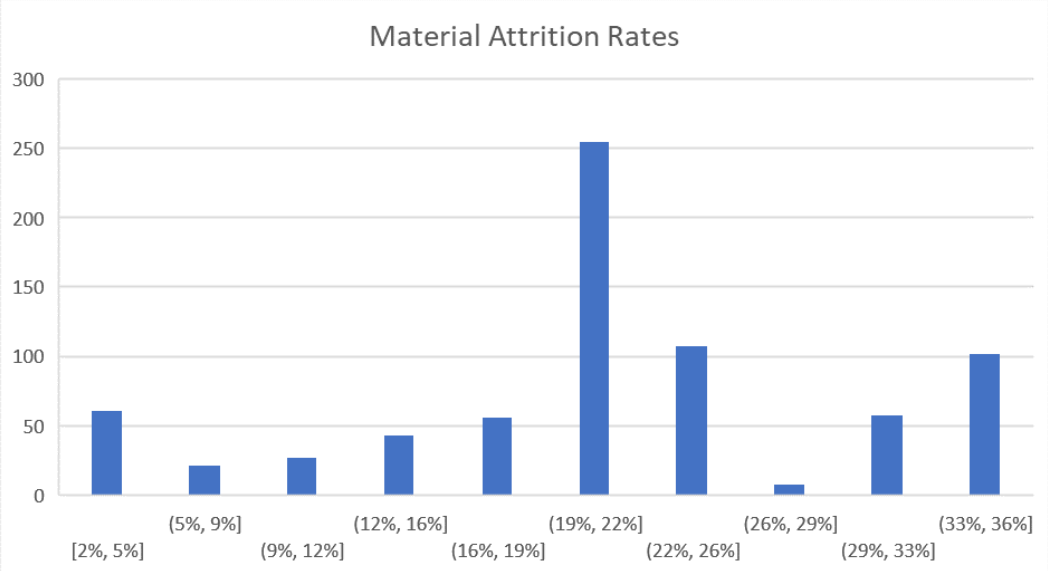

Figure 4: Material attrition rates of the company's inventory

Number	Category	Impact Counts	Percentage %	Average Score
1	Service TAT	73	33%	6
2	Service Quality	62	28%	6.5

3	Communication	44	20%	7
4	Price	14	6%	6
5	End of support	11	5%	3
6	Local capability	8	4%	5
7	Loaner Request	4	2%	4.5
8	On-site request	3	1%	6
9	Quotation format/Delay	3	1%	7
Total		**222**	**100%**	

Figure 4: Classification of customer's feedback

Differentiated by its attrition rate, all 740 SKUs are classified into three classes, High, Medium and Low as seen in Table 2.

Classes	Attrition Rate (%)	No. of Items
High	25% and above	221
Medium	10% to 24%	436
Low	9% and below	83

Table 2: Classification of inventory according to its attrition rates

The results from combining the ABC and HML classification technique to further classify the inventory items can be seen in Table 3.

ABC-HML Classes	Quantity
AH	0
AM	49
AL	23
BH	20
BM	94
BL	34
CH	201
CM	26
CL	293

Table 3: Number of inventory items belong to ABC-HML analysis

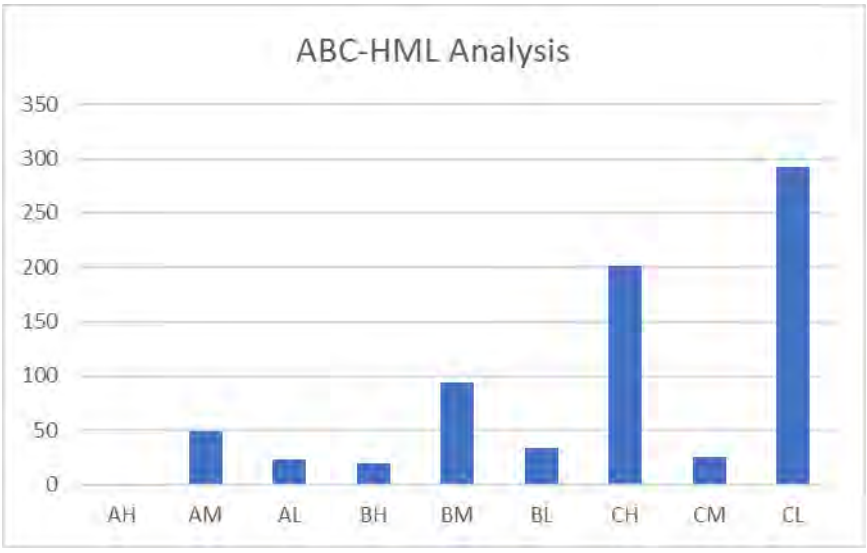

Figure 5: Histogram depicting number of items belong to the different classes in ABC-HML analysis

As observed, Class CL has the highest SKUs while Class AH has zero SKU. However, there is no direct relationship between total consumption value and attrition rate of a SKU. Items belonging to the Medium class, which is the most common, can be found in all three classes of the ABC analysis.

This further supports the point that a good classification tool should consist of non-monetary and monetary factors because the ABC analysis might not pick up attributes such as the SKU's attrition rate. The ABC analysis may be useful in planning for the allocation of resources, but it is not a good indicator for determining inventory policies such as reorder point and safety stock levels. To enhance its effectiveness, it should be used in conjunction with the HML classification tool, something that is relevant to the company in providing for an appropriate safety stock level because it accounts for the attrition rate. This ensured that the research objective of using inventory classification tools to improve application of inventory policies is achieved.

Economic Order Quantity (EOQ) versus Joint Order Quantity (JOQ)

Two models will be used to determine an order quantity for every SKU. Under both models, every order will incur both ordering and holding costs. These costs will be summed up and compared against. The model which has the lower total costs will be recommended as the more ideal inventory policy to determine order quantity.

In the joint order quantity model, the optimal number of orders will first be calculated, then worked backwards to calculate the optimal joint order quantity (Chopra & Meindl, 2013). It differs from the EOQ

model in that order costs previously determined are separated into a common order cost and a SKU-specific cost.

As mentioned, the order costs are determined through the wages of staff involved in managing an order by finding out the time they spent in each job task.

Applying the JOQ model, the optimal number of orders for the 12 joint ordering groups were calculated and shown in Table 4.

Groups	Number of Items	Optimal Number of Orders
1	45	5.6275
2	82	2.3932
3	227	1.0542
4	9	5.3127
5	157	3.6284
6	72	1.9935
7	37	2.4814
8	22	5.3261
9	35	3.4283
10	20	5.9796
11	22	10.6000
12	12	1.8902

Table 4: Optimal number of orders for each joint ordering group

After the total order and holding costs were calculated for each joint ordering group, we obtained the following:

Groups	Total Costs (JOQ)	Total Costs (EOQ)
1	$ 21,155.80	$ 25,680.85
2	$ 16,099.89	$ 26,050.64
3	$ 19,352.79	$ 35,926.13
4	$ 4,630.82	$ 4,394.95
5	$ 46,237.62	$ 59,524.31
6	$ 11,811.87	$ 16,286.28
7	$ 7,736.21	$ 10,334.43
8	$ 10,196.55	$ 13,877.35
9	$ 10,138.35	$ 12,360.10
10	$ 10,488.36	$ 12,195.57
11	$ 20,293.06	$ 17,149.13
12	$ 2,102.41	$ 2,880.90
	$ 180,243.74	**$ 236,660.64**

Table 5: Total order cost comparison between JOQ and EOQ

After applying the EOQ and JOQ models, we observed that the overall costs of using JOQ is significantly lower than using EOQ. The difference is $56,416.90, which is about 31% lower than using the EOQ model. This demonstrates that using the JOQ is a more effective inventory policy in determining order quantity because it reduces inventory costs significantly more in terms of order and holding costs.
Comparing the order costs of the two models against each other objectively and finding out that the JOQ is more effective in lowering costs answers the research questions of #3 and #4.

Reorder Point and Safety Stocks

The current inventory practices of the company do not include setting reorder points to determine when to purchase. A reorder point can be useful in reducing the rate of stockouts to improve service levels as mentioned in research question #3. A reorder point refers to a quantity that prompts a procurement or production of additional materials (Zipkin, 2000). To determine a reorder point, a statistical element that represents safety stocks and a computed average demand over the lead time will need to be calculated.

A reorder point that includes safety stock was set for every SKU. A sample of SKUs with the reorder point calculated is shown in Table 5:

SKU	Classes	Annual Demand	Average Daily Demand	Lead Time in Days	Safety Stock Levels	Reorder Point
Component GY	CM	7207	20	3	20%	1501
Component GZ	AL	788	2	42	10%	169
Component HC	CH	18750	51	3	30%	5779
Component MK	BM	1185	3	56	20%	419

Table 6: Sample showing the reorder point that was calculated for four items

A reorder point could reduce the risks of stockouts occurring and help in maintaining a consistent level of customer service.

Conclusion

The study has demonstrated that systematic approaches should be used in inventory planning because it can reduce costs and provide more certainty in an uncertain environment. The company is recommended to come up with a more comprehensive inventory management system to determine when and how much to order. It should also make use of inventory classification tools such as the ABC-HML analysis detailed in this study to classify its inventory. It is an easy way to suss out the characteristics of its inventory so that inventory policies can be tweaked to enhance its application.

In the context of the company, JOQ was determined to be a better inventory model than EOQ because it incurred lower overall costs. Hence, the company is recommended to use the JOQ model in determining its order quantities.

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MANAGING THE TANGIBLE AND INTANGIBLE DIMENSIONS OF CUSTOMER VALUE: A SURVEY STUDY

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Introduction

Creating customer value is in the heart of firms' competiveness. In today's markets, customer value is increasingly customer-centric process, and value is often co-created with the customer, providing firms with many opportunities as well as challenges in this process. Thus, the abilities to manage the process of customer value creation are increasingly relevant for contemporary firms.

However, we still now relatively little of the how firms' capabilities in customer value management contribute to different dimensions of customer value. It has been recognized that customer value is a phenomenon that involves both tangible as well as intangible aspects, such as economic and functional aspects, as well as emotional and symbolic aspects (Rintamäki et al., 2007). Furthermore, the marketing literature has long recognized that customer value is formed not only of the benefits, but also of the costs occurring to the customer from receiving an offering (e.g. Ravald & Grönroos, 1996). Managing customer value creation is thus a process of improving the customer benefits, while minimizing the costs of receiving those benefits.

Meanwhile, risk management literature has focused on the customer value process mainly from an analytical angle, where the focus has been analyzing the event and factors of uncertainty to the successful delivery of customer value (e.g. Vilko and Ritala, 2014). In today's highly networked and competitive business environment companies with structured approach to face risks tend to perform better. As organizations are increasingly extending their reach deeper into complex and dynamic service supply chains (Mena et al., 2012), they are expected to collectively manage the value provision. While the traditional risk management processed are used to identify the events and the direct impact and likelihood of those, typically those fail to take into account impact on customer value – especially the different dimensions of it. While the new technologies (such as additive manufacturing and block chains) are transforming the way supply chains produce value and the customer demands are getting higher companies need to pay more attention on the customer value management dynamics, where the nature of value is the essence (Vilko and Santonen, 2017). The holistic value management requires to take into account both the customer value benefits and costs where the systematic risk management process of identification, analysis and management can be utilized.

In the current study we integrate insights from the marketing and services literature regarding customer value creation with risk management literature regarding capabilities to manage this process. We develop a measure of customer value management (CVM) capability, that consists of dimensions of identification, analysis and management of various aspects of customer value creation. Using a survey study of 105 Finnish firms, we examine how this capability contributes to tangible and intangible customer benefits and costs. We find that the firms with high levels of CVM capabilities are able to increase the tangible customer benefits, as well as to reduce the intangible customer costs. On the other hand, there are less ability to improve intangible benefits, as well as to reduce tangible costs.

Our results contribute to the customer value creation by demonstrating the opportunities and challenges that firms face when they pursue to manage customer benefits and costs. The interesting contradiction is that firms can improve tangible benefits, but not reduce tangible costs as much. On the other hand, firms with high level of CVM capabilities can reduce intangible costs, but are not as adept in increasing intangible benefits. These results suggest that customer value is a multifaceted phenomenon, management of which requires extra attention and is contingent of firms' capabilities in identifying, analyzing and managing customer value.

Theoretical Background

In a value-perceiving situation, the customer is exposed to various physical, social, socially symbolic, and natural stimuli (Prahalad and Ramaswamy, 2000). This stimuli, can cause emotional responses in the customer which in turn may constitute a significant part of the overall value perception from the services. Although the value of services has been a popular topic in the scientific literature for several decades when considering the network perspective managing customer value requires a new way of thinking and new kind of approach (Sherer, 2005). All parts of the value network need to be linked to adaptability to customer value and individual portions of the value network must be measured in terms of their contribution to customer perceived value (Vilko et al. 2016). Actions should be, not merely a matter of fulfilling demand, but of responding to changing customer value. In a network context, the question is not only that of the company's own competencies, or even of its suppliers' and partners' competencies; the customers and their competencies play a substantial role as well.

Supply chains value creation depends upon the core capabilities, which in turn are limited because of, e.g., the range of technologies needed to produce a product, the rate of specialization, and the complexity of today's business environment. To add their value creation ability, supply chain actors need to find partners with whom to deliver offering of the value attributes that are important to the customer. Companies should manage the networked value creation in a way that allows a customer-oriented value to be co-created and the core capabilities of the partners complement the customer value creation. The actors in the network should realize that they bring value to the network only to the extent that they offer diverse core capabilities that are valued by the network and further, play a role in creating value for the customer (Kothandaraman and Wilson, 2001). Differentiating the tasks in supply chain value management is of importance, as it value is achieved through different types of relationships with customers as well as suppliers (Arlbjørn et al., 2011). The nature of value provided is created through these relationships and

Customer value is a very complex phenomena and there is no broad-based definition available (James et al., 2006). Customer value has been extensively studied in the last fifteen years (Lepak et al., 2007; Gummerus, 2013; Bourguignon, 2005; Ulaga and Chacour, 2001; Ford and McDowell, 1999). However, there still isn't consensus what customer value really is. In this study, we aime to gain insight in to the distinctive nature of customer value by referring to the categorization introduced by Rintamäki et al. (2007) where customer value is divided into four categories: 1) economic, 2) functional, 3) emotional and 4) symbolic. Each value proposition pursues to create value to the customer in one or more of these areas. Economic value refers to the financial benefits that can be offered to the customer. Functional value is the actual service, which helps to solve a concrete problem, e.g. moving products to one place to another. Emotional value refers to the feelings such as convenience, entertainment or feeling of safety. Finally, symbolic value refers to social status, respect and identity.

Value Management in Supply Chains

In modern supply chains, the value creation process becomes more complex when compared to dyad-level analysis between provider and customer. In a traditional view of supply chain, seven theoretical processes can be distinguished, namely: information flow; capacity and skills management; demand management; customer relationship management; supplier relationship management; service delivery management; and cash flow (Ellram et al., 2004). The functions responsible of managing value are the supply chain management and on the other hand supply chain risk management.

Supply chain management refers to a holistic and strategic approach to operations, materials and logistics management, and it can be considered as a management philosophy, the implementation of a management philosophy, and the management process (Tan, 2001). The aim of supply chain risk management is to identify the potential sources of risk and implement appropriate actions in order to avoid or contain supply chain vulnerability (Narasimhan and Talluri, 2009). According to Brindley (2004), it means "the management of supply chain risk through coordination or collaboration among supply chain partners so as to ensure profitability and continuity". Supply chain risk management steps can be divided into three different phases (Waters, 2011): Identification, Analysis, and Management action.

In supply chains, risk is defined as the potential occurrence of an incident or failure that inhibits the free and undisrupted flow of material and information, thereby causing interruption in to the creation and flow of value (Tang and Nurmaya Musa, 2010; Waters, 2011; Zsidisin, 2003, Vilko and Santonen 2017). While in traditionally the value management focus in the supply chains has concentrated on the functional and economical value creation, in complicated, networked value creation, the challenges become increasingly pronounced when it comes to more abstract value dimensions of emotional and symbolic value.

By connecting the service value creation perspective and the supply chain risk management process we aim to take better into account special systemic nature of customer value, where the customers' roles in creating value should be considered (Maull et al., 2012) and the overall complexity is higher (Mena et al., 2013) and consider both the customer benefits and costs perspectives in value. We consider these to be integrally linked to the inherent intangibility and to other service-specific features, which we will study in detail by the following hypotheses:

Hypothesis 1a: Customer value management capability (identification, analysis, and management of customer value) is positively associated with tangible customer benefits

Hypothesis 1b: Customer value management capability (identification, analysis, and management of customer value) is positively associated with intangible customer benefits

Hypothesis 2a: Customer value management capability (identification, analysis, and management of customer value) is negatively associated with tangible customer costs

Hypothesis 2b: Customer value management capability (identification, analysis, and management of customer value) is negatively associated with tangible customer costs

Research Design

The study followed an information-oriented case research strategy where the focus was on gaining understanding and discovering causalities of the phenomenon (Jensen, and Rodgers, 2001; Cresswell and Miller, 2000). More precisely, the purpose of the research strategy was to gain information about the value determinants, which would be of importance in the future. The interviews worked well for to gain information on how customer value was formed in service networks in different industry fields. As the previous research about the phenomenon was limited the explorative research approach allowed researchers to gain theoretical and empirical insight into the topic (Jensen, and Rodgers, 2001). The interviews also worked as a good way to gain perpectives into the customer value and thus helped to construct a sophisticated survey to gain deeper knowledge about the phenomenon.

Internet-based survey questionnaire collected responses from 105 companies representing different industries (manufacturing 32%, logistics and storage 23%, retail and trade 10%, other industries 35%) and that were mostly from B2B business. The respondents were part of Finnish purchasing and logistics association and represented companies of different sizes (48 firms over 250 employees, 28 firms with 50–249 employees, and 29 firms with fewer than 50 employees) and ages (most companies were quite well-established, with 45 companies over 50 years of age and most of the rest over 10 years). The respondents held different types of managerial and expert positions. The survey examined issues such as customer value creation and its vulnerability, risk management, and organizational problems in customer value analysis. The results of this survey allowed us to study the broader trends regarding customer value and its vulnerability and management in firms, supply chains, and networks.

Measures

Given the lack of established measures for customer value management, we developed a new measure based on literature on customer value identification, analysis, and management dimensions. In doing this, we mostly relied on risk management literature that has been focusing on these dimensions, and

adopted those insights into the more generic customer value management context. As a result, customer value management (CVM) capability includes eight items that include the three dimensions of identification, analysis and management (see Appendix A). The measure is treated as a uni-dimensional construct, for both conceptual and empirical reasons. Conceptually, we expect that the three dimensions are interlinked and part of the overall capability that firms possess as they identify, analyze, and manage the sources of customer benefits and costs. The same underlying processes might contribute to each of these dimensions, and firms abilities thus typically fall and rise together. Our PLS models (reported in the next section, and in Appendix A) indeed show that a uni-dimensional construct includes reasonably good convergent validity and individual item factor loadings.

For dependent variables, we constructed a measure for tangible and intangible benefits and costs based on a qualitative study of Rintamäki et al. (2007). In particular, we developed items related to economic, functional, emotional, and symbolic benefits as well as costs (one item each, total of 8 items). Aligned with the hypotheses formation, we further conceptualized economic and functional dimensions as tangible benefits and tangible costs, and the emotional and symbolic dimensions as intangible benefits and intangible costs. Empirically, the items loaded mainly to these factors in the PLS models (see Appendix A, and further discussion in the next section). There was one exception, however. The economic and functional costs did not load to the same latent construct, suggesting that they are empirically distinct. As a result, we treated them as separate constructs in the analyses.

Finally, we included three types of control variables. First, we controlled for firm size by asking the respondents to choose one of four categories regarding firm size: 1-9 employees, 10-49 employees, 50-249 employees, or over 250 employees. Second, we asked the respondents to report the age of the firm, again in four categories: 0-5 years, 6-10 years, 11-50 years, or over 50 years. Third, we used a detailed industry categorization based on statistics of Finland industry taxonomy to collect industry information from each firm. Given the sufficiently small sample size (n = 105), we aggregated the industries to three major categories: manufacturing (34 firms), trade and logistics (34 firms), and others (37 firms, this includes a variety of service and professional industries). In the analyses, we include industry dummies for manufacturing and trade&logistics, and leave the "others" category as a benchmark dummy.

Analysis of Managing Customer Value: Benefits And Costs

To test the hypotheses, we relied on Partial least squares (PLS) structural equation modeling (SEM), using SmartPLS version 3.2.8. PLS helps to analyze structural measurement models and related paths, and provides factor loadings similar to those in regular principal component analysis (Sosik et al., 2009). Therefore, PLS can be used to simultaneously asses the validity of an empirical model, as well as analyze the hypothesized paths and their significances. We chose PLS for this particular study due to certain benefits it has beyond other structural equation methods (see Hair et al., 2013). PLS is particularly adept to examine estimations for small samples such as ours (n = 105), while still allowing sufficiently complex model estimations.

In Table 2 the items used in the survey study are listed, along with the factor loadings for each item, as well as Average Variance Extracted (AVE), and Construct Reliability (CR) scores. For each of the construct, the factor loadings are significant, the construct reliability above the 0.7 treshhold (Bagozzi and Yi, 1991), and AVEs above the 0.50 threshold (Fornell and Larcker, 1981). Thus, the reliability and validity of the measures can be considered as satisfactory for the current data.

Table 1. Descriptive statistics, correlations, and discriminant validity of the measures

Variable	*Mean*	*S.D.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
1. Customer value management capability	4.61	1.04	***0.74***						
2. Tangible customer benefits	5.60	1.11	0.41*	***0.85***					
3. Intangible customer benefits	4.46	1.57	0.15	-0.40	***0.91***				
4. Economic customer costs	5.32	1.55	-0.03	0.17	-0.19	[a]			
5. Functional customer costs	3.97	1.79	0.02	0.14	0.07	0.19	[a]		
6. Intangible customer costs	2.47	1.77	-0.23*	-0.14	0.12	0.14	0.35*	***0.85***	
7. Firm size (employees)	3.03	1.10	-0.20*	-0.18	-0.03	0.20*	-0.04	0.06	[a]
8. Firm age	3.15	0.95	-0.22*	-0.17	-0.01	0.10	-0.11	0.11	0.72*

Notes: * $p < 0.05$; (two-tailed); a = single-item indicator

Table 2. Results for PLS path model

Path	Path coefficient	t-value
DV: Tangible customer benefits (economic & functional)		
Firm size → tangible customer benefits	-0.114	0.734
Firm age → tangible customer benefits	0.006	0.048
Manufacturing industries → tangible customer benefits	-0.017	0.146
Trade & logistics industries → tangible customer benefits	0.171†	1.685
Customer value management capability → tangible customer benefits	0.361**	3.437
DV: Intangible customer benefits (emotional & symbolic)		
Firm size → intangible customer benefits	-0.012	0.083
Firm age → intangible customer benefits	0.021	0.137
Manufacturing industries → intangible customer benefits	-0.027	0.235
Trade & logistics industries → intangible customer benefits	-0.146	1.241
Customer value management capability → intangible customer benefits	0.228	1.365
DV: Tangible customer costs: Economic		
Firm size → economic customer costs	0.137	0.999
Firm age → economic customer costs	0.051	0.358
Manufacturing industries → economic customer costs	0.040	0.321
Trade & logistics industries → economic customer costs	0.313**	2.735
Customer value management capability → economic customer costs	-0.038	0.354
DV: Tangible customer costs: functional		
Firm size → functional customer costs	0.105	0.757
Firm age → functional customer costs	-0.162	1.066
Manufacturing industries → functional customer costs	-0.101	0.321
Trade & logistics industries → functional customer costs	-0.180†	1.689
Customer value management capability → functional customer costs	0.007	0.063
DV: Intangible customer costs (emotional & symbolic)		
Firm size → intangible customer costs	0.205	1.340
Firm age → intangible customer costs	-0.236†	1.809
Manufacturing industries → intangible customer costs	0.020	0.153
Trade & logistics industries → intangible customer costs	-0.109	0.985
Customer value management capability → intangible customer costs	-0.244**	2.005

Coefficient of determination (R^2)	
Tangible customer benefits	0.21
Intangible customer benefits	0.06
Tangible customer costs: economic	0.13
Tangible customer costs: functional	0.04
Intangible customer costs	0.10

Notes: † p < 0.1; * p < 0.05; ** p < 0.01; (two-tailed)

Descriptive statistics and correlations for continuous variables are reported in Table 3. The discriminant validity between the constructs is also demonstrated in Table 3. Here, the square roots of AVEs (marked in italics and in bold in the diagonal) are shown to be greater than the correlation of these constructs to other model constructs (Fornell and Larcker, 1981). Thus, the constructs also show a satisfactory level of discriminant validity.

Table 3 reports the results of a PLS analyses for five different dependent variables. For each dependent variable, paths are reported for control variables (firm size, age, industry dummies), as well as for the dependent variable (customer value management capability). The path coefficient estimates and the t-values for each individual path are reported, allowing for testing our hypotheses. Based on the significant paths, we can see that H1a is strongly supported: customer value management capability has a positive and significant association with tangible customer benefits. On the other hand, despite a rather positive coefficient, H1b does not receive support, so a positive association to intangible customer benefits remains unconfirmed. As for H2a, we do not find any support, and the path coefficients are actually very close to zero. Thus, it can be seen that CVM capability is very weakly liked to tangible customer costs – for both economic and functional dimensions which were analyzed separately here. Finally, we find strong support for H2b: CVM capability is negatively and significantly associated with intangible customer costs.

Table 3. Results for PLS path model

Construct	Item	Factor loading	AVE	CR
Customer value management capability	How do you perceive your firm's capabilities regarding customer value management? (1 = fully disagree, 7 = fully agree)		0.546	0.905
	Our employees are able to identify the issues that are important to the customer	0.647***		
	We can identify the costs that occur to the customer from using the product/service	0.695***		
	We can analyze and measure the different factors that create customer value	0.758***		
	Our employees can distinguish in detail the issues that are more or less important to the customer	0.645***		
	We can distinguish the customer benefits and costs for each customer separately	0.788***		
	Our company pursues to deliberately manage the creation of customer value	0.764***		
	Factors that affect customer value are continuously followed and assessed	0.855***		

	The skills related to creation of customer value among our employees are continuously followed and assessed	0.735***		
Customer benefits	What type of value the customer typically receives from your products and services? (1 = very little of such value; 7 = very much of such value)			
Tangible customer benefits			0.714	0.840
	Economic (monetary benefits, such as cost savings and improved profits)	0.840***		
	Functional (the practical value of the solution, e.g. ease-of-use, speed, reaction time)	0.861***		
Intangible customer benefits			0.908	0.832
	Emotional (customer experience, e. g. amenity, feeling of safety, novelty)	0.981***		
	Symbolic (meaning to the customer, e.g status, ethics, self expression, brand)	0.838***		
Customer costs	What type of costs the customer typically confronts when acquiring or using your products and services? (1 = very little of such costs; 7 = very much of such costs)			
Tangible customer costs (economic) [a]	Economic (monetary costs, e.g. price, other costs)			
Tangible customer costs (functional)[a]	Functional (e.g. time spent, effort, learning)			
Intangible customer costs			0.837	0.720
	Emotional (costs and disadvantages related to the experience, e.g. stress, irritation, inconvenience, boredom)	0.908***		
	Symbolic (costs and disadvantages related to meaning, e. g. social disadvantages, shame, secrecy)	0.785***		

*** $p < 0.01$ (two-tailed); a = one-item indicators due to poor loading to joint construct

Discussion and Conclusions

The perspective this study provides aims to instigate the discussion of supply chain value production in two important perspectives. Firstly the study illustrates the importance of vulnerability of the value in service supply chains. The current scientific discussion has concentrated mostly of production of customer value, however considering the vulnerability perspective of it has been less discussed. In order to manage the value production in a sustainable way, the risks involved should be taken better in to account. Secondly, this study provides a network perspective to the value management. Currently, the discussion of value offering is concentrated on organizational perspective with most of the studies

deriving from business to consumer experiences. In our study we analyse the network perspective to value creation taking into account also the business to business perspectives.

The most important implications identified for value provision was the multi-dimensional nature of value, where especially the functional and emotional natures seemed to be relatively vulnerable. The most challenging issues in the value vulnerability was related to the internal processes in the organizations. From the inhibiting factors, the most dominant ones were those internal to the organization while the network or environment related were the least identified. This might imply about the limitations organizations have in their abilities to identify the vulnerabilities outside of their own organizational border. By better understanding the essential determinants of value vulnerability and how those comprise can able both scholars and managers to focus their efforts better in the further.

Limitations and suggestions for future

The study has some limitation in terms of the limited geographical area related to the empirical data. There is a need for further empirical studies, as well as for the further refinement of the analysis framework. In addition, the empirical studies could test the impact and nature of the studied value determinants in different fields of industry and in b2b and b2c environments.

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MODIFIED OF A WEIGHTED OVERALL VEHICLE EFFECTIVENESS MODEL

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Introduction

In recently, performance measurement is become more an important in several business companies. Due to the companies are now facing a competitive environment, this has pushed the companies attempted to enhance the effectiveness and efficiency in their company. Performance measure is the process of quantifying the effectiveness and efficiency of a past action)Neely et al., 1995(. Effectiveness is a succeed of met customers' requirement and efficiency is how economically a firm's resource are utilised. Moullin)2002(also defined the definition as a tool that evaluating how well of organised are managed. As the mention, Efficiency failure and leads to more information decision making regard to chain design. Performance measurement is a tool to identify opportunities for progressive improvement in process performance)Wegelius-Lehtonen, 2001(. Therefore, the definition of the performance measurement can be defined as a process of evaluating of the effectiveness and efficiency utilise on people, resource and technology and also how well organisations are managed. The knowledge of the company performance can help improve overall business capacity can enhance understanding.

Logistics is playing an increasing an important role in business. Therefore, it is important for organisation to manage their vehicle performance to successfully deliver customer requirement in an effectiveness. Many organisation are seeking to improve their operations to meet the demand on transportation which mainly is faster delivery, higher accuracy, greater flexibility, lower cost and not damage delivery. Company have also to increased profits. Having own private fleet indeed gives company many advantage but there are also the disadvantage sides that company has to deal with such as fixed cost in vehicle purchasing cost, maintenance cost, labor cost and so on. This is the reason why company must be aware of. OVE method aims to develop an operation measure of transport efficiency and to contribute to the way in which the road freight transport industry is measured and benchmarked)Simon et al., 2004(. This method can be also considered as one of the primary model for vehicle performance measurement. Many in the past decade has paid attention on this model and develop the concept into their own interested idea. However, OVE still has some weakness point due to different perspective on each industry that lead to the importance of adding weight on each single elements of the model to eliminate its own weakness.

This paper would like to proposed a model for the company that has cost dimension and round-trip problem interested which suit the concept of MOVE, a modified of OVE. Adding weighting method on each MOVE elements would make a model appropriated for the case study in the future work which is Royal Project Foundation, in Thailand.

Literature review

The Evolution of Overall Vehicle Effectiveness

Overall Vehicle Effectiveness)OVE(was developed by Simon et al.)2004(for holistic measuring the effectiveness of transport operation from the proportion of value added activities in the transport operations. OVE derived from the concept of Overall Equipment Effectiveness)OEE(. When it becomes to OVE, the three aspects are applied to benchmark the total performance of vehicle effectiveness in the basis of weight-distance)tonne-km(. Simon el al.)2004(converted six losses in manufacturing from OEE to the five transport losses in OVE which are driver breaks loss, excess load time, fill loss, speed loss and quality delays. The elements of OVE measure were apparently the same of OEE. The Availability, Performance efficiency and Quality rate were calculated and multiplied together to produce OVE rate as equation [1]:

OVE)%(= Vehicle Availability)%(x Vehicle Performance)%(x Quality)%([1]

However, Guan et al.)2003(mentioned that OVE has faced to the "round-trip problem", this occurs when there is a case of multiple destination which OVE gives higher value to the lower efficient route. Guan el al.)2003(mention that this problem exist because OVE considers the alternative of carrying good in longer distance as higher value adding to the end customer while it obvious that this alternative is loess fuel efficient, thus less effective therefore Modified Overall Vehicle Effectiveness)MOVE(was developed by Guan et al.)2003(in order to solve this problem

MOVE is a method of measuring a single vehicle performance for road transport which developed to solve the "round-trip problem" as above mention. In order to solve the round-trip problem.

Guan et al.)2003(added route efficiency as one important aspect of the vehicle performance rate. The route efficiency is calculated as in equation [2]:

Route efficiency = Minimum route cost / Actual route cost [2]

The route efficiency evaluates the efficiency between the weight-distance)tonne-km(of the actual route used for the shipments against the least distance of the optimal route which is considered as the most efficient route. The minimum route cost is the minimized weight-distance along an optimal route while the actual route cost is the total weight-distance for the selected route. The optimal route is referred to the most energy efficiency or the lowest weight-distance value to complete trip)Guan et al., 2003(.

Guan et al.)2003(also mentioned that time dimension also needs to be considered. The time performance needs to consider in all activities such as loading and unloading times, congestion, travel speeds etc. Time efficiency is one of MOVE metric and can be calculated as in equation [3]:

Time efficiency = Shortest possible time on the best possible route / Actual time taken [3]

Time efficiency is how much time is take to make the delivery and expressed in minute, the ratio between the actual time taken for a vehicle to complete the delivery against the shortest possible time required for that vehicle to complete all value-added activities for that delivery.

The other two metric of MOVE was referred from MOVE, which is Vehicle Utilization formally known as Availability in OVE and Quality rate unchanged in MOVE. Therefore, MOVE multiplied four aspects together, which is Vehicle utilization, Route efficiency, Time efficiency and Quality. MOVE has been proposed as in equation [4]:

MOVE)%(= Vehicle utilization)%(x Route efficiency)%(x Time efficiency x Quality)%([4]

Weighting of Overall Equipment Effectiveness

According to the current literature review on the evolution of OVE, it could obviously be seen that it has been developed from OEE. Even though OEE has been proved in various case studies and appears to be a complete performance measurement indicator, it still requires proper modification. To extend, its feasibility, several ideas have been proposed. Since, the weight of each OEE elements is equivalent, while their losses are totally different. In addition, every production line has its own characteristic. Therefore, OEE cannot always describe the actual condition of the production line depending on the case. There are some research related to Overall Equipment Effectiveness improvement have used weighted overall equipment effectiveness to advance this performance measurement for production line use such as Production Equipment Effectiveness)PEE(proposed by Raouf)1994(, Overall Weight Equipment Effectiveness)OWEE(proposed by Wudhikarn)2010(and OEE weight by Taguchi method with simulation)Yuniawan et al.)2013(. From previous studies that include the weight proportion determination of Overall Equipment Effectiveness elements, the concept of Analytical Hierarchy Process with weighted signed graph approach and Rank-Order Centroid method have been used to identify weight setting and added to Overall Equipment Effectiveness. However, the improvement of OEE concept using weighted methods, which are PEE and OWEE, still has its drawbacks)Yuniawan et al., 2013(. Yuniawan et al.)2013(suggested that Raouf)1994(did not specifically describe the calculation to obtain the weight value for each OEE elements in PEE and the weight setting in OWEE depends on authorized personnel, this can be very subjective if not accompanied by accurate data.

The concept of System Reliability calculation

In this research only uses the concept of system reliability which presents the interconnection of each single element in new modified OVE model and each weight single element to combine into a newly calculation method. According to Myers)2010(summarized the basic principles and function relationship used for reliability assessment of systems with simple interconnections by using mathematic function. The reliability. The system reliability is defined as its ability to react within a specified time during an operation period)Lisnianski and Levitin, 2003(. The reliability systems consist of the series systems, the parallel systems and the combination series)Myers, 2010(. The physical connection among elements represented by a series reliability block diagram, its can differ as well as their allocation along the system's functioning process. In this research will concerns two systems which is parallel systems and combined systems to develop newly calculation method

The parallel systems is a system that composed of element P_1 and P_2 and it is operational if either element or both elements are operational as shows in Figure 1.

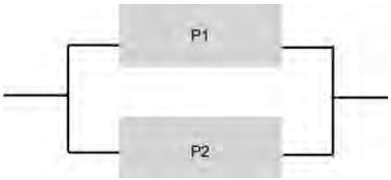

Figure 1. Block diagram for elements parallel.

The systems reliability of figure 10 can be determined using the mathematical function defined as in equation [5]:

$$R_P = 1 -)1 - P_1()1 - P_2(\quad [5]$$

Where P_1 and P_2 represent the reliability of element P_1 and P_2 respectively, and R_P is the reliability of the system composed of these two elements. The general relationship for a system of *n* components arranged in parallel as in equation [6]:

$$R_P = 1-\lceil\rceil n_{i=1})1 - P_i(\quad [6]$$

Then, to combine the all element in series and parallel as figure 11. In the figure 11 shows a system comprising four elements arranged in series and in parallel.

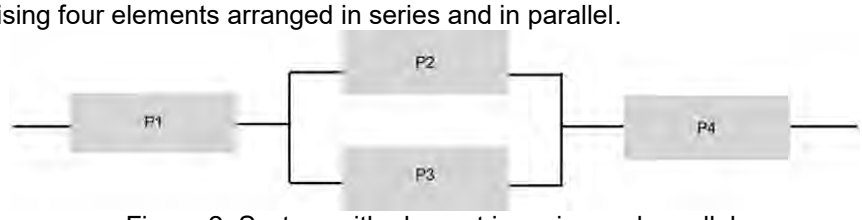

Figure 2. System with element in series and parallel.

If the element P_i in figure 2 also have individual element reliabilities Pi, then the overall system reliability $)R_{sys}($ can be formulate as follow equation [7]:

$$R_{sys} = P_1)1 -)1 - P_2()1 - P_3((P_4 \quad [7]$$

To combining original MOVE approach and weight in each single element will use these concept to create newly calculating method of MOVE to make it become more appropriate and the value would not over change from the original value.

Methodology

In the light of the above, OVE and MOVE is easy to use, not too complicated and cover most of interested are for the company and case study. This research divided in two parts which is the improving the equation of MOVE and the weighting of MOVE.

For improve the equation of MOVE. Since, MOVE seems not to be quite ambiguous on calculation and definition. The aim of this research is to extend the capability of MOVE, therefore, MOVE's equation is examined, justified limitations and adapted to be more suitable and clearly in this chapter. So, the four components in the original MOVE will assessed to improve their limitations. For the second part is weighting of MOVE. Due to the previous research from the literature review, MOVE was developed from OEE where there are several weaknesses including weighting method. In the original OEE the weakness especially weighting of each element is equivalent whereas losses are totally different. Therefore, this research propose a simple weight setting method by using AHP to identify dissimilar weight for each MOVE elements because weighting from AHP method is easy and accurate to identify weight while a weight must be identified by authorized person. Then, the research proposes newly calculating method following the improving MOVE's equation and weighted approach which integrated by using the concept of system reliability calculation.

Then, MOVE's equations will adapted to be more integrated for evaluation for evaluation of the overall vehicle effectiveness on each company's perspective and proposed as a refining model named Weighted Overall Vehicle Effectiveness or WOVE. Note that WOVE intends to measure the overall vehicle effectiveness in the same four components as the original MOVE since these four components could consider to be sufficient enough for evaluate in overall performance for vehicle.

After, the application of WOVE model is applied through a case study. Moreover, OVE and MOVE will be calculate for comparing with WOVE. Then, the result from three different methods.

1. Modification of the original Modified Overall Vehicle Effectiveness equation.

Previously, OVE and MOVE has a limitation to access especially in the calculation details. The concern MOVE are consist of four elements which are Vehicle Utilization)VU(, Route Efficiency)RE(, Time Efficiency)TE(and Quality)Q(and MOVE has been proposed as the following equation;

MOVE = Vehicle Utilization × Route Efficiency × Time Efficiency × Quality

MOVE is used for measuring an individual vehicle' effectiveness. Nevertheless, MOVE seems not to be quite compatible when each car has multiple delivered per day and also consisted of more

than one vehicle, is taken into consideration. Therefore, the equation of MOVE is assessed here to find its limitations and investigate the possibilities to adapt the equation to be more suitable performance. MOVE metric measures an individual vehicle' performance in four aspects which are;

Vehicle Utilization is the ratio between the available capacity of a vehicle in a period of time against the minimum required capacity which is need for completing the shipment. For the available capacity, it can be the actual travelling time or the allowable driving time in a day depending on propose of the user. Both capacities are measured in weight-distance in order to assess in the context of how full the vehicle is loaded, along the delivery distance, against its maximum loaded capacity. It also assesses a vehicle's travelling distance for completing the shipment against the maximum distance that vehicle can be travel with that given period of time. MOVE defined Vehicle Utilization's equation as;

Vehicle Utilization = Required Capacity / Available Capacity

Or

Vehicle Utilization = Minimum Route Cost / Available Capacity

In which;

Available Capacity = Maximum Load × Distance

Maximum distance in 1 day = Total available travelling time × Maximum speed

Total available travelling time = Total allowable hours on the road in 1 day - Statutory breaks

For the limitation, MOVE assesses only the utilization of a single round shipment of vehicle for certain route. In the real situation, the vehicle has multiple delivered per day and also multiple vehicle, the utilization measurement should be integrated to as in available capacity of all round shipment vehicle. Furthermore, the adaptation of MOVE in the available capacity is obtained by the following equation;

Available Capacity = Maximum loaded capacity × Maximum distance available

To modify the equation, the maximum loaded capacity should be the sum of maximum loaded capacity of every round shipment in the vehicle. Moreover, the both capacities that are measured in weight-distance in order to assess in the context of how full the vehicle is loaded, along the delivery distance, against its maximum loaded capacity. To be more accurate, weight and volume constraints should exist in such model. However, due to the lack of data collected, only volume requirements are considered)a practice also done by the company(since the practitioners stated that their perishable goods are light weighted with large space consumed and also the air flowing space within the stacks have to be concerned hence the weight record of goods is not needed nor being a problem. Furthermore, McKinnon and Ge)2004(mentioned that food is relatively low-density product so tend to be volume constrained rather than weight-constrained therefore in food sector expressed energy intensity in terms of pallet-kilometers rather than tonne-kilometers. Consequently, the Maximum capacity's equation can be adapted for measuring vehicle

Maximum capacity = Number of shipment round per one day × Maximum capacity of a vehicle

In addition, the maximum speed of each route is depended on each route speed planning by law that the urban area has low speed than the rural area. Route Efficiency is the ratio between the weight-distance of the actual route used for the shipment against the least weight-distance of the optimal route which is considered as the most efficient route. According Guan et al.)2003(, Route Efficiency measure the proportion of value-adding along the delivery process in the context of energy usage. For this reason, the less weight-distance which energy used in a route, the more efficiency that route is. Furthermore, the Route Efficiency in the optimal route is 100% since it is the most efficient rout which give the least weight-distance, that means this routes uses the least energy to make the shipment. MOVE defined Route Efficiency's equation as;

Route Efficiency = Minimum Route Cost / Actual Route Cost

For limitation examining, in MOVE equation, the cost of a route for a vehicle to make the delivery is measured in context of weight-distance in order to evaluate the efficiency of a certain route compare to the optimal route. However, as mention above in section 3.2.1 that for some business used volume-distance instead weight-distance for calculated vehicle carrying capacity. Therefore, there is no improvement needed for the equation of Route Efficiency except for the changing of measures unit of utilization.

Time Efficiency is the ratio between the actual time taken for a vehicle to complete the shipment against the shortest possible time for that vehicle to complete all value-added activities for that shipment)Guan et al., 2003(. In generally, activities such travelling time, loading time, unloading time, statutory break time, queue time etc. are considered in the calculation. However, the shortest possible time in this ration can be determined by the user which activity's duration will be counted as value-adding or non value-adding. Therefore, Time Efficiency ratio can be different depending on the purpose of the user. Note that, the equation of Time Efficiency is no improvement needed. Here, MOVE defined Time Efficiency's equation as;

Time Efficiency = Shortest Possible Time / Actual Time Taken

In which;
Shortest Possible Time for delivery = Time taken for the optimal speed + statutory break
Actual Time Taken = Travel time + Loading time + Unloading time + Queue time + Break time – Breaks taken while load and queuing

Quality is the ratio of the goods which are delivered to customers within promised condition, without any damage or loss against the total goods delivers. This ratio can be measured in terms of weight or the number of items. MOVE defined Quality's equation as;

Quality = Good Successfully Delivered / Total Goods to be delivered

The evaluation in the context of quality of the shipment is also able to measure and no needed to adapt. Therefore, the quality's equation is still same since there is no improvement need for the assessment of Quality ratio. In the above section, the four component in MOVE are assessed to improve their limitations. MOVE's equation are, them, adapted to be more integrated for evaluation of the overall vehicle effectiveness. Note that the modify equation intends to be measure in the same four components since these components could consider to be sufficient enough for evaluate in the "overall" performance. Therefore, the modify equation can be calculated as follows;

MOVE = Vehicle Utilization × Route Efficiency × Time Efficiency × Quality

2. Weighting of MOVE

Since, the traditional concept of MOVE specific the weight of each element equivalently. This design, still, is inappropriate because these elementary losses and important are totally different in each business. The idea of weight setting in model came from the previous research of OEE that has been mention above. However, the paper of PEE did not shows how to setting the weight in each element. For OWEE, Wudhikarn)2010(applied Rank-Order Centroid to identify weight in each element of OEE but Rank-Order Centroid cannot reflect the actual relative weight setting when compared to the Analytic Hierarchy Process and also cannot determine the relative importance of the factors that has the same rank. So, this research will be using the Analytic Hierarchy Process to identify dissimilarity in weighting each element which is Vehicle Utilization)VU(, Route Efficiency)RE(, Time Efficiency)TE(and Quality)Q(.

According to papers of Assavavichai and Chao in 2017, the calculating result of three weight adding methods namely: Raouf's method, Wudhikarn's method and system reliability concept, the first and second method have more than double the result from the original which does not reflect the result that it should be since the power numbers in the calculation will always yield high percentages on result. Furthermore, the calculated value of Raouf's method and Wudhikarn's method which is similar to each other are much different from the original MOVE due to the nature of power weight with less than one that will result in a higher number in case of Raouf's method and the summation of value that give more and more value in case of Wudhikarn's method. Then, this research will adapt the concept of system reliability calculation to combine the modify formulation of MOVE with weight setting and also proposed as a refining model named a Weighted Overall Vehicle Effectiveness)WOVE(. The concept of system reliability is applied to this research by using the parallel system to combine the four elements and weight in each element.Therefore, WOVE can be calculated as follows;

$$WOVE = VU_w \times RE_w \times TE_w \times Q_w$$

In which;
VU_w = 1-)1-VU(×)1-W_{VU}(
RE_w = 1-)1- RE(×)1-W_{RE}(
TE_w = 1-)1-TE(×)1-W_{TE}(

Q_w = 1-)1- Q(×)1-W_Q(
Where;
VU, RE, TE and Q is the percentage of Vehicle Utilization, Route Efficiency, Time Efficiency and Quality
W_{VU}, W_{RE}, W_{TE} and W_Q is weight of Vehicle Utilization rate element, Route Efficiency rate element, Time Efficiency rate element and Quality rate element

In addition, this methodology assigns weights to all elements by using the analytical hierarchy process. In this part, opinions from decision makers are required in order to identify the relative weight importance. To achieve this, the researcher must interview five Royal Project Foundation's decision makers on transportation field and check the reliability of the data as in Analytic Hierarchy Process)AHP(. . The interviewing will interview a top manager who has been in charged in the related filed such as vehicle performance, logistics performance or distribution center management. The interview will also use the self-administered interview technique.

Discussion

In this part, the application of OWVE model previously presented is exemplified through a case study. In this newly improved calculation method, the transport operations data as in table 2. must be collected. Moreover, a weight setting is required. In the case study, transport managing director was interviewed or prioritizing VU, RE, TE and Q.

Type of data	The Royal Project Foundation vehicle usage data
Period covered	13 December 2018 – 13 January 2019
Month in period with records	1 month
Vehicle included	6
Field included	Date and time of car used, registration plate, customer named, mileage used)distance(, idle time)pre-unloading(, unloading time, idle time)pre-loading(, loading time, break time, amount of goods delivered and empty basket, delay of delivery time, goods delivered with damage and mistake, fuel cost

Table 2. Description the data collection of the Royal Project Foundation freight vehicle usage data used in the analysis.

From table 3, the results from three different which is OVE, MOVE and OWVE methods have been calculated and all outcomes are presented in percentage unit. Note that this research selected three complex routes. It can be seen that OVE has the highest score among three method that does not represent the actual situation of the case study where the performances are too high which led to the higher overall score that MOVE has solved the problem yield a better realistic result while OWVE that has the concept of MOVE is bended the method to be more suitable for the particular industry gives a result according to the authorized priorities shows a weighted result that the industry can be used to inspect the overall score to adjust according to their plan.

Table 3. Numerical Results from Three Methods.

D/M/Y)car no.(	OVE				MOVE					OWVE				
	A	P	Q	OVE	VU	RE	TE	Q	MOVE	VU)0.13(	RE)0.05(	TE)0.23(	Q)0.59(	OVWE
13/12/18)5(	57.13	33	100	18.72	13.63	89.13	97.9	99.96	13.34	19.40	89.68	33.08	66	3.82
19/12/18)2(	55.03	24	100	13.41	7.46	92.35	58.33	100	4.02	19.63	92.73	67.82	60.64	7.49
28/12/18)3(	49.10	32	100	15.58	7.20	79.98	48.44	100	2.79	24.99	80.99	60.18	60.13	7.33

Conclusion

The performance measurement for operating transport is crucial and key for sustaining business organization. Therefor, a method to measure according to the company's interested can be used to clarify their overall transport performance through their needs which make OWVE a new concept that can be applied to this particular reason. An improvement of the original MOVE makes it suit for each industry on its interested perspective with a weigh added concept from System Reliability that needs an opinion on the related topic from the authorized person. Therefore, this paper proposed a newly calculating method with weight setting added on each calculation elements.

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MULTIPLE CRITERIA FOR TRANSPORTATION ROUTE SELECTION OF RESERVED COAL FOR MAE MOH POWER PLANT

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Introduction

Currently, the Electricity Generating Authority of Thailand Mae Moh Power Plant Lampang (EGAT) is the largest coal-fired power plant which has the production capacity of 2,400 MW. There are 14 plants unite by the 8th – 14th still operated but the 1st-7th has already shut down. It is the highest electricity production base in Thailand due to low production cost and use domestic energy resources. It has supplied 50% of electricity to the 17 provinces in northern part of Thailand 30% to the central region and 20% to the north-eastern region.

Now, Mae Moh mine has 242 million tons of coal reserves which can produce lignite to use for fuel annually about 15-17 million tons. EGAT aware the importance of having domestic fuel resources. Thus, the EGAT plan had extended duration for continuing the power plant until the year 2038. The 4th to 7th power plant unit already has been replaced by the new power plants which have more production stability and capacity of 655 MW. The 8th and 9th power plant unit also will be replaced by the new power plants which have capacity of 650 MW and will be launch at 2021. For the 10-13 units, the total production capacity is 1,200 MW, which gradually expires in 2022-2026, and the 10th-13th units cannot be replaced because the reduced coal quantity. Therefore, the remaining electricity generating capacity will be approximately 1,250 megawatts in the future and the coal consumption will be reduced to 8 million tons per year so that it can be used to feed the power plant throughout the power plant life of 30 years. Consequently, finding coal reserves to enable the power plant to continue generating power in the future has received more attention. In addition, selection a coal source depending on the quality and distance of the transport in the order to get good quality coal at a reasonable price.

Thailand has imported coal from neighboring countries. In the year 2018, the amount of coal imports was as high as 22.19 million tons, with the import value of approximately 49,929 million baht. It was imported for use in power plants and industrial plants because it is a fuel with high heat value and cheap compared to other types of fuel. Over 74.67% of Thailand's thermal coal imports are sourced from Indonesia. Followed by Australia, Russia, the United States, Vietnam, Laos and others, respectively shown in Table 1.

Rank	Country	Proportion of coal imports
1	Indonesia	74.67%
2	Australia	16.95%
3	Russia	2.96%
4	the United States	1.97%
5	Vietnam	1.43%
6	Laos	0.42%
7	others	1.60%

Table 1: Coal import sources of Thailand, 2018

Transportation of coal in Thailand can be divided according to the mode of transportation infrastructure and depends on the distance of transportation. They are six different ways, such as road transport, Rail system transportation, Water transportation, Sea transportation, Internal convey belts transport and multi modal transport. The power plants require a large amount of coal. Therefore, EGAT

should select suitable transportation route and transportation mode. In transportation process of this coal, both communities and environmental aspect should be considered. Due to Coal transportation could generate numerous pollutions such as, exhaust gas from the transportation system and the impact of noise which could impact toward nearby communities. Hence, this study identifies multiple criteria for selecting transportation route of inbound reserved coal to Mae Moh Power Plant, Lampang THAILAND by considering financial and non-financial aspects. By means of Analytical Hierarchy Process (AHP) method, the proposed approach is employed to define the important weights of criteria and calculate priorities from pairwise comparison approach. At the end of the study, the multiple criteria for selecting transportation route of reserved coal are determined.

Literature review

2.1 Performance Criteria of the Transportation System

In transportation route selection many researches applied multi-criteria approach for different purposes. The criteria were identified from literature review (Sawadogo & Anciaux, 2010, Awasthi & Chauhan, 2011, Kopytov & Abramov, 2012, Baran & Zak, 2014, Stoilova & Kunchev, 2017), the most commonly mentioned main criteria for selection of transportation route are cost, time, reliability and environmental impact. Macharis et al. (2012) found on the criterion of operator and investors were impaction for select transportation route. Kabashkin & Lučina (2015) suggested another criterion such as geography, infrastructure, technology must also be considered. The summary of criteria from previous studies is shown in Table 2.

After that, these obtain factor were preliminary determined by EGAT experts and stakeholders to identify liable criteria which affect the selection of reserved coal transportation route.

2.2 Multi-Criteria Decision Making (MCDM)

Due to the complexity of decision criteria found in previous strong evaluation models are critical in order to incorporate several conflicting criteria meritoriously. With its need to trade-off multiple criteria, the selection problem like transportation route selection is a multicriteria decision-making (MCDM) problem. Roszkowska (2013) found a very important role in MCDM models presents the weights of criteria which usually provide the information about the relative importance of the discussion criteria. Several different methods are developed to take criteria priorities into account. These MCDM methods included analytic hierarchy process (AHP), simple additive weighting method (SAW), technique for order preference by similarity to ideal solution (TOPSIS), Analytic Network Process (ANP) etc. (Chai et.al, 2013). AHP has been mostly used as decision making tool in the process of transportation planning (Saaty, 1995). The AHP method impart a complicated multi-criteria decision problem into a hierarchy and is based on a pair-wise comparison of the importance of different criteria and sub-criteria. AHP is able to deal with qualitative and quantitative criteria at the same time (Saaty,1977). The weight evaluation process quantifies the subjective assessment of experts, in addition we can check the consistency of decision-makers' evaluation. AHP has been used for analysing different types of problems in the field of transportation engineering. Kopytov & Abramov (2012) and Kabashkin & Lučina (2015) suggested the multiple-criteria approach for evaluation and choose the alternatives of cargo transportation. They used AHP method to evaluate the significance of each factor and to find the best alternative. Sawadogo & Anciaux (2010) explained a multi-criteria decision support system taking into account of the economic, environmental and social criteria. Used AHP and ELECTRE methods, to help the decision-makers in the choice of an appropriate path to. Chen & Deng (2018) outlined the problem of the evaluation of sustainable transport solutions. A modified method based on AHP which adapted to determine the weight of sustainability criteria and Dempster–Shafer evidence theory (D-S theory) was proposed for evaluating the impact of transport measures on city sustainability.

This study will apply AHP method to define the important weights of criteria and calculate priorities from pairwise comparison approach.

Main Criteria	**Sub Criteria**	Sawadogo & Anciaux, 2010)	(Awasthi & Chauhan, 2011)	(Kopytov & Abramov, 2012)	(Macharis, Turcksin, & Lebeau, 2012)	(Baran & Zak, 2014)	(Kabashkin & Lučina, 2015)	(Stoilova & Kunchev, 2017)
Cost	Transportation costs	✓	✓	✓	✓	✓	✓	✓
	Costs for handling			✓				✓
	Seasonal fluctuation of tariffs			✓				
	Costs for documentation processing			✓				
	Penalties (missing delivery terms)			✓				
	Possible additional costs During transportation			✓				✓
	Additional insurance (insufficient safety)			✓				
Time	Time for transportation	✓	✓	✓	✓	✓	✓	✓
	Time for border crossing			✓				
	Time for customs clearance			✓				
	Exchange rate Fluctuation during delivery time			✓				
	Loading time	✓			✓			
	Time for transport operation							✓
Reliability	Exceed of delivery terms			✓				
	Cargo safety (loss, damage of cargo)		✓	✓		✓		
	Availability of transport units		✓	✓	✓	✓		
	Safety (theft, unauthorized access to cargo)		✓	✓		✓		
	Reliability of transport means			✓	✓	✓	✓	
	Timeliness of delivery			✓				✓
Environmental	Emission of CO2	✓	✓	✓	✓	✓		✓
	Emissions of harmful substances			✓		✓		✓
	Noise and vibration	✓	✓	✓				
	Accidents and disasters from the ecological point of view	✓		✓				
	Death and traumatism of people			✓				
Geography	Quantity of custom/border points on the route						✓	
	Presence of regular shipping Lines/railway services/trucks in the loading area						✓	

Main Criteria	**Sub Criteria**	Sawadogo & Anciaux, 2010)	(Awasthi & Chauhan, 2011)	(Kopytov & Abramov, 2012)	(Macharis, Turcksin, & Lebeau, 2012)	(Baran & Zak, 2014)	(Kabashkin & Lučina, 2015)	(Stoilova & Kunchev, 2017)
	Possibility to change transportation route in the cluster group						✓	

Table 2: Summary of criteria for selection of transportation route

Main Criteria	**Sub Criteria**	Sawadogo & Anciaux, 2010)	(Awasthi & Chauhan, 2011)	(Kopytov & Abramov, 2012)	(Macharis, Turcksin, & Lebeau, 2012)	(Baran & Zak, 2014)	(Kabashkin & Lučina, 2015)	(Stoilova & Kunchev, 2017)
	Quantity of transit countries on the route						✓	
Infrastructure	Capacity of ports and/or border points						✓	
	Quantity of transhipments on the rout						✓	
	Quality of transport-related infrastructure						✓	
	Availability of bonded warehouses on the rout						✓	
	Availability of good railway services on the route						✓	
Technology	Availability of necessary equipment on the route						✓	
	Availability of necessary transport on the route				✓		✓	
	Ability to track and trace on the route						✓	
	Electronic invoices and customs procedure						✓	
	Terminal operations efficiency						✓	
Ulterior factors	Existing cargo flows						✓	
	People competences and quality of logistics services in transhipment countries on the route						✓	
	Quantity of used languages in the country/city of transhipment						✓	
	Additional added value services on the route						✓	
	Longstanding trading spirit" of ports of transhipment						✓	
Size and characteristics of the product		✓	✓			✓		

in transportation								
Entrepreneurs and investors	maximum net present value				✓			
	Possibility of maximum extension				✓			
	maximum capacity available infrastructure.				✓			

Table 2: Summary of criteria for selection of transportation route (continuous)

Methodology

3.1 Selecting criteria for evaluating coal transportation routes

Based on the criteria for selection of transportation route from previous studies (Table2), a questionnaire was set out to collect data for evaluating identify liable criteria. They were preliminary determined by EGAT experts and stakeholders. The initial questionnaire composed of factors found in previous related studies with 5-Point Likert scale. Seven EGAT experts were asked to score the importance of each factor. They have been focused on eight groups of criteria contain with cost, time, reliability, environmental impact, geography, infrastructure, technology and ulterior factors. As a result, 31 sub criteria were selected and grouped into 8 main criteria. The list of selecting criteria which are implemented in research is presented in Table 3.

Main Criteria [No.of sub criteria]	Sub Criteria
Cost [3]	(1.1) Transportation costs, (1.2) Costs for handling, (1.3) Additional insurance (insufficient safety)
Time [5]	(2.1) Time for transportation, (2.2) Time for border crossing Time for customs clearance, (2.3) Exchange rate Fluctuation during delivery time, (2.4) Loading time, (2.5) Time for transport operation
Reliability [5]	(3.1) Exceed of delivery terms, (3.2) Cargo safety (loss, damage of cargo), (3.3) Availability of transport units, (3.4) Safety, Reliability of transport means, (3.5) Timeliness of delivery
Environmental impact [5]	(4.1) Emission of CO2, (4.2) Emissions of harmful Substances, (4.3) Noise and vibration, (4.4) Accidents and disasters from the ecological point of view, (4.5) Death and traumatism of people
Geography [3]	(5.1) Presence of regular shipping Lines/railway services/trucks in the loading area, (5.2) Possibility to change transportation route in the cluster group, (5.3) Quantity of transit countries on the route
Infrastructure [5]	(6.1) Capacity of ports and/or border points, (6.2) Quantity of transhipments on the rout, (6.3) Quality of transport-related infrastructure, (6.4) Availability of bonded warehouses on the rout, (6.5) Availability of good railway services on the route
Technology [3]	(7.1) Availability of necessary equipment on the route, (7.2) Availability of necessary transport on the route, (7.3) Ability to track and trace on the route
Ulterior factors [2]	(8.1) People competences and quality of logistics services in transhipment countries on the route, (8.2) Longstanding trading spirit" of ports of transhipment

Table 3: Criteria for selecting transportation route of reserved coal.

Consequently, this study establishing the weights of criteria. It has been defined the important of weight for each criterion by compare to other criteria.

3.1 Weight Estimation Using AHP

Saaty&Vargas (2012) described that the weights of selected criteria were calculated in four steps in the pair-wise comparison matrix according to the AHP method.

The first step is called formation of judgments include eight groups of main criteria (cost, time, reliability, environmental impact, geography, infrastructure, technology and ulterior factors). The second steps is known as calculation of assigned ranks which use 1-9 scale of Saaty.The next step is

preparation of normalized pair-wise comparison matrix and finally, calculation of weights. The pair-wise comparison analysis helps to impose different levels of importance to criteria involved in transportation route selection. The cell values of the pair-wise comparison matrix were divided by the sum of the column to obtain the cell values in normalized pair-wise comparison matrix and averaged in row to calculate the weight of criterion. The judgment of ranks was based on Fuel engineering expert, Environmental expert and Planning Division of EGAT, then they created the judgment matrix by pairwise comparisons, using the 1-9 scale of Saaty (Saaty T. L., 2008) shown in Table 4. By applying the methodology of AHP to the collected questionnaires, 7 sets with a consistency ratio of less than 0.1 were used

Judgmen	Verbal equivalent	Comment
1	Equal importance	Two activities contribute equally to the objective.
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another.
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another.
6	Strong plus	
7	Very strong or demo-strated importance	An activity is favored very strongly over another; its dominance demonstrated in practice.
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation.

Table 4: Table of relative scores. (Saaty T. L., 2008)

Results and Discussion

Using the expert evaluation process the important each of eight main criteria by pair-wise comparison matrix. In the example below shown the priority vector from Fuel engineering expert. Referring shown in Table 5, every attribute is compared with others, ex. Cost first compared with itself so value is 1, then Cost is compared with Time as in this case Cost is moderately important than Time is value will be 5, when Time is compared with Environmental impact, in this Environmental impact, in this case Environmental impact is strong important than Time thus, its value will be 1/6. Similar evaluation was made for the other expert.

Main Criteria	Cost	Cost	Reliability	Environmental impact	Geography	Infrastructure	Technology	Ulterior factors	priority vector
Cost	1	5	9	2	8	7	7	7	0.37
Time	1/5	1	5	1/6	3	2	4	5	0.11
Reliability	1/9	1/5	1	1/7	1/3	2	2	3	0.05
Environmental impact	1/2	6	7	1	6	7	8	8	0.31
Geography	1/8	1/3	3	1/6	1	2	1	3	0.06
Infrastructure	1/7	1/2	1/2	1/7	1/2	1	2	4	0.05
Technology	1/7	1/4	1/2	1/8	1	1/2	1	4	0.04

Ulterior factors	1/7	1/5	1/3	1/8	1/3	1/4	1/4	1	0.02

Table 5: The priority vector from Fuel engineering expert.

According to the priority vector from EGAT experts, the importance of the criterion is evident from the average of the criteria priority vector shown in Table 6. The most important criteria are Cost with are weight at 0.3141 for selecting transportation route of reserved coal. This criterion is also influencing transportation route decision much. Followed by Environmental impact with are weight at 0.1866. Now on EGAT has focused on environmental impact which can reduce the impact of lawsuits from the community. Next, Time with are weight at 0.1763 which impact from time for transportation and time for transport operation. Then, Reliability with are weight at 0.1104. They have attended on timeliness of delivery and cargo safety. By the way, both of criteria can show the efficiency of transportation. Geography and Technology with are weight at 0.0685 and 0.0599. Finally, the least important factors are infrastructure and ulterior factors with are weight at 0.0453 and 0.0389.

Main Criteria	**Cost**	**Time**	**Reliability**	**Environmental impact**	**Geography**	**Infrastructure**	**Technology**	**Ulterior factors**
Weight1	0.3677	0.1132	0.0451	0.3057	0.0600	0.0479	0.0396	0.0207
Weight2	0.2684	0.1427	0.0945	0.0644	0.1468	0.0604	0.1468	0.0761
Weight3	0.2057	0.1984	0.2693	0.1318	0.0307	0.0636	0.0441	0.0564
Weight4	0.3766	0.2820	0.0672	0.1394	0.0605	0.0370	0.0219	0.0155
Weight5	0.3662	0.1918	0.0926	0.2140	0.0609	0.0341	0.0250	0.0154
Weight6	0.3081	0.1567	0.1041	0.2179	0.0605	0.0373	0.0713	0.0441
Weight7	0.3060	0.1492	0.1002	0.2329	0.0601	0.0370	0.0709	0.0438
Average	**0.3141**	**0.1763**	**0.1104**	**0.1866**	**0.0685**	**0.0453**	**0.0599**	**0.0389**

Table 6: Summary of the main criteria priority vector.

As a result, the most important criteria are Cost. Due to, having the important sub criteria contain with transportation costs and costs for handling that they considered these cost can create the most impact of Coal Cost rates. Followed by, Environmental impact criteria, which is another important issue that EGAT must be considered. By reason of, environmental issues concerning freight become more important presently since it is well known that the transport sector is the major sources of noise and many air pollutants. By the way, the EGAT has a problem with communities from the environment impact for a long time. They were contributing awareness of the environmental impact and the continual efforts to mitigate them. Next, Time criteria and Reliability criteria because electricity production cannot lack fuel. Therefore, the time for transportation of coal and safety must be at an acceptable level from EGAT. For, Geography and Technology. They considered with the possibility to change transportation route when they may have problems in the routing technology available. Finally, the least important factors are infrastructures criteria and ulterior factors criteria which EGAT cannot control. It is depending on the government, EGAT can only use as numerous as possible.

In this research, the weighting of only the main criteria are presented. Due to the several were achieved from previous study. The weights of sub criteria are determined in the later stage of this research.

.Conclusion

Multiple criteria for selecting transportation route of inbound reserved coal to Mae Moh Power Plant, Lampang THAILAND. This paper assembled multiple criteria from previous studies, and they were preliminary determined by Electricity Generating Authority of Thailand (EGAT) experts and

stakeholders to identify liable criteria which affect the selection of reserved coal transportation route. By means of Analytical Hierarchy Process (AHP) method, the proposed approach is employed to define the important weights of criteria and calculate priorities from pairwise comparison approach. As a result, 31 sub criteria were selected and grouped into 8 main criteria. However, the sub criteria have a major effect on the weighting of main criteria. So, the most important criteria are Cost and Environmental impact. By contrast, the least important factors are infrastructures and ulterior factors.

Further guidelines of the current research are the following: to find the important weighting for each of sub criteria by AHP and choosing the most favourable transportation route of reserved coal using TOPSIS approach.

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ON CLUSTERING TECHNIQUE OF DELIVERY PATTERN FOR CLASSIFYING COURIER CUSTOMERS

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Introduction

Today, Thai E-Commerce industry value is now worth 2.8 trillion THB, increasing 10% per year, bywhich 59% are B2B and 22% are B2C. 40% of these are from social media and 29% are from e-marketplace. Courier industry in Thailand has also grown more than 10% per year, resulting from this increasing trend of E-Commerce and the advancement of Information Technology [1]. The courier industry of Thailand has a value of more than 30 billion THB [2]. There are many courier companies competing in this market both multi-national companies, joint ventures, and local companies [3]. The service varies from traditional door-to-door and port-to-port delivery to the advanced Information Technology-based on-demand delivery. Price and speed are not the only requirements. Convenience, traceability, and confidence are today key success factors for courier service [4].

Thailand Post is the main player in courier and post service with an average of 8 million items delivered daily. However, Kerry Express, SCG Express, Flash Express, Best Express, Nim Express, DHL, FedEx are examples of new entrants growing fast in the courier service. The service today is "same day" within the main cities and "next day" otherwise. IT has been used extensively in these service providers aiming at increasing service value such as mobile application, website, barcode, etc. Despite the strong competition, the market is growing rapidly and still attractive.

Case Study Courier Company

The case study courier company for this study is a new entrant to the courier industry. Before, the company had been providing a passenger bus service for northern Thailand region. Recently, the service was expanded to all regions of Thailand. With available space under the bus, the company has introduced a courier service, port-to-port using the existing facilities and bus routes. The courier service has been successful with 17% of the company revenue and has been increasing concretely. The strengths of the company service are speed and reliability. For example, from Chiang Mai to Chiang Rai (153 km) the parcel could be sent port-to-port within 3.5 hours, as quick as the passenger transfer. Where in this case, the other providers could offer next day at best.

The company provides service of in-transit merge, serving shippers to ship the parcel to their consignees within area of the company service. Today, there are more than 60,000 items sent via the company per month. Transaction data is collected using the company IT system. It is linked to the financial and planning department. However, these data have never been utilized otherwise. Whilst today, Data Mining techniques, e.g., association rules, decision trees, can be applied to such data to generated value information [5-7]. Therefore, it is the aim of this study to investigate this database to create useful information. The study proposes the use of clustering technique in order to understand and classify customers by extracting their delivery pattern, both shipper and consignee sides. Then, the information can be used by decision-maker if any measures shall be deployed to increase customer satisfaction.

Clustering Technique

Clustering technique is a machine learning technique that can classify data into a group with the same properties or features. In other words, the technique can separate data that have dissimilar properties.

The technique has been used widely in many application including market research, pattern recognition, data analysis, logistics and image processing [8-10].

Among many clustering techniques, K-means algorithm is the least complicated clustering technique and therefore mostly used [11-12]. Giving a predefined number of cluster 'k', the data can be allocated into the nearest cluster center. Then the Euclidean distance can be calculated to determine as the fitness of the data into the cluster. The algorithm repeatedly changes the membership of the clusters until it reaches a local optimum [13-14].

RFM Concept

RFM is a method to analyse customer purchasing patterns and therefore segment customers based on their loyalty [15-18]. RFM stands for Recency, Frequency, and Monetary. Within a specific time of interest, the customer value can be multi-dimensionally measured by how recently the customer purchase (Recency), how often the customer purchase (Frequency) and how much the customer spends (Monetary). A variation of RFM was introduced to emulate categorical customer value, for example, RFD where D is Duration of using service, LRFM where L is Length, RFM-I where I is Interactions, RFMTC where T is Time and C is Churn rate [19-21].

In this study, the RFM concept is used and RFM is defined as

- R (Recency) is the period of time between the previous services used date and set date. The low recency customers tend to use the service more than the high recency [22].
- F (Frequency) is the total number of service used within a particular period of time.
- M (Monetary) is a total THB amount that the customer uses the service within a particular period of time.

In the courier case study, the delivery pattern is of interest. Therefore, additional factors were introduced to RFM, i.e., Weight (W), Day (D), number of Product category (P) and number of Customers (C), called RFMWDPC. The purpose of the inclusion of these factors as follows

- W (Weight) is an average weight per transaction (kg.) It can differentiate customer type by weight. This help the company to understand the norms and requirement of the customers.
- P (number of Product category) represents a level of a variety of products sent from shippers or received by consignees. P can be suggestive of what the type of business they are. For example, shippers with high P which can supply a variety of products might be a retailer or wholesaler. On the other hand, if shippers have low P, they might be manufacturers or specialty stores [23].
- C (number of Customers) represents how many customers have been served by shippers. It is also suggestive if the shippers are large business trading with many customers or businesses that trades with a limited customer. The e-commerce businesses are likely to deal with a large C [24-25].
- D (Day) represents the average number of day interval between transactions. The lower D reflects the frequent delivery pattern.

Methodology

The methodology of this study is exploratory. With many product types delivered by the company, "clothes" product is used as an example of this study. The delivery of this product generates income for the company of 10.88m THB in 2018, accounting 19 % of the company's gross income on parcel business unit.

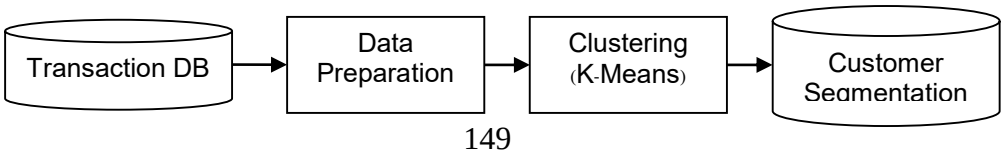

Figure 1: Conceptual Model of Clustering Delivery Pattern of Courier Customers

Sorted and cleaned from the database, there are 58,987 transactions from 14,848 shippers and 20,442 consignees during year 2018. Characteristics of shippers and consignees can be summarised in Tables 1 and 2.

Table 1: Shippers Characteristics

Stats	Mean	Median	Max	Min	SD
R	158.20	148.00	364.00	0.00	113.72
F	3.98	1.00	3158.00	1.00	34.71
M	734.59	118.00	465751.00	0.00	7083.13
C	1.58	1.00	560.00	0.00	6.45
P	1.88	1.00	54.00	1.00	1.78
W	12.17	5.00	473.50	1.00	20.61
D	274.97	364.00	364.00	0.50	142.37

For shippers, the average R is at 158.20 days. The highest recency is at 364, meaning these shippers send parcel every day. The lowest is at 0, meaning the last shipment of these shippers are as far back as 1 year. The frequency of delivery (F) ranges from 1 to 3,158 delivery per day. The average F is at 3.98. F Median is at 1. The average spending (M) of shippers is at 734.59 THB/ year. M Median is at 118 THB/year. The highest M is at 465,751 THB/ year. The average number of customers per shipper is at 1.58 customer/shipper. However, some shippers serve up to 560 customers in a year. The average number of products per shipper is at 1.89. However, some shippers serve 54 product types. Weight also ranges from less than 1 kg. to 473.5 kg. per shipper per year. The average weight per shipper is at 12.17 kgs. The median weight is at 5 kgs. Days interval between transactions also ranges from 0.5 days to 364 days. The average is at 274.97. The median is at 364.

Table 2: Consignees Characteristics

Stats	Mean	Median	Max	Min	SD
R	161.90	154.00	364.00	0.00	113.82
F	2.37	1.00	315.00	1.00	6.28
M	431.88	114.00	196646.00	0.00	2458.98
C	1.16	1.00	45.00	1.00	0.80
P	1.63	1.00	33.00	1.00	1.23
W	14.27	14.27	775.00	1.00	23.49
D	5.81	5.81	337.00	0.00	20.86

For consignees, the average R is at 161.90 days. The highest recency is also at 364. The lowest is at 0. The frequency of delivery (F) ranges from 1 to 315 delivery per day. The average F is at 2.37. The median of F is at 1. The average spending (M) of shippers is at 431.88 THB/ year. M Median is at 114 THB/year. The highest M is at 196,646 THB/ year. The average number of shipper per customer is at 1.16 shipper/customer. The maximum shipper per customer is at 45. The average number of products per customer is 1.63. However, some customer receives up to 33 product types. Weight also ranges up to 775 kg. per customer per year. The average weight per customer is at 14.27 kgs. The average days interval between transactions is at 5.81.

From above, it can be seen that shippers and consignees of the case study company possess a relatively similar delivery pattern, except days interval between transaction.

Exploratory Results

Here, RFMWDPC is clustered using K-means and the results are shown in Tables 3 and 4. For shippers, they are grouped into 5 clusters. For consignees, they are also grouped into 5 clusters.

Table 3: Shipper Clusters

	Cluster_0S	Cluster_1S	Cluster_2S	Cluster_3S	Cluster_4S	Mean
Number of Shippers	14,534	40	3	228	13	
Average R	160.84	7.00	1.33	27.21	1.69	158.20
Average F	2.32	124.98	1960.00	44.01	334.15	3.98
Average M	313.65	38288.36	408641.00	9920.17	100562.37	734.59
Average C	1.31	15.45	301.00	8.81	63.85	1.58
Average P	1.85	3.85	13.33	3.18	8.92	1.88
Average W	11.59	54.68	36.28	39.52	48.06	12.17
Average D	280.13	5.06	1.38	13.05	2.30	274.97

Here, it can be seen that 5 groups of shippers vary in delivery patterns. The biggest group is Cluster_0S of 14,534 shippers with the same delivery pattern. Cluster_0S can be considered one-time customers with average F of 2.32, average M at 313.65, average C at 1.31 and average D at 280.13. The second biggest group is Cluster_3S of 228 shippers. This group is also considered irregular customers with average F of 44.01, average M at 9,920.17, average C of 8.81 and average D at 13.05.

3 shippers in Cluster_2S, on the other hand, are the regular customers who have used service as frequent as 1,960 times per year, with average R at 1.33, average K at 408,641, average W at 36.28 and average D at 1.38. They also serve as many customers as 301 with an average of 13.3 product types.

53 shippers in Cluster_1S and Cluster_4S are also considered regular customers. Their average F is at 124.98 and 334.15, average M at 38,288.36 and 100,562.37 and average D at 5.06 and 2.30. The slight difference between these 2 clusters is their number of consignees. Whilst Cluster_1S serves averagely 15.45 customers, Cluster_4S serves 63.85.

Table 4: Consignee Clusters

	Cluster_0C	Cluster_1C	Cluster_2C	Cluster_3C	Cluster_4C	Mean
Number of Consignees	26	130	743	19537	5	
Average R	10.27	33.40	67.54	166.58	4.20	161.90
Average F	64.04	34.32	13.25	1.61	195.60	2.37
Average M	29901.85	10308.48	2817.85	206.22	117554.91	431.88
Average C	3.96	3.31	2.32	1.09	10.20	1.16
Average P	3.15	2.62	2.30	1.59	17.00	1.63
Average W	83.34	55.13	44.15	12.75	96.84	14.27
Average D	6.42	8.54	17.34	5.35	2.76	5.81

For consignees, 19,537 irregular customers can be identified by grouped into Cluster_3C. Their R is at 166.58, F is at 1.61, M is at 206.22, D is at 5.35 and W is at 12.75. Cluster_2C are also considered irregular customers with more frequency than Cluster_3C. Their R is at 67.54, F is at 13.25, M is at 2,817.85, D is at 17.34 and W is at 44.15.

Oppositely, Cluster_4C is considered the most valued customers. These 5 consignees received parcel with R at 4.20, F at 195.60, M at 117,554.91 and W at 96.84. They also received from an average of 10.20 shippers and 17.00 product types.

Cluster_0C and Cluster_1C are in between these two groups. Average R is at 10.27 and 33.40. The average M is at 29,901.85 and 10,308.47.

Discussion

Customers of the company can be divided into direct customers and indirect customers. Direct customers are the shippers who choose the service and responsible for sending the parcel. Indirect customers are the consignees who are, in fact, the customer of those shippers. But in many cases, they can be the ones who choose the delivery service.

To illustrate the characteristics of the shippers, aggregated normalized scores are used here. Where Volume represents a combination of M and W, Regularity represents a combination of R, F, and D, Diversity represents C and P.

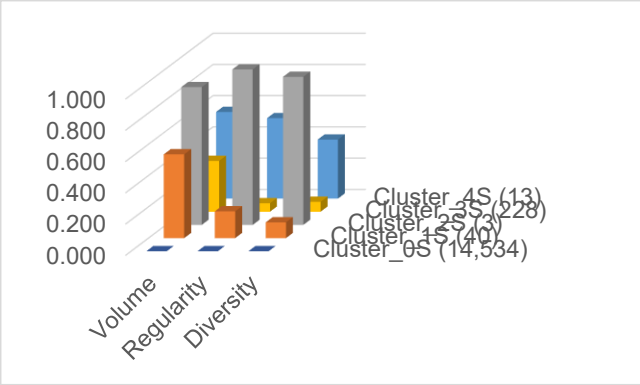

Figure 2: Shipper Cluster Characteristics

As for a direct customer, shippers can be segmented and high-value customers can be identified. Cluster_2S, Cluster_1S, and Cluster_4S can be the prioritized target if the company wishes to offer reactivation campaigns, high-value customer programs or combating churns, the focus can start from the top-spending regular customers [26-27]. The 3 shippers in Cluster_2S are the top customers with extremely high volume, regularity, and diversity (see Figure 2). Shippers in Cluster_4S are also valued customers with relatively high volume and regularity. Cluster_1S also possesses relatively high volume pattern with lesser regularity and diversity. Whilst possible, the relationship must be maintained or even improved. Especially, new customers, which have just started doing business with the company, can become top value customers in the future.

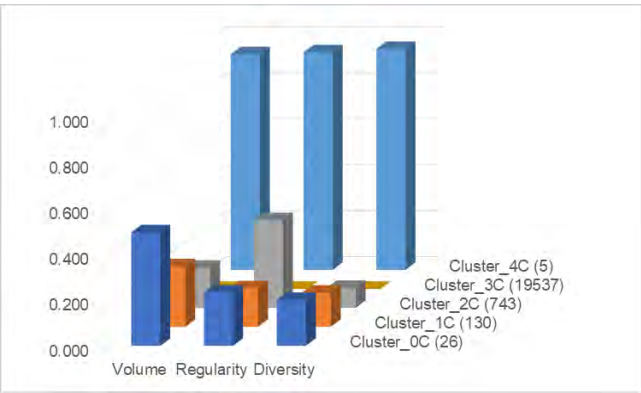

Figure 3: Consignee Cluster Characteristics

On the other hand, consignees in Cluster_4C, Cluster_0C, and Cluster_1C can also be segmented as the value indirect customers. Cluster_4C possesses high volume, regularity and diversity

characteristics. The priority might be lower than those direct customers. Yet, pattern monitoring and further investigation can be beneficial.

Conclusion

The study uses K-mean clustering technique to classify courier customers, both direct customers or shippers and indirect customers or consignees of the case study courier company in Chiang Mai, Thailand. The delivery pattern is based on 7 factors, i.e., Recency, Frequency, Monetary, Weight, Day, Number of Product Category and Number of Customers. The exploratory result is based on the example product, "clothes". Where the shippers were classified into 5 clusters, the consignees were also classified into 5 clusters with different delivery characteristics. The top value direct and indirect customers with high volume, regularity and diversity can be identified. The information can be suggestive if any measures shall be deployed to increase customer satisfaction.

Acknowledgement

The authors gratefully acknowledge the Thailand Research Fund (TRF) for financially supporting this research under Contract No. PHD58I0068. This research work was partially supported by Center of Excellence in Logistics and Supply Chain Management, Chiang Mai University – Thailand.

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RE-VISITING ASSUMPTIONS USED IN CALCULATING NATIONAL LOGISTICS COST: A THAI CASE STUDY

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Rationale

Thai economy has been suffering from the low efficiency of its logistics systems. This is evident that Thailand has remarkably high logistics cost in relation to its Gross Domestic Product (GDP). Having impacts on industrial structure as well as spatial distribution of the economy, the high relative logistics cost in Thailand greatly constrains the sustainable development of Thai economy (Liu, 2016). While the Thai government, including other Asian countries, are proactively taking measures in order to help reduce its logistics cost in relation to its GDP, a special attention should be paid is the relation between the logistics cost and economic development (Banomyong, 2008; Banomyong et al., 2008). This will help support the development of Thailand logistics policies and, finally, will have impact on the improvement of its regional economic development (Banomyong et al., 2008).

Although proactive measures have been taken to help increase the efficiency of Thailand logistics systems, its logistics cost relative to GDP remains high for a decade (see Figure 1). In 2017, the total value of logistics cost of Thailand was approximately 2.1 trillion Baht which accounted for 13.8 percent of its GDP. In comparison, the US's total logistics cost in 2017 were around 1,494.7 billion US dollars, an equivalence of 7.7 percent of the GDP (ATKearney, 2018).

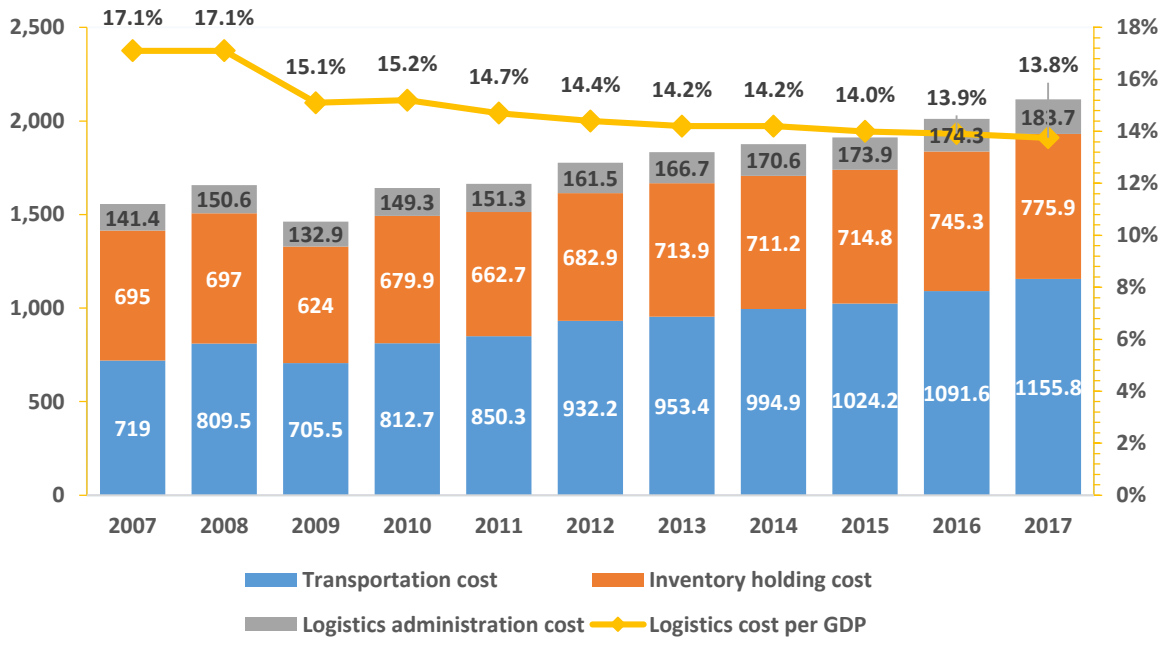

Figure 1: Thailand logistics costs per GDP during 2007-2018 (in percent)
Source: *National Economic and Social Development Council*

Although it might be argued that Thailand versus the US share few commonalities and might not put them to compare with each other, a comparison between Thailand versus with its ASEAN neighboring countries is more persuasive. While Thailand's logistics cost relative to its GDP are nearly 14 percent, the logistics costs of Singapore and Malaysia are about 8.5 percent and 13 percent, respectively, in comparison to their GDPs. Meanwhile, the logistics costs in most OECD countries are in between 8 to 10 percent (Armstrong & Associates, 2019). According to Rodrigues et al. (2005), global logistics costs in 2002 were estimated at USD 6732 billion, and corresponded to 13.8 percent of the world's GDP in that year. It seems that Thai's logistics cost per GDP is relatively high as compare with theses data.

National logistics cost is a key performance indicator used in Thailand's Logistics Development Plan. The National Economic and Social Development Council (NESDC) has responsibility to calculate the ratio of Thailand logistics expenditures over GDP. Secondary data were used with a series of assumptions in order to calculate its national logistics cost. However, these assumptions have never been revised and have been used in this sense since 2000. As macro logistics cost can be reflected from the users of a country logistics system (Havenga, 2018; Banomyong *et al.*, 2019), an exploration of the country's actual logistics performance is needed in order to determine, update and adjust these assumptions. In 2018, NESDC deployed a project aiming to develop the Thailand logistics cost model used for determining, exploring and improving the calculation method of the logistics cost calculation model. The model will help improve the calculations as well as help update the assumptions and variables used for Thailand logistics cost calculations. These variables are such as a transportation cost relative to the transport costs of van, pick-up and private port; an inventory carrying cost used as a component of inventory holding cost; and logistics administration cost.

The purpose of this manuscript is, thus, to show how the revisiting of these initial assumptions was done and how the exploration of empirical data for testing the assumptions used in the calculations was conducted. The results can lead to a more precise on a share of Thailand logistics cost per GDP and also reflect the current situation of the country's logistics performance. For the policymakers, this study provides a guideline that can help them formulate both infrastructures and regulations regarding the development of logistics systems in Thailand.

Logistics cost measurement terminology

Logistics cost is usually reported as its share of GDP (Havenga, 2018). Without taking a stand on the GDP's explanatory competence, a definition should be provided. GDP measures the value of all final goods and services as well as the value of export generated in a certain area during an observation period. GDP can be combined in many ways. One is by summing the final uses of goods and services (OECD, 2011). This study quotes the logistics cost as a percentage of GDP as this, wherever possible, can make the results for use in other purposes with different countries.

Costs are presented as a part of GDP here because, firstly, in the literature, this term is more commonly used than other macro economical indicators, such as Gross National Product or Purchase Power Parity, in order to represent the countries or regional logistics costs (Rantasila and Ojala, 2012; Havenga *et al.*, 2013; Havenga, 2018). Besides, when measuring costs in relation to GDP, it is widely a accepted barometer for gauging the rate of growth in economics (Coyle et al., 2008). Secondly, this is also because the data from national statistics institutions are considered reliable (Farahani et. al, 2009).

Review the assumptions of Thailand's Logistics Cost

In 2000, Thailand had published the first national logistics cost report by NESDC. This report employed an experimental study by employing the data from Input and Output (I-O) table as the main data source and combined it with GDP data. However, the results found that some activities did not include in the I-O table. Basic information used for calculating Thailand national income did not comply with the logistics concept and logistics cost calculation methodology. The statistical data derived from other reliable sources were needed. These data came from such as the Department of Land Transport, Marine Department, Ministry of Transport, Department of Internal Trade, National Statistical Office and many other state-owned enterprises that have the roles related to logistics activities such as the Port Authority of Thailand, Airports of Thailand and Expressway Authority of Thailand. There was a belief that these data can provide the precise data that can improve the quality of Thailand's logistics cost imputation.

In order to make a diagnosis on Thailand's logistics system, the authors started an analysis by examining the structure of Thailand's logistics costs. Based on the framework and methodology proposed in the annual 'State of Logistics Report U.S.' written by Delaney and Wilson (2003), logistics

costs can be divided into four categories, namely, transportation cost, warehousing cost, inventory carrying cost and administration cost.

(1) Transportation cost focuses only on freight transports, excluding passengers. Most of the data regarding transportation cost can be derived from the I-O table as shown in Table 1. However, the coverage of the I-O table did not include the transportation cost of truck loaded less than 1.6 tons (hereafter pickup truck). NESDC had to impute this cost by assuming that the average income of pickup truck is equivalent. Multiplying the average income with total number of pickup truck (the latter data obtained from the Department of Land Transport) results as the transportation cost of truck.

I-O code	Description		Remark
136	*Pipe line and gas distribution*	This sector covers gas distribution such as liquefied petroleum gas, ethane, propane and natural gasoline	Calculate all CT
149	**Railways**	This sector covers the service related to the transportation of both passengers and cargo. Also included are dining car services. Since the repair of railway equipment is not covered in this sector	Calculate only CT of freight transportation
151	**Road freight transport**	This sector covers local and long distance trucking. Also included are such services for one's own business purposes	Calculate all CT
152	**Land transport support service**	This sector includes all land transport support services such as the operation of parking lots, toll roads rental of automobiles and self-driven trucks	Calculate only CT of truck transportation
153	**Ocean transport**	This sector covers the ocean transport of both passengers and freight	Calculate all CT
154	**Coastal and inland water transport**	This sector refers to the operation of freight and passenger vessels along various parts of the coast of Thailand. Those operated on inland waterways, river ferries and tugboats are included	Calculate only CT of freight transportation
155	**Water transport services**	Included in this sector are the provision of supporting services for water transport of all kinds such as the maintenance and operation of harbours, docks, lighthouses and other navigation aids, loading and unloading services, the salvaging of vessels, ship leasing and rental. Included in this sector are the activities of the Port Authority of Thailand	Calculate only CT of freight transportation

156	**Air transport**	The transportation of passengers and freight by air by regular services or by charter are covered in this sector. The operation of airports, landing fields and navigational facilities such as flight control centres, radar stations and the rental of aircraft are also included in the sector	Calculate only CT of freight transportation
157	**Other services**	This sector covers the activity of establishments engaged in providing travel information and arranging tours and transportation for passengers. The activities of establishments engaged in cargo transportation are also covered	Calculate only CT of freight transportation

Note: CT refers to "Control Total" or the sum of total intermediate transactions and value added

Table 1: The I-O table of transportation cost

(2) Warehousing cost is represented by the I-O code 158. The I-O table includes only the cost of outsourcing warehousing and other silo activity but excludes in-house warehousing activities incurred inside a firm. As a result, an imputation of the in-house warehousing activities was done based on the assumption suggested by Goh and Pinaikul (1998) who stated that the ratio between in-house and outsourcing warehousing is equal to 65:35.

(3) Inventory carrying cost in the I-O table focuses on opportunity cost incurred by carrying inventory stocks. This cost was imputed based on the data derived from the Control Total of a producer price for each manufacturing sector appeared in the I-O table. It was calculated using an equation: opportunity cost equals to the value at producer price multiplies with interest charges.

(4) Logistics administration cost is not a common cost used in the Thailand's accounting system as well as in GDP and I-O table. Thus, an imputation of logistics administration cost was done based on Delaney's framework. It assumes that 10 percent of the sum of transportation, warehousing and inventory carrying cost is the logistics administration cost. During that time, this ten percent was based on that Thailand lacked of technological supporting system

These assumptions used for logistics cost calculation have been updated and adjusted many times by NESDC. Based on the Thailand national logistics cost report 2017, the recent updated assumptions are presented in Table 2.

(1) Transportation cost for pickup trucks was imputed using this following formula:

Cost of pickup truck = The number of registered and active pickup trucks * Average income per trip * Days of transport per year

The number of registered and active pickup trucks	Bangkok	The sum of the number of registered cars increased in the last past 7 years
	Rural area	The sum of the number of registered cars increased in the last past 10 years
Ratio of pickup trucks used for freight transport	Bangkok	0.4
	Rural area	0.3
Ratio of pickup trucks used for transporting products	Agricultural	0.48
	Others	0.52
Average income per trip	Agricultural	1,900
	Others	2,200
Days of transport per year	Agricultural	150
	Others	300

Source: NESDC

Table 2: The recent updated assumptions of pickup trucks

(2) Warehousing cost consists of private warehouses and expenditures on silos that were derived from the Public Warehouse Organisation's database, under the authority of Ministry of Commerce. This was the only accessible database for NESDC. However, the cost was collected from only the expenditures incurred by outsourcing warehousing activities. Thus, it does not include the cost of incurred when private sectors manage their owned warehouses.

(3) Inventory carrying cost is an opportunity cost. Based on Delaney's method, the opportunity cost composes of two components. Firstly, the value of inventory multiplies with interest rate suggested by 1-Month AA Financial Commercial Paper Rate of Bank of Thailand. Secondly, NESDC adapted this component based on Alford-Bangs Production Handbook. This component is the sum of taxes, obsolescence, depreciation and insurance. It can be calculated by multiplying the value of inventory with Beta which was assumed that equals to 19 percent. Thus, the overall formula can be present as:

$$Inventory\ carrying\ cost = Value\ of\ inventory * (i + Beta)$$

(4) Logistics administration cost is based on the assumption mentioned previously. It equals to 10 percent of the sum of transportation, warehousing and inventory carrying costs.

Hereafter, NESDC aims to revise the calculation method of logistics cost model to be more accurately and up-to-date as well as to be able to reflect the country's logistics system development.

Research methodology

Thailand Standard Industrial Classification (TSIC) developed by Department of Business Development Ministry of Commerce provided a classification of business sectors in Thailand. There were totally 21 business sectors (TSIC, 2009). A challenge was that logistics has an important role in all businesses. It would be costly if data were collected from all businesses in all sectors. A meeting group organised by NESDC was set up. Participants were experts in Thailand logistics (i.e. officers from NESDC, the National Statistical Office, the Ministry of Industry, the Ministry of Agriculture and Cooperatives, as well as academic experts in the logistics field). A consensus was drawn. There were 6 business sectors that were mostly related to Thailand logistics cost (see Table 3). As GDP is usually traded off against national logistics costs (Havenga, 2018), the GDP values of these 6 sectors were also summed up. As a result, these 6 business sectors contribute as 96.8% of total final demand of GDP value created by all business sectors. This can be concluded that these 6 sectors can be representatives of all sectors.

This manuscript employed a survey methodology. A questionnaire with a structured interview was employed. A set of questions and systematical interview methods were set up in advance. Samples were drawn from population based on the theory of probability. For a participant to be considered as a probability sample, he or she must be selected using a random selection. The most important requirement of probability sampling is that everyone in a population has a known and an equal chance of getting selected. Probability sampling gives the best chance to create a sample that is truly representative of the population.

Sector	Description
A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
S	Other service activities

Table 3: The six selected sectors based on the TSIC classification

In 2017, Department of Business Development Ministry of Commerce reported that there were totally 438,857 firms in these 6 business sectors. The calculation of sample size was done by employing a formula provided by the National Statistical Office of Thailand. The formula is illustrated as follows:

$$= \frac{Nz^2v^2}{z^2v^2 + NE^2}$$

where N = Population
n = Samples
Z = Standardised score at 95% confident interval (Z = ±1.96)
V = Coefficient of Variation (C.V. = 1.0)
E = Margin of error (2.5%)

The formula suggested that this study should collect at least 6,000 samples out of 438,857 firms in 6 sectors. The sample selection was purposive and criteria were made. Selected samples were diverse covering all Thailand regions, namely, Bangkok and its vicinities, Northern, Central, North-eastern, East, West and Southern. Companies were ranked according to the capital investments. Companies with higher capital investments were chosen first.

A 6 months full survey was conducted. There were 15,000 requests sent covering all regions of Thailand and only 6,020 questionnaires responded. These 6,020 questionnaires that were sent back on-time are approximately 40 percent of reply rate. Finally, the obtained data from a survey were calculated according to all the formulas mentioned previously. The new assumption numbers were compared with the assumptions used by the NESDC. A comparative analysis was done. The NESDC's assumptions were replaced with the new calculated assumption numbers. Re-calculation of Thailand logistics cost was done.

According to Thailand's logistics cost model development, this combination of methodologies from the initial through recent model were validated with NESDC (who had published an annual Thailand's logistics cost report) and representatives from the related government agency and the stated-owned enterprise e.g. the Ministry of Commerce, Ministry of Transport, Ministry of Industry, etc.

Findings

The comparative results of each logistics cost component are presented below.

(1) Transportation cost: the results from survey slightly differ from the original assumptions used by NESDC (see Table 4).

Description	Agricultural product	Others
Ratio of van and pickup used (%)	15	85
Average income per trip (Thai Baht per trip)	1,275	1,578
Days of transportation (days per year)	217	278

Table 4: The proposed assumptions for pickup trucks

It can be seen that the new assumptions calculated from the survey data, especially the income per trip for agricultural products and other products transportation are lower than the NESDB's assumptions. Regarding the days of transportation per year for agricultural products, the number calculated from the survey data is higher than those used by NESDB. For other products type, these numbers show slightly difference. This can be suggested that NESDB can still use its original assumptions. For the more accuracy, the new calculated assumptions regarding income and the number of days of transport products can also be used.

(2) Warehousing cost consists of in-house and outsourcing activities. However, only outsourcing cost was included in the current model used by NESDC. Thus, the ratio between in-house and outsourcing warehousing was included in the questionnaire. As a result, the survey data showed

that 92.8% of respondents use their owned in-house warehouses. This ratio is then can be used as an assumption to calculate the warehousing cost. This can be implied that the value of outsourcing from NESDC equals to 7.2 percent while the imputed value of in-house warehousing equals to 92.8 percent. The reason of this method is that NESDC cannot specify the cost of in-house activities due to the limitation of unavailable data. Therefore, NESDC may have to consider the use of the proportion of warehouse management to estimate the cost of warehousing in order to increase consistency and to be able to reflect the current Thailand business environment.

(3) Inventory carrying cost consists of two cost components. The part that considers tax depreciation and insurance fees was based on the Alford-Bangs Production Handbook Formula. Tax depreciation and insurance costs were originally estimated by assuming that the constant-beta equals to 19 percent. This percentage was multiplied with the value of inventory stock each year. However, based on the result from the survey, this calculation indicates constant-beta values for each sector as shown in Table 5.

Sector	**Constant-beta**
A: Agriculture, forestry and fishing	22.11%
B: Mining and quarrying	0.00%
C: Manufacturing	26.17%
F: Construction	11.15%
G: Wholesale and retail trade; repair of motor vehicles and motorcycles	22.87%
S: Other service activities	0.00%
Sample Median	**16.63%**

Table 5: The value of constant-beta for each business sector and the averaged constant-beta value

The proposed assumption for inventory carrying cost is:

$$Inventory\ carrying\ cost = Value\ of\ inventory * (Interest\ rate + 16.63\%)$$

Regarding the calculation of the tax depreciation and insurance fees costs based on the Alford-Bangs Production Handbook Formula, the new numbers are reduced to 16.63 percent constant-beta. This better reflect Thai business.

(4) Logistics administration cost based on the survey result is 151,773,029,911 Baht. According to the concept of logistics cost calculation by NESDB, it can be said that

$$Logistics\ admin\ cost = 10\% * (Transportation + Warehousing + Inventory\ carrying)$$

The survey data reveals the actual values of logistics administration, transportation, warehousing and inventory carrying costs. Based on these new values, the new constant value ($X\%$) can be calculated as follow:

$$\begin{aligned} Logistics\ admin\ cost &= X\% * (Transportation + Warehousing + Inventory\ carrying) \\ 151,773,029,911 &= X\% * (1,098,341,028,069 + 788,231,228,188) \\ X\% &= 151,773,029,911 / (1,098,341,028,069 + 788,231,228,188) \\ X\% &= 8.04\% \end{aligned}$$

The analysis based on the survey data indicates that the constant value should be less than 10 percent which is the number NESDB has been used since 2004. NESDB may consider adjusting the constant value and may change from 10 percent to 8.04 percent. This new number may be more appropriate as it reflects many developments of Thailand logistics system for over the years.

Table 6 summarises all proposed assumptions that were calculated based on the survey data.

Logistics cost	Original NESDCs' assumptions	Suggestions emerged from the survey data
Van and pickup truck cost	Ratio Agricultural : Others 0.48% : 0.52%	Ratio Agricultural : Others 0.15% : 0.85%
	Average income per trip Agricultural : Others 1,900 : 2,200	Average income per trip Agricultural : Others 1,275 : 1,578
	Day for transportation Agricultural : Others 150 : 300	Day for transportation Agricultural : Others 217 : 278
Warehousing cost	Calculated only outsourcing warehousing	Based on the ratio calculated from the survey data In-house : Outsource 92.8% : 7.2%
Inventory carrying cost	Constant Beta = 19%	Based on the new constant beta calculated from the survey data 16.63%
Logistics administration cost	10% of the sum of transportation cost, warehousing cost and inventory carrying cost	Based on the new constant value calculated from the survey data 8.04%

Table 6: The proposed assumptions for the Thailand's logistic cost estimation

Research limitations

There are two limitations in this study. Firstly, the survey data were drawn from 6 business sectors due to the limited budget and time of this study. Although the generated GDP of these 6 sectors contributed about 96.8 percent of the final GDP, in order to get better explicit and precise logistics costs, all 21 sectors according to the TSIC classification should be investigated. Another limitation is that the respondents' understanding of logistics administration cost was limited. This caused by the traditional cost accounting system did not deploy for logistics activity. However, the estimation of logistics administration cost was identified by re-collecting the ratio of firm's logistics administration cost versus their total administration cost. The short survey and interviews with participants who were working in logistics management levels of companies were conducted, align with the regional seminars and large firms' interviews were set up. These reflect that the understanding of logistics management for Thai entrepreneurs is still a significant limitation and is always a challenge for research studying logistics costs in Thailand.

Practical implications

This manuscript provides steps for updating assumptions used in the estimation of Thailand's national logistics cost per GDP. The updated assumptions calculated based on a survey data can better reflect the country's current logistics context. It is important to NESDC to have a more precise national logistics cost per GDP as this will impact on the monitoring and evaluation of national logistics development plan (Banomyong *et al.*, 2019). Public and private organisations may use these new assumptions in order to monitor and evaluate the successes and progresses of their organisations.

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RISK ASSESSMENT OF MODERN AGRICULTURE SUPPLY CHAIN FOR VEGETABLE

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Introduction

Nowadays, customer behavior has changed gradually due to adopt technologies in supply chain for enhancing competitiveness and meeting customer demand that need easiness and convenience. However, they are considering on sustainable sector especially on environmental impact. Agriculture is one of important supply chain which produce food to world population and has been transformed, modern agriculture when compare with traditional agriculture supply chain since population increase dramatically and the growing demand including climate change. Redesign the supply chain operation is necessary owing to increase serving productivity by several methods particularly technologies implement; Information technology, Green technology, etc. that shapes stakeholder roles and activities to both supporters and controllers of technology operation. Besides productivity, modern agriculture emphasizes on sustainable; social, economic and environment. On the social side, traditional agricultures in worldwide process in push market normally because of inequality bargaining power among stakeholders despite many farmers or producers, all orders were driven by fewer processors, trader, manufacturers that shows in Figure 1 and lead to imparity income to upstream economic sector. Moreover, the traditional supply carries on huge food loss due to ineffective process and food waste from many steps of food flow.

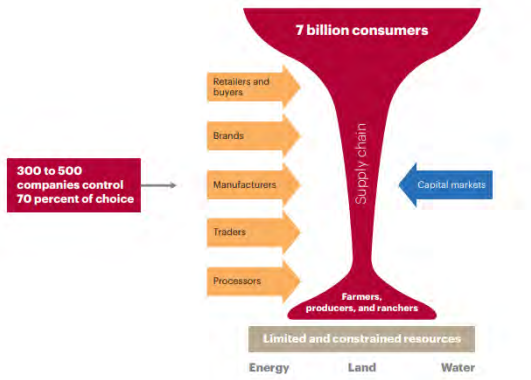

Figure 1: The world food industries supply chain bottle neck
Source: A.T.Kearney, 2012

Nevertheless, process improvement is not only pivot process, but risk assessment is essential to manage supply chain effectively. Even sustainable supply chain is adopted, stakeholders need to understand uncertainty of supply chain then identify potential risk to assess severity and consequence (Tummala and Schoenherr, 2011) as negative uncertainties and unpredicted events can occur typically to supply chain (Heckmann et al., 2015).

Therefore, this paper aims to address meaning of modern agriculture supply chain including characteristics from historical articles aspect then gathered risk factor to be screened by experts and stakeholders and obtain potential risks to direct the appropriate mitigation approach. The rest of the paper is organized as follows: Section 2 presents relevant literature reviews. Section 3 shows results of researching and demonstrates the mitigation plan. Then, the last section concludes this paper.

Literature reviews

2.1 Agriculture Supply Chain

Agriculture plays an important role in the world supply chain to produce foods and nutrients, thus several countries have their agriculture system within countries despite developed countries and show in Table 2. World vegetable production has increased by 60% compare to 1991-2000 along with fruit production because of the growing demand (Parajuli et al., 2019).

Table 2: Statistic of agriculture sector in 12 countries

Countries	Agriculture hiring (% of population)	GDP per capital (US$)	Value-added of agriculture (% GDP)	Agriculture area (% of total land area)
Australia	2.6	44,494	2	48
Brazil	10.2	14,077	4	34
China	18.1	14,644	9	56
French	2.9	38,063	1	52
Germany	1.3	44,432	1	48
India	43.4	6,096	16	60
Italy	3.9	34,655	2	43
Spain	4.2	33,320	3	53
Russia	6.7	24,417	4	13
Turkey	19.5	23,757	6	50
England	1.1	39,309	1	72
USA	1.7	53,399	1	44

Source: Kucukvar et al., 2019

Agriculture supply chains consist of input supply, production, postharvest, storage, processing, marketing and distribution, foodservice and consumption function with many players in the chain (The World Bank, 2010) The major challenge of agriculture that players are facing is climate change, therefore researchers aim to manage agriculture with environmental by concerning climate change effect on production. Appropriate adaptation and mitigation measures are adopted to expand resilience in agriculture supply chain. Parajuli et al. (2019) revealed that climate change influence CO2, temperature, drought, and air pollution alteration which are major resources of plantation, Technology adaptation was suggested along with supply chain management. Moreover, planning tools are necessary for the entire supply chain to provide breed, transportation type, and market properly to reach the highest price (Flores et al., 2019) including inventory problem and freight consolidation. Moreover, customer behavior can propel agriculture operation due to tend to value in food safety. Ariyawardana et al. (2017) mentioned that customers ensure in farmers more than retailers and would like to consume national products more than imported because of shorter length of the supply chain. Food security also has been encountering worldwide and affect to food production sector to end hunger by reducing food loss and improve food and dietary needed effectively.

Thus, modern agriculture nowadays concerns to increase productivity and effectiveness in sustainable aspect; social, economic and environment by adding resilience to supply chain.

2.2 Supply Chain Risk Management

Risk is the probability of event affecting operation to achieve objectives negatively or positively, risk management is therefore applied to gain the most advantage of positive risk and control negative risk at acceptance levels. Tummala and Schoenherr (2011) presented comprehensive risk management approach for entire supply chain, Supply Chain Risk Management Process (SCRMP) which comprises Phase 1; risk identification, risks measurement and risk assessment with following by Phase 2 is risk evaluation, risk mitigation & contingency plans and the last phase is Phase 3; risk control & monitoring that shows in Figure 2 and aim to enable stakeholders managing risk effectively that conform to ISO:13000 standard procedure (de Oliveira et al., 2017).

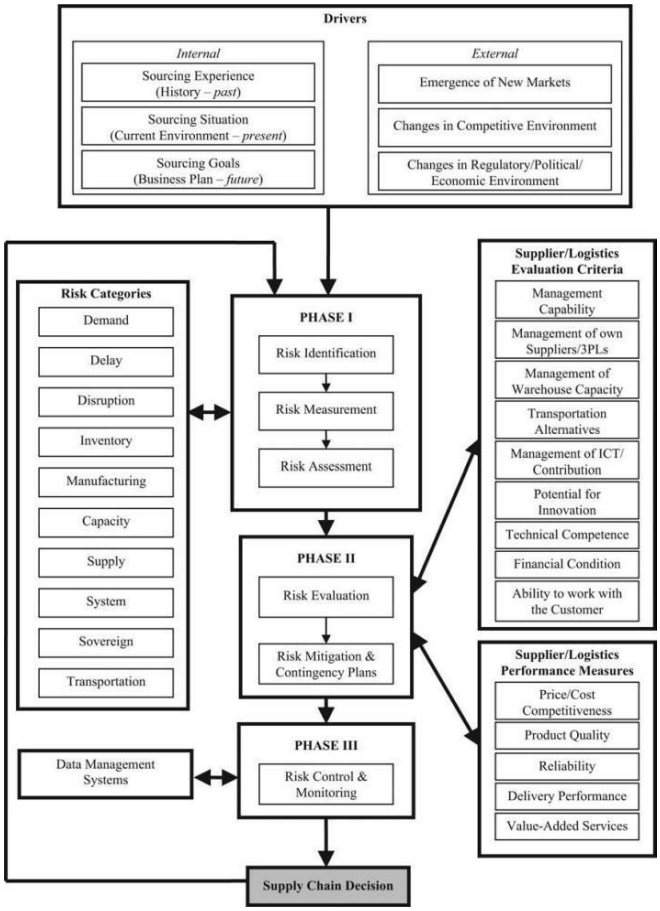

Figure 2: Supply Chain Risk Management Process (SCRMP)

However, agriculture supply chain is more vulnerable than further supply chain due to seasonality, supply spike and perishability (Behzadi et al., 2018) including weather, unpredictable nature of biological processes, market cycle, geographical separation and end uses and unique or uncertain political economy of food and agriculture (The World Bank, 2010). There are 2 groups of agriculture goods that Behzadi et al. (2018) categorized; crops and livestock with 2 criteria groups of risk that are supply risk and demand risk while Riwthong et al. (2017) claimed 4 types of operation risk that consist of production risk, market risk, financial risk, and human risk. Similar to Deng et al. (2019) that summarized key risk for perishable products into 9 types including demand and raw material risk, staff risk, equipment risk, inventory risk, method risk, logistics risk, organizational risk, information risk, and environmental risk. As evidence from above, several articles show risks in agriculture supply chain but only traditional. Therefore, this paper aims to identify risk in modern agriculture supply chains which is Phase 1 in Figure 2 from gathering from previous studies then being screened by experts and stakeholders.

Methodology

3.1 Meaning of Modern Agriculture

This paper aims to define meaning of modern agriculture by applying for systematic review according to Bhakta et al. (2019) in last 5 years context (between 2015-2019) from historical article in ISI database with keyword "Modern agriculture" within title, abstract, author keywords, and keywords plus field then 1,869 articles were found including 67 articles in title area. After that, the articles were screened by research area, journals, categories, source titles and 255 was detected since there are massive irrelevant article to agriculture directly. Next, 62 articles were assessed preliminarily by abstract which only relevant articles were selected as many irrelevant article still showed up because of wide screen erewhile and this paper only focuses on contemporary agriculture so other articles were

eliminated then finally, 44 articles have been selected to provide meaning of modern agriculture and 18 articles were sorted out because even though these articles claim about modern agriculture in abstract but content does not involve and is not expedient. The systematic review shows in Figure 3. However, the definition of modern agriculture is demonstrated in sector 4.

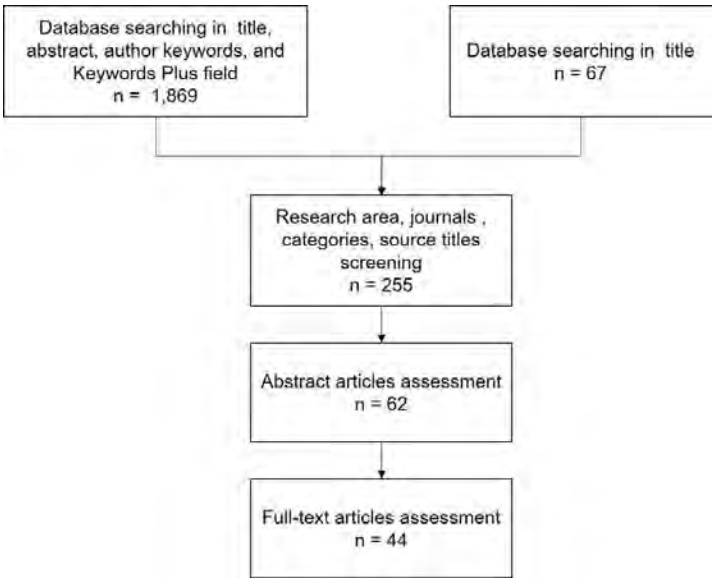

Figure 3: Systematic review on modern agriculture definition

3.2 Risk management of modern agriculture

According to the Supply chain risk management process (SCRMP) in Figure 2, this paper aim to identify potential risks solely which influence to modern agriculture supply chain negatively. Interview was adopted to experts and stakeholders for further operations and screening risks. Nevertheless, traditional agriculture risks were set from historical studies to obtain comprehensive risk thus this interview was semi-interview. Eventually, mitigation plans were suggested to alleviate risk influences.

3.3 Scope of research

- Direct supply chain level was considered in this study to obtain further operations and characteristics
- Vegetable modern supply chain in Chiangmai province, Thailand is studied.

Results and Discussions

According to the systematic review, 44 historical articles were selected to define meaning of modern agriculture supply chain and some show in Table 3. Most of the articles mention mainly about food security which concern about producing agriculture products or food to meet world population demand and aim to end poverty that lead to apply technologies and innovations (technology implement) for productivity improvement including sustainable agriculture that propose to operate agriculture activities by realizing social, economic and environment along entire agriculture supply chain whilst eco-friendly, food waste, equality among players were claimed but less than those.

Table 3: Modern agriculture in historical studies between 2015-2019

Author(s)	Sustainable agriculture	Technology implement	Productivity improvement	Resource conservation	Food security
Bhakta et al., 2019	✓	✓	✓	✓	✓
Collado et al., 2019	✓	✓	✓		✓
Sherwood et al., 2016	✓		✓		
Baker, 2017	✓	✓	✓	✓	✓

Lakhiar et al., 2018	✓	✓	✓		✓

In additional, modern agriculture is agriculture practice that encourages accessibility of scarcity resources worthily and enhance operation sustainably by applying vary technologies which lead to better control and insult in higher productivity to converge on food security.

After that, risk identification of modern agriculture supply chain was processed by interviewing experts and stakeholders. In Thailand, only farmers regularly apply technologies; information technology and green technology in only small-scale that lead to be not worthwhile to adopt high cost technologies as drone, driverless tractors when considers about net profit. Furthermore, implement of information technology and interconnection among direct supply chain players is not wide since huge invest cost as small-scale farmers are unable to afford and influence on other's players. So, risks that can affect to both tier 1 upstream and downstream are similar to traditional agriculture. Then risk criteria were collected from literature reviews that show in Table 4.

Table 4: Examples of risk criterial and criterion from historical studies

Risk Type	**Risk Criteria**	**Risk criterion**	**Behzadi et al., 2018**	**Riwthong et al., 2017**	**Deng et al., 2019**	**Hess & Sutcliffe, 2018**
Supply side	Supplier	Reliable	✓			
		Order responsiveness				
		Time				
	Material	Material quantitation	✓			
		Material quality	✓		✓	
		Material price	✓		✓	
Demand side	Customers	Demand variability	✓			
		Product variability	✓	✓		
		Being unable to sell produce		✓		
Internal Risk	Planning	Raw material forecasting			✓	
		Order planning				
	Production	Quality of product	✓			
		Plant time	✓			
		Colour and ripeness harvesting	✓			
		Human error			✓	
		Inappropriate equipment			✓	
	Waste disposal	Wastewater treatment				
	Inventory and warehouse	Inefficient use of space			✓	

Risk Type	Risk Criteria	Risk criterion	Behzadi et al., 2018	Riwthong et al., 2017	Deng et al., 2019	Hess & Sutcliffe, 2018
		Low efficiency technology			✓	
	Transportation and delivery	Transportation failure	✓			
		Delay of inverse transportation	✓			
		Quality degradation			✓	
		Delay of transportation			✓	
	Financial	Investment cost		✓		
		Net profit				
		Operation cost				
	Organization management	Land lost		✓		
		Employee training				
		Corporate Social Responsibility				
External Risk	Economic and social	Policy			✓	✓
		Reputation on environment				✓
		Pleasure survey				
	Natural	Weather and disaster	✓	✓	✓	
		Pests and plant diseases	✓	✓	✓	

According to interview, farmers emphasize on control systems which manage the whole plantation more than employee error due to employee role is supporter of automatic system including this technology can take place of human. However, product quality is the most concerning risk that can affect other operation negatively while net profit is considered due to specify business existence and rely on price of material and final product. Moreover, external risk can implicate internal risk, demand risk and supply risk of stakeholders because of vast effect.

Conclusion

Modern agriculture risk varies to traditional agriculture and affect mostly on farmers owing to different operation which emphasize on automatic control systems whereas in Thailand, automation systems were not applied in all members of the supply chain. Maintenance of automatic control system is necessary for internal risk. Diversity plantation should be considered to mitigate external risk effects specially weather, disasters, pests and plant diseases. While Growing high crops could be important alternative to gain more profit including various suppliers and market which can reduce supply and demand risk. However, the mitigation plan should be established by considering specific context in each stakeholders and product type of supply chain.

Suggestion

This study identifies potential risks and suggests mitigation approach for only specific supply chain. Thus, the results may not apply to other organizations directly nevertheless research method could be as guideline plan to assess the risk in other supply chain.

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SOCIAL NETWORK ANALYSIS OF SUPPLY CHAIN AGILITY

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Introduction

Agility is one of three core qualities constituting effective and efficient supply chains (SCs) (Lee, 2004). How to achieve, improve, and enhance supply chain agility (SCA) is not only a research interest of academics but also a burning question for the practitioners. Accordingly, building an appropriate agility model and assessing agility levels are essential before improvement plans are implemented. However, both agility models and agility assessment approaches have received little attention. Meanwhile, much of the literature centres on exploring the concept, developing measurement, and examining the effects of SCA on firm performance (AlKahtani et al., 2019, Sharma et al., 2017).

From the lens of a complex adaptive system (CAS), like other SCM phenomena, SCA is neither determined merely by an aggregation of firms' efforts nor controlled deliberately by a single entity (Surana et al., 2005, Choi et al., 2001). The network perspective also highlights that SC capability varies upon the interconnectedness of SC relationships (Wichmann and Kaufmann, 2016). However, SCA is often studied from a firm's view (Sharma et al., 2017). A few studies take a supply chain view yet little consider relationship dynamics and interconnectedness with other SCs (Fayezi et al., 2017).

Social network analysis (SNA) is a powerful methodology and a valuable lens that can shed light on networks in either statistical or exploratory research of different disciplines (Quatman and Chelladurai, 2008). With the integrated lens of network and CAS, SNA can unveil hidden structures and mechanisms, which allows the study of a range of SCM phenomena in a comprehensive and systematic manner (Kim et al., 2015, Bellamy and Basole, 2013). However, applying SNA to the SCM domain is still a fledgling (Wichmann and Kaufmann, 2016, Bellamy and Basole, 2013). To address the current shortfall in empirical supply chain agility research using SNA this study factors on both the dynamics and interconnectedness of SC relationships to examine the agility of a network case.

Literature review

Agility was first explored in the supply chain context by (Dove, 1996). However, it was the work of Christopher (2000) that made supply chain agility (SCA) popular and has driven the concept development ever since. As a multidimensional concept, SCA encompasses diverse capabilities (Fayezi et al., 2017, Sharma et al., 2017). Quick response capability is the most emphasised because the essence of SCA is to respond to unexpected sudden changes in time-based competitions (Christopher, 2000). Responsiveness has two aspects; reactive and proactive (Gligor et al., 2013, Sharma et al., 2017). The former refers to responses to recognisable changes (Sharma et al., 2017) whereas the latter is usually described as an ability to detect changes, opportunities, and threats (Christopher, 2000, Li et al., 2008, Gligor et al., 2013). Flexibility is widely agreed as an inherent component of agility as the latter concept evolves from the former (Abdelilah et al., 2018). It commonly refers to the ability to modify operations (Gligor et al., 2013), to reconfigure, and to adjust types of collaborative relationships to the extent needed (Stevenson and Spring, 2007). Responsiveness and flexibility could not be achieved without information accessibility in virtual supply chains (Gligor et al., 2013, Baramichai et al., 2007, Ismail and Sharifi, 2006, Christopher, 2000). Indeed, visibility is necessary for SC capabilities including agility (Christopher and Peck, 2004, Gligor et al., 2013).

According to the systematic literature review of AlKahtani et al. (2019), few researchers have developed agility models or explored methods and tools for evaluating agility. Table 1 summarises five SCA assessment studies, these are theoretical, using either real case studies to test their models or illustrative cases to explain applicability. The assessment is most often made by a focal firm for its own SCs. An exceptional case is Xu and Liu (2015) who propose an agility evaluation method for a network of firms including the focal firm. The approaches, methods, and tools in these studies differ from each

other in terms of theoretical motivation and algorithm. However, they somewhat address the subjectivity and multidimensionality of SCA (Hernández and Pedroza-Gutiérrez, 2019).

Authors	Approaches	Methods	Unit of analysis	Research outcome(s)
Lin et al. (2006)	Fuzzy logic & multi-criteria decision making	Arithmetic mean, uclidean distance, and fuzzy ranking	Focal firm	A fuzzy agility index to identify major barriers to agility
Seyed Hosseini et al. (2010)	Adaptive neuro fuzzy inference system	Deductive, fuzzy inference systems, artificial neural networks	Focal firm	An adaptive neuro fuzzy inference system (ANFIS) to evaluate SCA
Faisal et al. (2007)	Graph theory	Digraph & matrix representation	Focal firm	An agility index to evaluate and rank SCA
Charles et al. (2010)	Symbolic modelling	Case study	Focal firm	A maturity model to assess SCA
Xu and Liu (2015)	Complex network theory	AHP and FCE, network structure parameters	Supply chain network	Network structure and organisation type agility evaluation

Table 5: Summary of selective studies of agility assessment approaches, methods, and tools

Theoretically, integrating both network and complex adaptive system (CAS) lenses can enrich SC research, particularly aspects related to structure and dynamics (Bellamy and Basole, 2013). In this stream, Hearnshaw and Wilson (2013) made an important contribution to the development of SC theory based on complex network theory considering SCs as CASs. The investigation of different network models together with complex and adaptive phenomena advances the understanding of SCs. The propositions set forth can be applied to explore characteristics of efficient SCs from both lenses. Subsequent authors (Sonia et al. 2015) go beyond efficient SCs to develop resilience metrics and examine the applicability of various network models to resilient SCs by agent-based simulation.

SNA was first introduced to the field of logistics by Carter et al. (2007) who outlined the potential of at the intra-organisational and inter-organisational levels. Borgatti and Li (2009) tailored relevant SNA concepts and network mechanisms to supply chain contexts. Their work not only adds clarity to the application of SNA but also emphasises the importance of selecting appropriate theoretical perspectives to maximise the benefits of SNA approaches and tools. The relevancy of SNA for inter-firm relationship management is reinforced by Galaskiewicz (2011) who advocates network visualisations as a means to study network dynamics over time. With the integrated lens of network and CAS, SNA is appropriate to investigate diverse SC phenomena including but not limited to SC flexibility, complexity, and sustainability (Wichmann & Kaufmann, 2016).

The literature of supply chain agility (SCA) is dominated by theory-based and exploratory studies on agility conceptualisation, there is a paucity of research on agility evaluation approaches and methods. Furthermore, SCA studies adopting qualitative or inductive methodologies outnumber those following quantitative approaches (Sharma et al., 2017). A lack of studies going beyond a focal business to a wider network view is still evident. Much of the literature on SCA apply organisational contexts rather than considering relationship dynamics (Fayezi et al., 2017).

The adoption of SNA either as a lens, a methodology, or a set of analytical tools is still nascent in the domain of SCM (Kim et al., 2011, Bellamy and Basole, 2013). Among network properties, network structure and topology attract the most attention, thus leaving a significant pool of other properties not yet explored. Therefore, it is observed that a macro network view and a micro actor view are the most popular whereas analyses at the group level is scarce. In addition, a wide range of SNA tools, metrics, and visualisation techniques have not yet been fully deployed or explicitly integrated, even in the extant studies of SC topologies and typologies (Kim et al., 2015, Basole, 2016). Empirical studies can be another potential gap to fill to either assess or demonstrate the applicability, reliability, and practicability of SNA in such SC phenomena.

This paper posits that SCA can be modelled by an integrated lens of network and CAS. A network perspective allows a supply chain-wide view rather than a firm focus as usually observed in the literature (Hearnshaw and Wilson, 2013) whereas agile SC dynamics arguably share some similarities with CASs, particularly in non-linearity, aggregation, flow, and diversity (Changrui et al., 2002). As a CAS, an agile SC evolves together with the environment characterised by dynamism, uncertainty, and risks. Any changes in the environment can impact network elements which then in turn may impact the environment either directly or indirectly by altering SCA. From network perspective, the network agility is determined by all network elements that are interrelated (Sonia et al., 2015). Following the work of Borgatti and Li (2009), transmission and coordination are two mechanisms underlying such network effects on SCA. In addition, as Towill (2005) notes, agile supply chains should be prepared and robust for severe shocks and disruptions. This is echoed by Pettit et al. (2010) that agility capabilities should reduce vulnerabilities. Consequently, robustness is incorporated as a foundation for network agility.

Methodology

This study adopted a quantitative methodology as by nature, SNA as an analytical method aligns well with relationship measurement. Structured and face-to-face interviews were used for data collection. Most interview questions were open-ended to solicit information of main suppliers and customers who all together contribute to 80% of supply value and 80% of sales respectively. The subject of this research was registered businesses in a targeted rural area of New Zealand. Respondents were business owners or managers. Since it is quite challenging to find them by conventional methods, the principal technique was a combination of purposive and snowball sampling (Bryman, 2016). The collected data had two main categories; organisational attributes – non-network data, and relations – network data. The former provided an overview of the network case and involved descriptive statistics for numerical results. The latter contained information of ties to construct a network which was analysed at three levels via UCINET.

Findings

The rural network case was constructed from 50 ego-networks wherein egos were interviewees and alters were their main suppliers and customers. This network included 456 entities and 724 business ties, Figure 1. Underlying this transaction-based network were two prominent supply chains; agriculture (A), and tourism and hospitality (T&H). Network A outperforms the tourism and hospitality network (see Table 2) across a wide range of indicators. In particular, the former has greater visibility, faster responses, better information integration, and higher relationship flexibility. It also benefits from greater SC collaboration and stronger robustness. In terms of network topology, with a lower network centralisation, Network A has more freedom, and hence, greater flexibility, and better responsiveness to changes and disruptions. This may contrast with previous research in manufacturing contexts wherein a highly centralised network structure accommodates flexibility that in turn contributes to operational effectiveness (Hernández and Pedroza-Gutiérrez, 2019). However, the result aligns with the performance implications of controllability asserted by Kim et al. (2011) that the higher centralisation, the less effectiveness, and the more undermined responsiveness. Network A is more robust than Network T&H though the latter has a clearer core-periphery pattern than the former. This might go against the common theoretical proposition that resilient supply networks tend

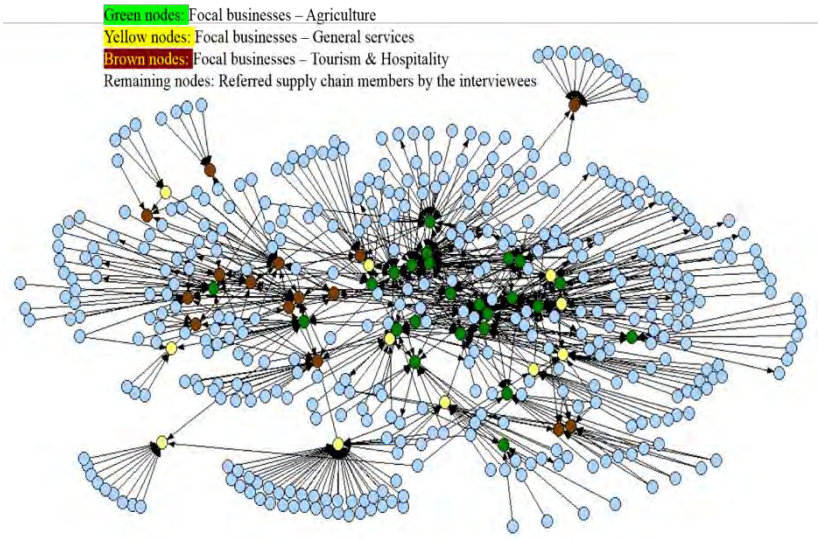

Figure 1: The total transaction-based network in the research

to follow a power-law distribution (Kim et al., 2015). To some extent, like food supply chains, the latter network reflects a restricted relationship structure that seems to be prevalent in rural settings (Hernández and Pedroza-Gutiérrez, 2019). Specifically, the current catering service providers do not purchase agro-based food and materials directly from local producers. Instead, they are supplied by middlemen who are in turn supplied by farmers and growers. The middlemen in this rural network case include food processors, wholesalers, and retailers who link the agriculture sector to this service sector. Hernández and Pedroza-Gutiérrez (2019) argue, in such a SC, "homogeneous distribution of links may favor agility more than heterogeneous distributions." (Page 7), thus a power-law degree distribution may be not the case for robustness and agility in supply networks that heavily depend on the middlemen.

Network properties	Comparable characteristics/ attributes	Agriculture (A)	Tourism & Hospitality (T&H)
Network topology	Degree centralisation	0.107	0.158
	Complexity	-	+
Network cohesion	Average degree	3.38	3.46
	Density	1.1%	1.405%
	Connectedness	1	1
	Fragmentation	0	0
	Average distance	3.66	4.065
	Diameter	6	8
Linkages of network regions & subgroups	% of open triads	0.13%	0.17%
	No. of cohesive subgroups - *cliques*	43	35
	No. of clusters formed by cliques	1	3
	Average number of common member(s)	14.97	8.06
	>4 members subgroups – *k-plexes*	11	5
	> 10 edge-independent paths – *Lambda sets*	9	6
	Highest level of edge connectivity	22	17
Importance of actors/ entities	% reached in 2 steps by 5 optimal actors	98.7%	94.2%
	% fragmentation if 8 most fragile spots	56.2%	77.1%

Table 6: Comparison of key network characteristics between the two supply chains

The shorter path length benefits Network A faster responses and greater visibility. This then can confirm the proposition of Hearnshaw and Wilson (2013) about the relationship between SC efficiency and short path length, particularly for information flows. The result may also confirm the validity of a method using average path length to measure responsiveness of resilient SCs proposed by Sonia et al. (2015). Meanwhile, the longer path length of Network T&H indicates a higher intermediation level. While the go-between actors facilitate information exchange they may risk network efficiency as bottlenecks or individual role overload (Long et al., 2013). The lower level of responsiveness and robustness of Network T&H, adds to a few empirical studies on undesirable effects of intermediation.

Network A is less complex than Network T&H. Though the former is of bigger size, it has a lower density and shorter graph-theoretical distance. Since network complexity is related to network centralisation and density (Kim et al. (2011), the less denser/ centralised, the less operational burden for the network. Consequently, the network may be more efficient and robust. The results suggest that high density/ complexity does not always equate to high resilience supports (Kim et al., 2015).

Hearnshaw and Wilson (2013) suggest the presence of communities with overlapping boundaries as one of key features of an efficient SC. Network A mirrors this characteristic better than Network T&H. The former has more cohesive subgroups. Furthermore, the overlapping boundaries are more evident in the former, where an actor is more likely to be a shared member between subgroups than its counterpart in the latter. Likewise, a pair of actors in the former has a higher chance of joining the same subgroups together. With denser and relatively stronger connections among subgroups, the former

arguably has better horizontal coordination of information flows. This is evidenced by better information diffusion in the former network via simulations.

Network A possesses more robust subgroups of high edge connectivity levels than T&H. This indicates that the former is not only more robust but also more flexible thanks to more edge-independent paths for messages to travel between organisations. In other words, the former has relatively more options to reconfigure information flows. The co-existence of both higher robustness and greater flexibility may go against the conventional thinking that presumes a trade-off between resilience and efficiency, or between resilience and flexibility (Ali et al., 2017, Lotfi and Saghiri, 2018, Gligor et al., 2019). However, the result supports the idea of Wieland and Marcus Wallenburg (2012) that both agility and robustness constitute effective supply chain risk management strategies. The agribusinesses play an important role in both networks by their popularity and potential influence for information accessibility and process integration. They are key to information diffusion and supply chain coordination in Network A. Their dominance is somewhat replaced by a wider range of businesses in Network T&H based on graph-theoretical distance-based measures. Network T&H tends to depend rather heavily on the brokers, making it more vulnerable.

The results confirm the multidimensionality of agility. Two networks may be at parity at a certain agility dimension but in different ways. There are still some aspects wherein Network T&H demonstrates a better capability than Network A and thus can learn from to further enhance the overall agility. Market sensitivity is the most noticeable attribute at which Network T&H is superior. The organisations in the former are of more diverse business demographics than those in the latter. Particularly, in the former, the key actors for information dissemination, resource mobilisation, and exchanged flow coordination have varying business nature. They are not dominated by a single industry like those in the latter. This implies that the former can benefit from diverse sources of information. The result is supported by the literature of tourism supply chains which commonly emphasises their profound diversity (Zhang et al., 2009). The higher proportion of open triads alone cannot confirm the higher chances to receive 'structural holes' benefits advocated by Burt (2015). However, the heterogeneity of key network coordinators coupled with the current triad configuration implies that Network T&H is more potentially able to capture novel information and new opportunities. Furthermore, the former is more likely to detect changes better than the latter.

Discussion

The applicability of SNA to evaluate SCA became discernible throughout a relative agility comparison between two networks by a range of SNA analytical metrics, tools, and techniques. The findings shed light on how SNA is appropriate to tap into areas that are barely recognised by previous research. Via SNA, the network agility was evaluated with respect to relationship interconnectedness rather than merely from the firm's view. The results were neither a specific index, a maturity range nor a relative agility grade like such conventional approaches as fuzzy logic (Lin et al., 2006), symbolic modelling (Charles et al., 2010), and case studies (Faisal et al., 2007, Patel et al., 2017). The overall agility level of each SC could not be determined statistically. However, the findings supported SNA proponents that SNA allowed a comparative analysis of different network structures between two SCs. This complements the approach of Faisal et al. (2007). Furthermore, the SNA uncovers hidden structures and processes that are rarely evident from the conventional approaches (Kim et al., 2011). For example, the results at the group level reveal the co-presence of competitors in the same robust subgroups or the collaboration of distance connections that even the entities may not be aware of.

The results at three levels were not mutually exclusive or independent of each other. Rather, the network agility and even one agility dimension could be evaluated from different yet complementary angles. For example, visibility was evaluated from reachability of network cohesion, membership of cohesive subgroups, and the popularity of organisations within the network. Different roles of the individual organisations and their relative importance with respect to others in the same network were assessed not only by node-level metrics but also by the closer look into network regions and subgroups they join.

In contract conventional approaches, agility dimensions are measured by a set of associated metrics at fixed levels, organisational importance is assessed by the actors themselves with little consideration of

surrounding relationships of other SCs (see Lin et al. (2006), Swafford et al. (2006), Seyed Hosseini et al. (2010) as examples).

The works of Xu and Liu (2015) and Hernández and Pedroza-Gutiérrez (2019) are few exceptional studies that take a complex network approach to evaluate agility, allowing the application of different units of analysis, yet none of the studies have utilised this advantage. Xu and Liu (2015) used three node-level centrality metrics to calculate the weight for entities; betweenness centrality, node strength centrality, and network centrality. Network structure was examined from the point of individual actor's position in the supply chains. Network characteristics of the whole network remained unexplored. Our research fills the gap in their study by evaluating the agility of two networks via network characteristics at the network level and the linkages within and across subgroups.

While SNA is a potentially powerful approach, there are some aspects of agility assessment that the conventional approaches address better than SNA. The integration level is barely evident by SNA because the analysis was based on selective tools and techniques focusing on interrelationships whereas integration is related to process and practice sharing. Furthermore, this attribute incorporates such 'qualitative' elements as team-based goals and top management commitment which are better investigated by traditional measurement methods. Additionally, how well the network aligns their working practices may require more in-depth non-network data which the current dataset did not cover. Only a part of reconfiguration flexibility could be demonstrated by the line connectivity analysis, relationship flexibility was difficult to evaluate due to the numerous measures inherent to the concept.

There are three main managerial implications from the findings. First, SC relationships and SC partners, if appraised from a social network perspective, will highlight the potential impact on network outcomes rather than by such conventional measures as transaction value and frequency of communication (Kim et al., 2015, Wichmann and Kaufmann, 2016). Accordingly, relationships are evaluated in view of the pairwise properties and the linkages with other business relations in the same network. SC members are evaluated based on their positions in the network and how their linkages constitute the network. The conventional evaluation methods are still valid. However, such methods often focus on "egos", with little consideration of relationship dynamics. Secondly, SC members can be classified based on their different roles and impacts on network agility. Some organisations are better at diffusing information while some other can enable the adoption of agility practices. Some may be bottlenecks for communication whereas some may risk the network operations. Given the restricted resources, reaching the right actors of the right capacity is instrumental. Finally, each SC has relative strength that can be learnt from to improve agility. Since SCA is multidimensional, two SCs can be equally agile but in different ways. SCs differ by characteristics, hence there are no "one-size-fits-all".

Like any research, this paper is not without limitations. The most noticeable shortcoming is the secondary supply chain data only solicited from interviewees that may undermine the data accuracy. The metrics related to direct connections such as network density could not be interpreted sensibly as expected. Similarly, there might have been hidden network regions and subgroups that if uncovered would tell a different story. The key actors should be treated as critical within the current research network and in the research context. Due to restricted resources, this research was conducted at a given point of time. The results are just a snapshot and thus could not provide a picture of how agility dimensions interacted with each other and changed over time therefore network dynamics could not be examined. Furthermore, this paper only used a selective set of metrics, tools, and techniques, leaving a pool of potential tools unexplored. For example, network wiring was not yet applied to evaluate the reconfiguration aspect of flexibility. These limitations open two main avenues for further investigation. The future research can address the methodology shortfalls either by increasing the sample size or combining both quantitative and qualitative approaches for more insights into the network agility. SNA can be combined with traditional approaches for comparative and complementary analyses. If resources allow, longitudinal studies are recommended to explore how network agility is maintained and modified over time. SC relationships can be weighted with such criteria as transaction value or volume, frequency of communication or interaction, the criticality of flows, and even other qualitative factors such as reciprocity and trustworthiness. Different connection types can also be explored, as Hearnshaw and Wilson (2013) posit, material flow-based networks have the same key properties as those of information flows. Another set of metrics, tools, and techniques can be also selected to study similar topics such as

resilience. Agility without resilience can negatively impact organisational performance and even supply chains' survival (Gligor et al., 2019, Lotfi and Saghiri, 2018, Ali et al., 2017, Wieland and Marcus Wallenburg, 2012).

Conclusions

The key contribution of this research was to add to the increasing body of knowledge the applicability of SNA to evaluate SCA, and to more broadly, model supply chains. This not only supplemented the current scarce research on agility assessment approaches and methods but also enriched the extant SCA papers that are dominated by theoretical and qualitative methodologies. To our best knowledge, this paper is one of few studies examining a specific SCM phenomenon from a network perspective at all three analysis levels. The illustration of SNA tools and techniques in a real network case, particularly at the group level, supplemented the abundant literature focusing on network and node level. In addition, this research extended the application of SNA not only to SCM phenomena but also to tourism research that usually examine the tourism destination networks from a governance lens (Casanueva et al., 2016). Moreover, throughout the analysis, the two sides of brokerage became discernible, especially in the tourism and hospitality network. Therefore this research highlights brokerage's affects which, albeit theoretically, lack empirical evidence (Everett and Valente, 2016, Long et al., 2013). Practically our research has contributed by demonstrating how business owners can learn from the findings in regard to a new approach to SC relationship management and mutual learning among SCs. Further, local authorities may understand more clearly how the local business network is agile and robust, which directly impacts the local economy.

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SUPPLY CHAIN RESILIENCE MANAGEMENT IN DEVELOPING COUNTRY: A CASE STUDY OF THAI MANUFACTURERS

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Introduction

In today's economy, there are some turbulences that may affect organizations processes around the world such as fires, floods, earthquakes, terrorism or economic crisis. As there is a flooding from one side of the world but it affects the economy on the other side. The complexity of supply chain at this moment is how to overcome these disruptions while organizations could to reduce inventory and transportation cost or stream production systems. Business leaders need a method to manage and control this complex supply chain. The global supply chains are also becoming more vulnerable to disaster risks, especially in the Asia-Pacific region (Abe and Ye, 2013). For example, in 2011 there were earthquake and tsunami in Japan and a huge flooding in Thailand, these events provided some impact to organizations in these two countries. Regarding these events, the physical devastation and loss of 20% of the nation's electrical grid due to nuclear power shut-downs caused TOYOTA production to drop by 4,000 vehicles, costing $72 million in profits daily (Kachi and Takahashi, 2011). Furthermore, as some organizations in Thailand permanently closed after this disaster or some organizations moved their plant to others country. Thus, after these events, the concept of supply chain resilience management is used to define how to deal with any disasters. Nevertheless, it is difficult at this moment, as the complexity to manage the supply chain is there are lot of members in there so organizations cannot survive with themselves but they need to help other members to survive too.

Several studies have provided about the learning from past experience for coping better results in the future, e.g. Fiksel et al. (2014), Pettit et al. (2010) and Ponomarov and Holcomb (2009). Thus, SCRES concept can apply and use in organization to support organization for planning a suitable action for the next disaster. Furthermore, as mentioned before, Thai manufacturing has some experiences about disruption before so the researcher would like to study an understanding of practitioners related to SCRES concept and also needs to explore how organizations apply SCRES practices in their process. For example, Chee Wai and Wongsurawat (2012) found that in 2011, Western Digital's who produce Hard Disk Drive (HDD) to supply a quarter of the world's HDD was faced a massive flood that affect their production to be shut down around 45 days; while other organizations still under-recovery process, but it still disrupted to the global computer hardware supply chain.

Thus, this study aims to identify an understanding about supply chain resilience management in Thailand as a developing country and also explore how Thai manufacturers adopt or apply SCRES for improving better plan for the future unforeseen events. Moreover, this study will presents factors that motivate and inspire organizations to think about SCRES concept. Therefore, this study makes various contributions to the relevant literature and practice. First, it provides a link between academic and practitioners' understanding in SCRES field. Second, this study provides valuable reasons for managers to apply SCRES in their organization. Finally, this study proposes some practices to build SCRES in organizations for public and private sectors.

Literature review

Supply chain resilience management definition

The concept of supply chain resilience management is used in different ways. Regarding to Liu and Lee (2018), they separated SCRES into three ways as (1) SCRES has a single dimension, (2) SCRES has two dimension such as robustness and agility or redundancy and flexibility, and (3) SCRES has multiple components. For instance, Pettit et al. (2013), they found that SCRES concept integrated with several disciplines such as ecology, psychology, sociology, risk management and network theory. In addition, there are some definitions about SCRES in the literature as explained by Christopher and Peck (2004)

that SCRES as the ability of a supply chain to return to its original state or move to a new, more desirable state after being disturbed, or Ponomarov and Holcomb (2009), they defined SCRES as the accommodative capability of the supply chain to plan for surprising event, react to disruptions, and recover from them by remaining continuity of operations at the desired level of connectedness and control over structure and function. According to these concepts, organizations may follow these definition and prepare their organization to cope with unforeseen disruptions in the future. Thus, in this study, SCRES is defined as "the ability to prepare for unforeseen disruptions with the ability to respond and recover from disaster period faster than their competitors" (Christopher and Peck, 2004; Fiksel et al., 2014; Pettit et al., 2010; Ponomarov and Holcomb, 2009). Furthermore, based on contingency theory, it suggests that an optimal course of action is dependent on the internal and external situation of organizations which related to SCRES concept, thus SCRES framework in this study will follow the contingency theory as well.

Supply chain resilience management dimensions

According to SCRES dimensions appeared in the literature, there are some dimensions were discussed. For instance, Soni et al. (2011) discussed that organizations can improve their SC performance in term of resilience by maximizing their capabilities in flexibility, adaptability, collaboration, visibility and sustainability and minimizing in risk (probability of hazard occurrence, vulnerability (exposure and susceptibility to losses) and hazard (potential threat to humans and their welfare). Moreover, Ponomarov and Holcomb (2009) provided some discussion about the relationship between logistics and capability and SCRES, the study presented that event readiness, efficient response and recovery are the key for organizations to gain sustainable competitive advantage in unforeseen disruptions period.

An interesting thing from Blackhurst et al. (2011), they provided that SCRES should integrated tangible resources (as physical capital resources) and intangible resources (as human capital) with organizational and inter-organizational capital resources. Furthermore, the study from Mandal (2014) showed the scope of SCRES which encompass with various concepts as supply chain risk management, supply chain security, supply chain performance, competitive advantage, green practices, sourcing strategies and supply chain design.

In addition, Pettit et al. (2010) and Pettit et al. (2013) developed resilience fitness space that combined vulnerabilities factor and capabilities factor together for creating zone of balanced resilience in organization. Therefore, vulnerabilities and capabilities factors are focused SCRES dimensions in this study because the researcher found that these dimensions are related to supply chain performance and organizational performance.

Supply chain resilience practices and processes

As SCRES is multidisciplinary and multidimensional concept so there are various practices and processes to use and implement in organizations that related to SCRES field in emerging literature. For instance, Christopher and Peck (2004) provided 5-steps to design supply chain resilience in the organization as 1) organizations need to provide supply chain strategies that may suit to their processes; 2) organizations need to re-examine between efficiency and redundancy trade off; 3) organizations need to develop collaboration between supply chain; 4) organizations can now develop visibility in SCs; and 5) organizations would improve their supply chain velocity and acceleration their processes and practices. While Nils-Ole et al. (2015) argued that organizations would success in implementing SCRES with three key factors as customer service, market share and financial performance.

Furthermore, as mentioned before Pettit et al. (2013) found that there are seven categories of vulnerabilities, i.e. turbulence, deliberate threats, external pressure, resource limits, sensitivity, connectivity and supplier/customer disruptions; while there are 14 capabilities factor as flexibility in sourcing, flexibility in order fulfillment, capacity, efficiency, visibility, adaptability, anticipation, recovery, dispersion, collaboration, organization, market position, security and financial strength. The results from these studies presented that external pressure and connectivity are the highest vulnerabilities factors that organizations faced; while market position, recovery and financial strength are capabilities factors

that organizations should have. Thus, these practices should have in organization to ensure that organizations would be prepared well-planning for unforeseen disruptions.

SCRES and Performance Measurement

As discussed above, SCRES has lot of dimensions so it is difficult to measure performance in SCRES; however, regarding to Liu and Lee (2018) confirmed that SCRES has an effects on organizational performance. There are some researches that studies about performance measurement in SCRES. For instance, Sheffi and Rice (2005) described that SCRES can be measured based on the recovery time after organizations faced any disruptions. Wieland and Wallenburg (2013) found that timeliness of delivery, customer satisfaction and the effectiveness of problem-solving for customers are three mains factors that used to measure performance. In addition, effective integration between departments also increases organizational performance in term of visibility an also support organizations to reduce uncertainty which related to SCRES concept (Christopher and Peck, 2004). However, there is no tool that can measure SCRES performance at this moment. Thus, organizations can measure their performance in term of supply chain and organizational, which organizations may focus on recovery time after disaster or disruptions, time taken to respond, delivery lead time during disruptions, and customer complaints.

SCRES literature in Thailand

Based on the existing literature about SCRES, it can be seen that there are some studies in this field; however, when reviewed SCRES field in Thailand context, it only has just a few publication such as Abe and Ye (2013) that studies about the building SCRES against natural disasters with the case study of Japan and Thailand; or Haraguchi and Lall (2015), who studied flood risks and impacts of Thailand's floods 2011 and so on. Moreover, Thailand is the global supply chain for many industrial sectors, so the disasters caused significant supply-chain disruptions both domestically and worldwide. Therefore, Thailand is a good gap area for SCRES field to study for collecting more information.

Research Methodology

For this study, a case-study approach based on interview section as it is more suitable for the research in developing theoretical bases (Yin, 2013). According to this approach, it helps to collect in-depth understanding and new insights when examining "How" and "Why" questions. As the aims of this study, the study required an inductive approach by using an in-depth interviews to identify which SCRES definitions and processes are used in organizations and why they have these practices. Thus, the interview with experienced practitioners are required.

Moreover, Thai's manufacturers are also good examples for this topic because Thailand is a major supplier in the global market and supply chain for automotive and electrical-electronic industry sectors. Thus, this study will gain more information about SCRES concept from developing country as Thailand to fill the literature of this area. Therefore, to enhance the research results for this report, the interview section will be set up individually with slightly different emphases to provide a more comprehensive picture for SCRES concept. For selecting participants into this study, the researcher used snowball technique because the researcher knew some participants who have their experienced in SCRES field.

Therefore, in this study, there are nine participants from automotive (3), electrical-electronic (4) and distributors (2) industry. For more details of these participants, most of them are working in their company more than 10 years and also working in these industry more than 20 years. These participants have their experience related to SCRES concept with their company; thus the information from these participants are good enough for getting an important concept. Please refer Table 1 Below.

An interview protocol was developed with the existing questions in the literature. The questions for interview were sent to all participants before interview section happen for supporting all participants to prepare the answers for each question. The interview session was held at the participant's company for giving more comfortable to participants. All interview sections were recorded with tape-recorder and also

received a permission from all participants. All recording tapes were transcribed from voice to word. The findings from these interviews were described at the next section.

Company	Practitioner's position	Company's product	Type of company	Location	Experienced in company	Experienced in industry
1	General Manager	Integrated Circuit	Electrical-Electronic	Chonburi	5	>20
2	Physical Distribution Manager	Integrated Circuit	Electrical-Electronic	Nonthaburi	>15	>20
3	Production Planning Manager	Air-condition	Electrical-Electronic	Pathumthani	10	15
4	Co-Chief Executive Officer	Integrated Circuit Design	Electrical-Electronic	Bangkok	3	15
5	General Manager	Tube	Automotive	Chonburi	>15	>20
6	Quality Management Manager	Metal stamping and plastic injection	Automotive	Bangkok	4	>20
7	Operation Manager	Mirror, plastic part and lamps	Automotive	Samutprakan	>20	>20
8	Assist. Manager	Freight Forwarders	Distributors	Thailand	5	5
9	Key Account Manager	Freight Forwarders	Distributors	Thailand	10	>10

Table 7: Practitioner's information

Research Findings

Supply Chain Resilience Management Definition – from practice return to academic

According to the results from this study, it can be seen that SCRES concept is not clear in Thailand because all participants did not know what is supply chain resilience management means? However, when the researcher explain that SCRES means "the ability to prepare for unforeseen disruptions with the ability to respond and recover from disaster period faster than their competitors", participants had some re-act as "Yes, we have this concept as..." or "We have some activities or policy for this like...".

Regarding the interview results, participants explained that organizations have a consistency plan or business continuity plan with their supplier or sometimes organizations need to provide their plan to their customers as well. So once organizations and their supply chains faced some disruptions, all SCs members will have a suitable plan to do before-during-after disruptions that make organizations can recover their production faster than competitors even though this plan cannot work 100% completely.

There are some example from this interview section as organizations have a problem with late or un-delivery with their suppliers, so organizations need to have a second plan for their option because the production line cannot wait for a long time. However, participants also noticed that all sources should not be in the same country because if organizations have suppliers in the same country, it might be faced the disruption both; then organizations should have suppliers from different area. Therefore, most of participants confirmed that organizations have suppliers for all materials than one sources for protecting out-of-stock product that might lead to production line-down which make more impact than expect. However, participants also suggested that organizations need to review their recovery plan for updating plan for future disruptions.

An interesting point from participants is top-management knew their aims for SCRES but operation level did not know. It might be the problem from top-down communication that managers cannot provide knowledge and understanding about SCRES concept to operation level so operation level is following standard operating procedures (SOP) or work instruction (WI) without the understanding of SCRES concept. Moreover, some practitioners explained that they do understand other concepts than SCRES, such as sustainable supply chain management (SSCM) or green supply chain management (GSCM). A reason is Thai Government provides information about SSCM or GSCM rather than SCRES or these concepts are widespread in the literature than SCRES at this past decade. So, this should be the reason that why Thai manufacturers less understand in SCRES concept.

Thus, the researcher assumes that organizations in Thailand have SCRES concept in their organizations but they do not know that this concept in their understanding called SCRES. Moreover, we can conclude that organizations in Thailand implemented SCRES practices based on their past experienced for protecting future unforeseen disruptions. However, if they face new disruptions that do not face before, it is difficult to respond or well-planned surely. Because organizations might not have an experience to overcome it. Furthermore, sharing the information about SCRES is more important thing in Thailand because organizations can prepare better plan with their chain, as suppliers-manufacturers-customers, which will provide better performance than operate individually. Finally, the researcher summarize SCRES for Thai manufacturers is "the business plan for unforeseen disruptions that organizations provide to suppliers and customers for understanding the process to cope with the disruption period".

Supply Chain Resilience Practices – Plan, Do and Develop

As the findings from this study, organizations have business continuity plan (BCP) or contingency plan in their process for protecting unforeseen disruptions that will happen in the future as SCRES concept. However, there is no one explain the exactly SCRES practices that organizations should have. So the researcher can summarize the three main SCRES practices that emerged from this interview section as following:

1) Collaboration and connectivity practices

For this practice, participants from all industries, electrical-electronic, automotive and distributors, explained that collaboration and connectivity are the most important practice in SCRES. Because organizations cannot pass or overcome the disruption by themselves, they need to have a good partner or good collaboration between supply chains. Collaboration should be intra- and inter-collaborations which all members understand their responsibility to overcome any disruptions. While, connectivity is the process that all members should do in the same ways. Thus, collaboration and connectivity are the standard practice that organizations and supply chain members should have.

2) Recovery plan

Organizations need to prepare their recover plan as a basic, but at this moment, organizations also focus to review a recover plan from their suppliers and customers too. Because even though organizations do not face disruptions but their supplier faced, organizations will get the impact too. Thus, recovery plan should at this time is plan for supply chains, does not for individual organization anymore. A good recovery plan should be state the process in each stage as before-during-after disruption that organizations and their supply chain follow.

3) Pressure from outside organizations

For this practice, the researcher found that organizations have some procedures based on Government legislation as labour laws, ISO or any global legislation as the Waste Electrical and Electronic Equipment (WEEE) and so forth. Then, organizations adopted some procedures or processes following these regulations which related to SCRES concept.

In conclusion, organizations in Thailand have SCRES practices based on their experience as mentioned above, but they always develop their practices to be better than before. Thus, SCRES practices from this study suggests that organizations should prepare and plan their practices for unforeseen disruptions, and do or take action like a contingency plan, then develop actions and plan for future events. Thus, this study concludes organizations should have SCRES practices which encompass with collaboration/connectivity, recovery plan and external pressure, with three actions as "Plan-Do-Develop" which related to Plan-Do-Check-Act (PDCA) in the literature.

Performance Measurement in Supply Chain Resilience Management – measurement scale

The findings showed that performance measurement in SCRES from Thai manufacturers is difficult to define. However, participants confirmed that organizations need to set the objective for measuring first. So as following to participants in this study, they mentioned that performance measurement in SCRES might be measure about how fast organizations react to any disruptions or how organizations reply to customer's requirement with more effective way. Moreover, most of participants argued that measurement scale should be measurable factors such as on-time delivery in different situations or cost reduction in a normal time.

Furthermore, the results showed that the level of customer satisfaction is one of performance measurement in SCRES that organizations used; even though it still difficult to use because this measurement depends on the situation at that time measure. However, organizations can use customer's comment to enhance their performance in organizational and supply chain.

Moreover, the scale to measure performance should be in range such as Likert's scale (1 to 5) because participants explained that if organizations used measurement with 2-digits (0 or 1, complete or fail), it will provide more stressful to organizations and also it cannot provide the insight information that organizations should receive.

Thus, measurement scale for SCRES from this study should be 1 to 5 with implementation level from "Do not consideration this practices" to "Successfully implementation this practice" with related to SCRES practices in previous section. For this measurement, it can be used for measuring the current practices that will support organization to implement other SCRES practices which improve better performance for organizational and supply chains. Finally, organizations should focus on profit growth, average market share, average profits, or average overall competitive position for organizational performance; while focus on operational cost, business wastage, environment cost and customer satisfaction for supply chain performance.

Goals for Supply Chain Resilience Management – for a whole supply chain

There are different goals emerged in the interview section; however, the main goal for SCRES from practitioner's perspective is organizations can survive and respond to any disruptions that might be happened in the future. So organizations would prepare their contingency plan or BCP to overcome any disturbances that better than before.

Some participants suggested that organizations should provide information about SCRES alongside their supply chain by supporting suppliers to prepare a contingency plan because if suppliers can be more resilience, organizations will be more resilience too. Organizations should set up contingency plan as a standard procedure if possible. Furthermore, customers might be share their plan return to organizations as well because collaboration and connectivity in supply chains are the most important process that will support organization to be more resilient. In addition, organizations could prepare their plan by understanding what is an exactly customer's requirement.

Furthermore participants argued that organizations would improve organizational performance by developing four main pillars as human resource and development (HRD), creative thinking, teamwork and social contribution. Moreover, participants also suggested that organizations should provide SCRES concept from top-down communication to be better than before by providing some advantages that operation level will gain if they can follow organization's procedures.

Thus, goals for SCRES from Thai manufacturers are 1) they can survive in an unforeseen disruption better than before, 2) they can provide insight information between supply chains for supporting together, and 3) they can earn competitive advantage from SCRES concept within supply chains.

Direct and Indirect Impact and Benefits from Supply Chain Resilience Management

All participants confirmed that there is some impacts from SCRES, in both terms, direct- and indirect-impact. However, these impacts are a positive thing rather than negative thing because there are an improvement in organizational and supply chain performance.

According to direct impact from practitioner's perspective, they argued that 1) organizations need to have more suppliers or sources from different country; 2) organizations may have more processes to do related to SCRES practices; 3) organizations can use a suitable plan for upcoming disruptions, 4) organizations forecast with more accuracy with alternative plans and sources and 5) the global supply chain will operate more efficiently than ever before.

Regarding to indirect impact from practitioner's perspective, they argued that 1) organizations can increase in customer satisfaction or customer' confidence because they are more resilient; 2) customer loyalty will increase if organizations can survive in any disruption periods; 3) organizations can increase more revenues and profits if they have a good SCRES practices; 4) organizations can increase more motivation to their employees because they will feel safe and confident while working within the organizations and 5) organizations can minimize risk as much as possible from the collaboration between suppliers-manufacturers-customers.

Therefore, there are some impacts from SCRES to organization and supply chains; however, these impacts will change organizations' procedures in short- and long-term which will provide different impact for each organization. Thus, organizations need to study and define the impact from SCRES before apply or implement SCRES into organizations to ensure that they will gain a better result.

Research Conclusions

This study identifies the understanding about SCRES from Thai manufacturers as a case study, which presented the significant impact from SCRES concept on practitioner's perspectives. The concept of SCRES is quite new in Thailand; but Thai manufacturers have lots of SCRES practices in their process or procedure. Thus, the definition of SCRES is not affect to SCRES practices that implemented in Thailand; however, the researcher found that participants in this study suggested organizations to provide more information and knowledge about SCRES with top-down communication from top-management to operation level for gaining more benefits from SCRES concept. Therefore, at national level, Thai Government should provide more detail about SCRES concept to all organizations and encourage organizations who are interesting in SCRES field to implement or operate with more resilient.

As the implementation practices in SCRES from Thai manufacturers, it can be concluded that Thai manufacturers implemented or applied SCRES practices from their past experience in each disruptions and then they develop a better SCRES practice that more suitable than before for the future unforeseen disruptions. Furthermore, employees should understand the concept of SCRES for gaining more benefits from this concept.

The results show that organizations in Thailand have prepare a contingency plan for their own organizations and also with their suppliers and customers so this is an attractive place for investors to invest in Thailand, even though they faced a huge flooding or other disruptions before. Thus, Thai manufacturers should study and apply SCRES with more understanding to gain more benefits from this concept.

Regarding to SCRES practices from Thai practitioner's perspective, there are three main practices as mentioned before as collaboration/connectivity, recovery plan and external pressure, which are the most important practices. This finding related to the studied by Pettit et al. (2010) and Pettit et al. (2013) about

vulnerabilities and capabilities factors that they use to develop resilience fitness space. Thus, this confirmed that these practices are importance for SCRES concept. Moreover, organizations may review and assess their process or procedure with these practices to define which practice should be implement in organizations by using the scale between 1 to 5 with meaning from Do not consideration this practices", "Planning to consider this practice", "Currently consider this practice", "Initial implementing" and "Successfully implementation this practice". However, this measure need to use with sub-practice in each practice

Limitation and future research of this study

This study is also has got some limitations. Firstly, SCRES is a process before-during-after disruption so longitudinal research design could capture more insight information of SCRES in the long run, so future research could use longitudinal focus. Secondly, this study was conducted within the specific industry, i.e. electrical/electronic and automotive industry and in one country; however, replications in other contexts would increase confidence and quality in the research so next further research may be undertaken in more cross industrial in different context. Thirdly, this study did not provide the barriers for using SCRES concept so future research should study about barriers and limitations to implement SCRES concept and practices for minimizing risk that will be happened. Finally, future research should quantitatively examine SCRES to further disruptions for reducing risk and SCs vulnerabilities while maintaining competitive advantage.

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SUPPLY CHAIN RESILIENCE SOCIAL NETWORK ANALYSIS

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Introduction

There is growing interest in supply chain risk management, to the extent that it is now a crucial research area in both the academia and practice. There are three major reasons behind this development: the recognition of supply chain complexity; the reduction of redundancy due to more efficient logistics; and the increase frequency of catastrophic events (Behzadi *et al.*, 2018). For the purpose of business continuity and sustainability, researchers and practitioners have recently concentrated attention on resilience (Ponomarov and Holcomb, 2009) to build sustainable competitive advantage, especially given the interdependencies among organizations and individuals.

In New Zealand, natural hazards are among the top risks and causes of supply chain disruptions. The Centre for Economics and Business Research (2012) ranks New Zealand as the third most vulnerable economy to be impacted by natural disasters. Such hazards have cost the country on average one percent of the GDP, since 1990 (Insurance Council of New Zealand, 2014). Although the rural economy is a crucial pillar of the New Zealand economy (New Zealand Government, 2014), it is especially vulnerable to natural disasters such as earthquakes, floods, hurricanes, volcanic eruptions and tsunami. As agriculture is a vitally important component of the New Zealand economy, the need build resilience in this sector is critical.

Complex adaptive system theory captures the complexity and capabilities of global supply chains in the context of a dynamic environment. In line with this theory, social network analysis (SNA) provides an excellent approach to study these supply chain attributes thanks to its focus on the interactions and complexities of a network. SNA is a powerful method which has been used widely in sociology, anthropology, politics, technology and economics (Rodriguez and Leon, 2016). It employs concepts from graph theory, statistics and algebra (Wasserman and Faust, 1994). The potential for SNA to explore supply chain is widely acknowledged (Borgatti and Xun, 2009), but as yet there is no comprehensive SNA framework for studying risk management in general and supply chain resilience specifically.

Supported by a larger research project on resilience led by the Scion research institute, this research aims to assess the applicability of SNA for studying supply chain resilience via asking "*How can SNA be applied to study the resilience of supply chains?*" By examining the characteristics of a rural supply chain network in New Zealand, the study aims to explore the relationships between network patterns and resilience attributes. As methodological research, the study is expected to make an important contribution to the area of risk management and sustainability development for supply chains, especially in terms of research methods to investigate resilience.

Supply Chain Resilience and Social Network Analysis

Supply chain resilience removes the limitations of conventional approaches, which cannot cope with today's complexity and unpredictable disruptions (Pettit *et al.*, 2013). Christopher and Peck (2004) emphasized the resilience ability of a system in regard to how it recovers or bounces back to a better state after disruption. This early work triggered the interest of researchers and practitioners to build a resilient network (Abe and Ye, 2013). One of the most popular and comprehensive definitions was developed by Ponomarov and Holcomb (2009), as "*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 the desired level of connectedness and control over structure and function*" (p.131).

Previous studies have identified the attributes of a resilient supply chain; proactive strategies include anticipation capability, visibility, robustness, network security and information and knowledge management. Specifically, anticipation refers to the ability to sense the risk (Datta *et al.*, 2007), to build continuity plans (Pettit *et al.*, 2010), understand supply chain vulnerability (Melnyk *et al.*, 2014) and thus control and minimize risks and consequences (Manuj and Mentzer, 2008). Visibility is necessary for all resilience stages, relating to supply chain transparency, information sharing and connectivity (Ali *et al.*, 2017). Robustness depends on supply chain design or configuration and supply base strategy (Craighead *et al.*, 2007), and therefore to continue to function despite disruptions. Meanwhile, concurrent strategies

require the capability to adapt and respond, in which flexibility, redundancy, adaptation and agility all play essential roles (Ali *et al.*, 2017). Rather than merely withstanding disruptions, flexibility allows supply chains to adjust their management functions and processes in different ways (Wagner and Neshat, 2010). Redundancy refers to excess capacity to cope with sudden changes in a supply chain (Rice and Caniato, 2003), relating to supply chain design. Adaptation, in general, means the ability of the supply chain to respond to a disturbance before recovering, while agility focuses on how quickly a supply chain adapt to a disruption (Ali *et al.*, 2017). Although many researchers define "visibility" as a sub-element of agility, many others argue it should be a separate element as visibility focuses on information transparency, whereas agility emphasizes responsiveness. Finally, the ability to learn or manage knowledge/ experience and collaboration are crucial elements to resilience (Jüttner *et al.*, 2003).

SNA is considered a powerful methodology in supply chain studies, which require analyzing and understanding the interrelationships between members. As complex adaptive system theory has more popular, the social network lens is becoming an area of interest because of the holistic network approach (Carter *et al.*, 2007, Childerhouse et al., 2010). Through this lens, a supply chain network is considered as a set of entities that have both interdependencies and independence. As modern supply chains are considered as networks of interrelated actors, increasingly researchers have chosen study them via SNA (Carpenter *et al.*, 2012, Childerhouse et al., 2010, Kim *et al.*, 2015, Rodriguez and Leon, 2016).

SNA is believed to be a powerful analytical approach that can quantify the different network properties. On the one hand, SNA allows researchers to test hypotheses with a confirmatory approach quantifying the subjective character of relationships to objective parameters, measure or probability (Hanneman, 2005). On the other hand, SNA also offers the capability to conduct exploratory research, facilitating visualization and exploration of special properties of networks and individual's position (Rodriguez and Leon, 2016) via a range of analysis tools such as network density, network fragmentation, centrality measures and reachability. Further research on supply chain resilience is warranted in regard to empirical and analytical studies. Existing studies concentrate on the firm level (Craighead *et al.*, 2007, Blackhurst *et al.*, 2011), whereas, the vulnerability of a supply chain is a network-level phenomenon that needs to be tackled via a holistic perspective. The association between supply chain network patterns and resilience appears to be an area for urgent academic research. The extant research largely focuses on business-as-usual disruptions, leaving a gap to research resilience from serious and rare disturbances which may have catastrophic consequences (Behzadi *et al.*, 2018).

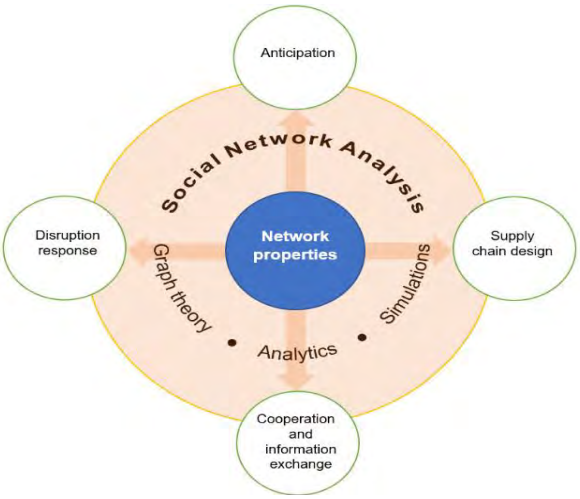


Figure 1: SC Resilience SNA Modelling

A general framework (see Figure 1) is proposed to guide this further research. As SNA is a method specially for network exploration (Borgatti and Xun, 2009, Wasserman and Faust, 1994), it might be powerful to examine properties of network interconnectedness, network structure and actor criticality. Many researchers have recognized the impacts of various network properties on supply chain resilience through anticipation (Blackhurst *et al.*, 2011, Pettit *et al.*, 2013), information exchange (Jüttner and Maklan, 2011, Brandon□Jones *et al.*, 2014), supply chain design (Day, 2014, Wieland and Wallenburg, 2013, Zhao *et al.*, 2011) and disruption response (Craighead *et al.*, 2007, Kim *et al.*, 2015, Wieland and Wallenburg, 2013). This research framework puts forward the proposition that SNA provides an effective means to understand all four categories of supply chain resilience via characteristics of the supply chain network, using different sets of techniques of graph theory, analytics and simulations. These tools have potential to discover network properties with both a quantitative and qualitative angle. The quantitative techniques consists of graph theory tools, which can visualize the web of relationships using graphs, and analytical tools, which can help understand properties at the network, group and individual level (Borgatti *et al.*, 2013, Hanneman, 2005). Qualitative approaches

include simulations to examine the network dynamics and in-depth analyses – in combination with quantitative methods – to see how network characteristics affect performance (Scott, 2013). SNA therefore bridges the methodological gap to fully investigate resilience from a network perspective with empirical data.

Research Methodology

Semi-structured interviews were used to collect the data, in order to gain appropriate insight into the current situation, achieve the predetermined target for information within time and budget constraints, and minimize researcher and respondents bias (Bryman and Bell, 2015). Before conducting interviews, a detailed guideline for data collection was developed, followed by pilot interviews. The interview technique was face-to-face and one-on-one, as this is the most effective way to acquire rich information from interviewees. Respondents were in management positions, with those who understood their business and its supply chain interactions. The research area selected was a rural New Zealand district that faces considerable natural hazards.

A non-probability sampling technique was applied. This is because it is difficult to determine all potential subjects, coupled with the difficulty of selecting cases equally among critical actors and peripheral members in any supply chain network. Initially, a purposeful technique was adopted to select a few key organizations within the research area, and snowball was then applied. Since it is almost impossible to set a boundary for a full supply chain network (Choi *et al.*, 2001), the data collection stage stopped at 50 interviewees, with 456 total members in the network. As the target of this research is agricultural supply chains, only those operating in this sector were included in the analysis, resulting in a network of 322 organizations, of which 39 businesses were directly interviewed. The remaining 283 organizations were referred to by respondents as their suppliers or clients (so-called "secondary organizations"). UCINET 6, a comprehensive software for SNA, was used to analyze the data (Carrington and Scott, 2011), together with supporting software: Key Player 2 in the case of the simulation analyses.

Analysis and Findings

Figure 2 illustrates the resultant research network, the green nodes refer to primary organizations and blue nodes represent secondary organizations. This network contains 546 business ties, depicted as arrows. The method used to locate these organizations in the diagram is based on the graph theoretic layout of UCINET, whereby close actors (in terms of direct connections) are located near to each other, and nodes with large numbers of business relationships are sited more centrally.

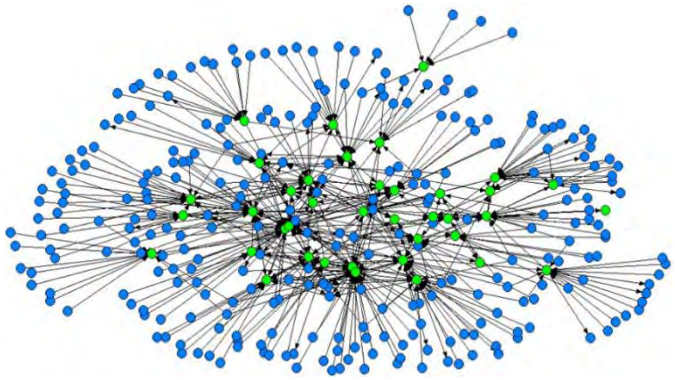
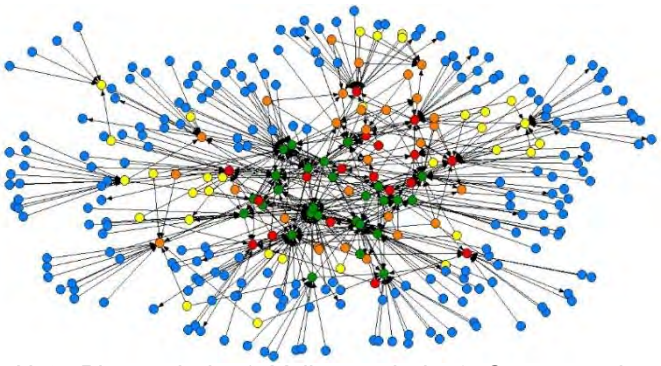


Figure 2: Visualization of the research network

Network density is a common measure of network cohesion analysis, characterizing probability that a business relationship exists in the underlying network (Carrington and Scott, 2011). It shows that there is an 8.9% probability that a tie exists between two random primary members. Compared to examples from 7.4% and 6.6% density of networks in Kim *et al.*'s (2011) SNA study, this 39-member primary subset is relatively dense. This suggests that the research network is complex and might contribute to the severity of disruptions (Craighead *et al.*, 2007). On the other hand, the relatively dense feature indicates a good chance that organizations can cooperate with others for information and resource exchange and thus speed up the information flow, thus visibility.

Network cohesion also contains connectedness and fragmentation indices which quantify the extent to which the underlying network is connected as a whole. In this research network, the connectedness index is 1 and fragmentation is 0. This means that each organization in the network can reach all the other members. Component analysis provides an overview of network structure that is how the network is separated into disconnected areas. Its result indicates that the network has a wholeness feature, that all



Note: Blue node: k = 1; Yellow node: k = 2; Orange node: k = 3; Red node: k = 4; Green node: k = 5

Figure 5: K-core layers in the research network

actors form a connected community. This result matches the previous finding from network connectedness and fragmentation of network cohesion analysis. Thanks to this feature, information and other resources can be disseminated within the entire network.

Connectivity analysis examines how the network retains its connectedness when removing nodes or ties. The most popular technique is cut-point analysis in which a cut-point is defined as one point or node that if deleted will result in the generation of one or several components (Wasserman and Faust, 1994). The parts into which the cut-points separate a network are called bi-components (Hanneman, 2005). This research network has 29 cut-points (green nodes in Figure 3) with 216 bi-components. Instead of using the graph theoretic layout, the positions of the nodes are re-arranged to illustrate how the bi-components are linked together by the cut-points. Noticeably, 16 of the 29 cut-points are focal farms of the supply network. These 29 cut-points, due to their special positions, are important to network connectedness, playing brokerage roles among otherwise disconnected groups. Among the 216 bi-components are 215 groups each with only two members; one cut-point and one other node. These 215 blue nodes are considered peripheral because the removal of cut-points will leave them isolated and thus have relatively weak links to the whole community. The group with magenta nodes and green cut-points is the central bi-component, which accounts for one-third of the network. It is where many connections and important actors are embedded, forming a hard-to-disconnect cluster. This connectivity analysis helps construct a supply chain vulnerability map and emergency plans to ensure the network cohesion.

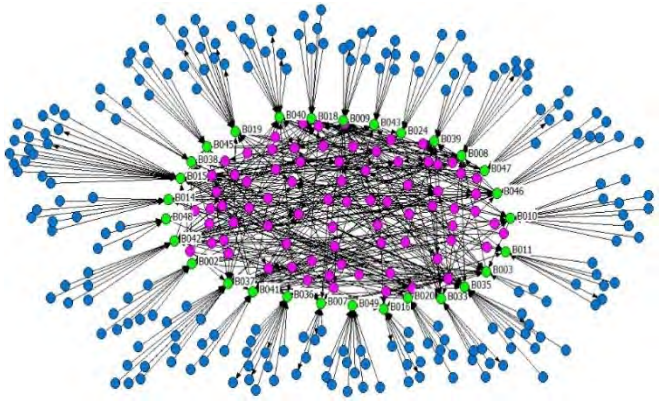
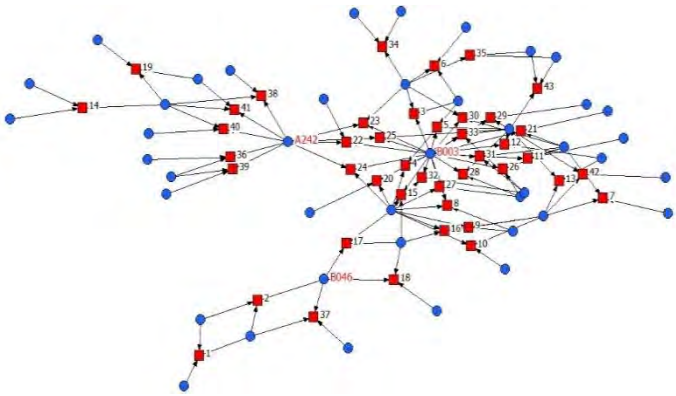


Figure 3: Cut-points and bi-components of the research

Group-level analysis has been conducted using selected tools (clique and k-core) to examine cohesive structures. Clique analysis is the strictest analysis of cohesive groups, in which each member has ties with all others. The connection of each organization to its clique is difficult to break even if any relationship or other node is removed. Figure 4 illustrates a cluster of 43 cliques with 42 members. This cluster, therefore, is a robust and cohesive group in which the flows that run through organizations are faster and more efficient than for the remainder. It might therefore be a solid foundation for a strategic alliance which supports anticipation and adaptation by constructing resilience plans, developing situation awareness, passing information or effectively collaborating against disruption. Actors who mutually join in more cliques will have stronger relationships and be more central in their clique cluster (Hanneman, 2005, Borgatti *et al.*, 2013). The analysis shows that certain organizations have this special position; in which farm service



Red square: Clique name; Blue circle: Clique member

Figure 4: Cliques in the research network

provider B003 joins the most cliques and thus plays a central role in transferring information and resources between cliques. The government agent A242 and farms B041 and B042 are also important in this sense. In addition, the agent A242 and veterinary clinic B046 play a special bridging role, as without them several cliques will be separated from their large cluster. Considering the clique cluster alone, they are fragile spots for flows running through clique members.

K-core analysis is a more relaxed approach, examining groups in which each member has ties with at least *k* other members. Figure 5 shows that the research network is divided into five clear, core-peripheral layers. The 215 blue nodes with the lowest *k* value match the 215 peripheral nodes in connectivity analysis; while actors whose *k* scores is from two to five belong to the central bi-component. The most inner group (green nodes) plays as a "seedbed" for important actors. This analysis could be used to eliminate peripheral layers, supporting further analysis, thus, developing resilience plans in the preparation phase.

To study the embeddedness of actors, centrality, reachability and fragmentation analyses was used. Among centrality measures for actor's positional importance, eigenvector centrality is useful to evaluate popularity and influencing potential (Borgatti *et al.*, 2013). The top 10 organizations with the highest eigenvector centrality scores also have the highest closeness centrality scores (i.e., potential to quickly communicate and exchange resources with others); these included five farms, the local government agent, two service providers and two farm supply businesses.

Reachability analysis focuses on the ability to transmit between organizations. It shows that the top 10 reachability actors can reach a significantly large proportion after three steps and the entire network after only four steps. They possess significant capability to pass information or resources effectively throughout the network. Remarkably, the local government agent, A242, has the most powerful position, reaching two-thirds of the network in two steps and 95% of the network after the third step. Node-level fragmentation depicts the importance of the actor's presence to network connectedness. The result reveals 29 organizations in this position, interestingly a café is at the top of the fragmentation index, despite its small size.

SNA also allows researchers to conduct simulations for different scenarios, we used it to conduct diffusion and disruption analyses. The diffusion simulation identifies optimal sets of actors in information or knowledge exchange and demonstrates how these flows are transmitted. It shows that to reach the whole network in one step, the minimum initial number of organizations is 31, which is 10% of the network. Starting by selected five organizations could reach the majority of the network (99%) in two steps. If 1% of the network (i.e., three organizations in magenta in Figure 6) start passing information, it takes only two steps to reach most of the network (87%), and three steps to reach the entire network.

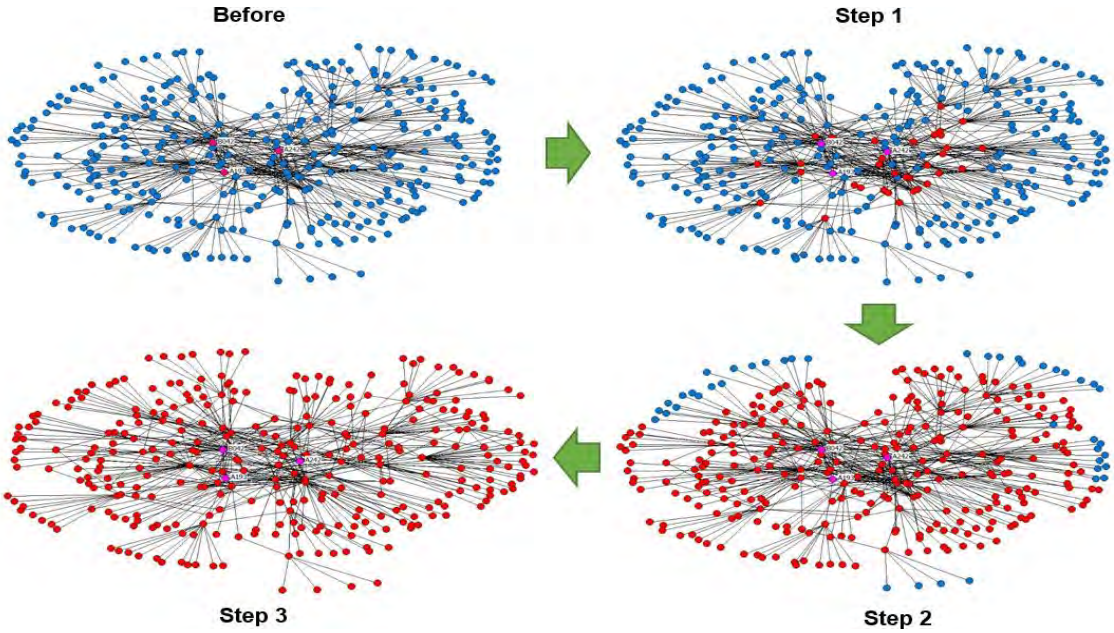


Figure 6: Simulation of information diffusion in the research network

While, disruption analysis is based on a scenario where a disruption occurs, leaving some organizations out of action. It unveils the importance of specific nodes, which might lead to a serious network separation if they shut down. If the most vulnerable 1% of this network (3 nodes) is closed, the network would be impacted by one quarter. These three organizations are also the three cut-points with the highest node-level fragmentation indices. While, closing a 10% of the network will compromise the whole network connectedness, indicating its connectedness depends significantly on a small sub-set.

Discussions

Figure 7 illustrates how SNA tools can bridge the gaps between network properties (left-hand column) and supply chain resilience attributes (top row). The figure shows that SNA can be used to ascertain all three categories of network properties and relate them to the full range of resilience attributes. The interconnectedness impacts all five afore-mentioned aspects, which can be explained using SNA tools at the network level; that is, network cohesion, connectivity analysis, fragmentation analysis and simulations. Network structure can also influence the anticipation, visibility, agility, robustness and adaptation of resilience. Network-level tools, such as component analysis, help to explore network typology and configuration, while group-level tools are useful to explore network sub-structures. Finally, the importance of actors can be examined using centrality, reachability and fragmentation measures, helping to develop aspects of anticipation, visibility, agility and adaptation.

SCRes Elements / Network properties	Anticipation	Visibility	Agility	Robustness	Adaptation
Interconnectedness	Connectivity analysis	Network cohesion	Network cohesion	Connectivity analysis	Network cohesion
	Simulations	Simulations	Simulations	Simulations	Simulations
		Fragmentati -on analysis			
Network structure	Group-level analysis set	Group-level analysis set	Group-level analysis set	Group-level analysis set	Group-level analysis set
		Component analysis		Connectivity analysis	
Actor criticality	Centrality measures	Centrality measures	Centrality measures		Centrality measures
	Fragmentati -on analysis	Reachability measures	Reachability measures		Fragmentati -on analysis

Figure 7: Applications of SNA tools to investigation supply chain resilience

In summary, the most meaningful contribution of this study is its methodology. Within the current literature, which lacks empirical studies on resilience and its related network attributes, this research provides a powerful analytical approach. While a considerable number of studies have focused on conceptualization and theory building (Ali *et al.*, 2017, Christopher and Peck, 2004, Hohenstein *et al.*, 2015), it is also necessary to study resilience and related issues using empirical approach. Empirical research has been carried out in the past (Blackhurst *et al.*, 2011, Craighead *et al.*, 2007, Johnson *et al.*, 2013), but mainly qualitative case studies, which leaves a gap for quantitative approaches. The analytical approach to studying resilience is similarly limited, with a few exceptions; for example, Brandon-Jones *et al.* (2014); Kim *et al.* (2015) and Wieland and Wallenburg (2013). This study demonstrates how to use SNA as a quantitative method with an analytical approach, graph theory and simulations to explore supply chain resilience.

The SNA approach in this study allows researchers to study networks at different levels of analysis, from individuals to groups and holistic networks. A large part of the previous research has focused on resilience at the firm level and its ego-network (Wieland and Wallenburg, 2013, Blackhurst *et al.*, 2011, Johnson *et*

al., 2013). A plausible explanation is that organizational resilience has been considered a foundation upon which to build supply chain resilience, and collecting and mapping network data is limited in prior studies. This study continues the recommended research direction of the previous literature, proposing research on an empirical network dataset. The data is sliced in different ways and analyzed at both the micro and macro level. As resilience and its related issues are network-level phenomenon, it is appropriate and more meaningful to focus on evaluating resilience at the network level. Compared to previous research, this study offers a more comprehensive framework to evaluate resilience attributes by exploring network properties. Other studies have confirmed various associations between resilience and network properties, such as network connectedness and anticipation, visibility and agility (Brandon□Jones *et al.*, 2014, Hohenstein *et al.*, 2015) and network structure and visibility, agility and adaptation (Johnson *et al.*, 2013, Kim *et al.*, 2015). Using a complex adaptive theory view, this study develops and tests a framework to evaluate these previous propositions.

The study focuses largely on the readiness phase, with its related attributes of anticipation, visibility and robustness. Further study has been called for in this phase (Ali *et al.*, 2017), as is type of disruptions another gap to which this study contributes. Generally speaking, much of the current research has focused on business-as-usual disturbances, such as demand fluctuations or demand-supply mismatches, while resilience against catastrophic events has received inadequate attentions. This study helps filling this gap by focusing on natural disasters and significant disruptions.

Our study natural has its own weaknesses there is a lack of considering given to some important elements (e.g., sensing future disturbances and supply chain security) in anticipation analysis, the need to study further the organization capabilities of responding quickly and cooperating effectively to boost the agility. Noticeably, the disruption severity and the way a network responds to a disruption in the real-world setting are necessary to be studied for more understanding of the adaptation aspects.

Conclusions

The most valuable result from this study is the research framework, which can be used as a guideline for the application of SNA to resilience studies. It indicates that SNA is a powerful method to study supply chain resilience in regard to different elements of resilience with different levels of analysis from the macro to micro. Accordingly, the study contributes to bridge the gap between network properties and network resilience using various types of quantitative methods (i.e., graph theory and analytics) and qualitative analysis tool (i.e., simulations and interpretation to synthesize the findings). With real-case data collected from a rural region, it offers a practical view of network resilience.

This study has some policy implications which should attract the attention of policymakers to consider including elements of network properties in their decision-making processes. Accordingly, they could use the framework to understand how a regional network and the mechanisms of its internal and external relationships determine resilience. Our findings could also be used to build resilience plans and develop appropriate supply chain relationships. Understanding the structure and characteristics of supply chain relationships, as well as how those attributes impact resilience, will support supply chain managers to develop appropriate strategies.

The research provides a picture of the network using fixed 'snapshots' with cross-sectional data. However, supply chain networks are dynamic ever-changing relationships. This has restricted the depth of our network study. Hence, a longitudinal study would be appropriate to explore the changes over time.

This research has focused on the topic of resilience in supply chain management using SNA, which could be expanded to other potential application areas in future research. SNA could be applied more broadly to study other supply chain problems, such as supply chain agility, supply chain collaboration or inter-organizational trust. Different tools of SNA may therefore be useful to a wide range of other applications to enhance value creation along the supply chain.

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SUPPLY CHAIN SENSING CAPABILITY IN AUSTRALIAN MANUFACTURING ORGANIZATIONS AND DYNAMIC CAPABILITES

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1. Introduction

Volatility, uncertainty, complexity and ambiguity (VUCA) of the business environment is intensifying. This is characterized by increasing competition, changing market and customer demands, advancing technology, and explosion of data (Teece 2019). As a result, many firms are struggling due to their inability to address the increasing uncertainty and complexity in the business environment. (Vergne & Depeyre, 2016; Teece, 2019).

Addressing VUCA in the business environment requires firms to rapidly reconfigure their capabilities but this takes time to do. Thus, firms need some form of radar to identify, evaluate, interpret and act on leading indicators of change. This radar is often referred to as 'organizational sensing'; a crucial activity for organizational survival in today's business environment (Teece 2007; Teece 2014a). The challenge is how firms can be quickly alerted to changes in the business environment, seize the opportunities presented and reconfigure their capabilities in order to adapt and sustain competitive advantage overtime in rapidly changing business environment (Winter, 2018).

Early scholars on competitive strategy research relied on several theoretical perspectives to explain heterogeneity in competitiveness across firms. These theoretical perspectives were based on for instance, organizational economics (e.g., Jensen & Meckling, 1976; Nelson & Winter, 1982; Williamson, 1975), organizational theory (e.g., Weber, 1947; Katz, & Kahn, 1966), and organizational behaviour (e.g., March & Simon, 1958; Simon, 1955). Examples of these include the transaction cost economics (Williamson, 1975, 1985), evolutionary view of the firm (Nelson & Winter, 1982), agency theory (Ross, 1973), and decision-making theories (Cyert & March, 1963; March & Simon, 1958; Simon, 1955). These theoretical perspectives rely on the assumption that the firm is independent of the market and the competitive context within which it operates.

However, such assumptions were deemed insufficient in explaining firm competitiveness, performance, and survival by advocates of the resource-based view (RBV) of the firm (e.g. Barney, 1986, 1991; Collis, 1994; Penrose, 1959; Rumelt, 1984; Warnerfelt, 1984). Advocates of the RBV argue that the content of a firm's strategy and its broader competitive context and environments are important conditions in understanding firm competitiveness (Barney & Zajac, 1994). The RBV of the firm asserts that the firm is a collection of resources and capabilities which serves as the source of competitive advantage for the firm as long as the resources and capabilities are found to be valuable, rare, inimitable and non-substitutable (Barney, 1991). However, in the light of recent hyper-volatile environments characterized by VUCA, existing capabilities have been shown to very quickly become obsolete. Thus, the RBV is insufficient in explaining firm competitiveness and performance (Teece, Peteraf, & Leih, 2016).

The dynamic capabilities (DC) perspective was thus formulated to address the shortcomings of the RBV by introducing a dynamic element to it (Teece & Pisano, 1994). The DC perspective attempts to explain "the sources of enterprise-level competitive advantage over time" (Teece 2007, p. 1320). DC was originally defined as 'the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments' (Teece, Pisano, & Sheun, 1997, p.516). They assert that these dynamic capabilities are developed from the firm's asset positions and evolutionary paths (Teece et al., 1997).

Research on DC have since progressed and highlighted the importance of organizational culture, managerial capabilities and organizational capabilities in determining the sources of competitive advantage (Helfat & Martin, 2015; Teece 2007, 2014a, 2014b, 2016, 2018). Recent developments in the DC view reaffirms the importance of supply chain-like integration of internal and external partners' capabilities into the development of unique processes, business models, resources and strategy required to achieve high-performance sensing, seizing and reconfiguring capabilities (Teece, 2014b, 2018). Accordingly, the DC view has been increasingly acknowledged by researchers in the SCM, business and management field, and the view has become influential in recent times (Mikalef & Pateli, 2017; Pisano, 2017; Salvato & Vassolo, 2018; Schilke, Hu, & Helfat, 2018; Wilden, Devinney, & Dowling, 2016).

This paper advocates for a supply chain and supply chain management role in the further development of the dynamic capabilities of firms, and in the theoretical development of the dynamic capabilities view. This position is premised on the firm supply chain acting as a sensing mechanism for identifying strategic threats and opportunities in the firm environment.

This paper advocates for more managerial, researcher and theoretical attention to be paid to three important strategic processes and activities: (1) identifying and assessing opportunities and threats in the environment (sensing) (Teece, 2007), (2) addressing opportunities and threats through implementing business processes to capture value (seizing) (Teece, 2007), and (3) continuous renewal of the firm's resources and capabilities (reconfiguring) (Teece, 2007). The adopted DC perspective in this paper argues that in times of rapid change, the capability to (a) sense and shape opportunities and threats, and (b) reconfigure the firm's assets and resources in a quick and proficient manner to seize those opportunities is necessary to achieve, maintain and improve competitiveness (Teece, 2007).

The rest of the paper is structured as follows: Section 2 introduces the research problem. Section 3 introduces the literature review, research gaps and research aims. Section 4 presents the research method adopted for the research including sampling and data collection and analysis, Section 5 presents the results, while section 6 presents the preliminary theoretical model to be tested in the case studies down the line.

2. Research problem

A fundamental reason for business failure is the inability to effectively generate, process, and evaluate data about current and future changes in market trends, and turn them into valuable insights (Satell, 2018). The traditional focus of DC has been internal within the single focal firm with the sensing, seizing and reconfiguring triad of DC viewed as processes occurring solely within the firm (Baretto, 2010). However, recent research indicates that cross-organizational capabilities that cut across multiple firms such as the supply chain are essential to create and maintain competitiveness (Craighead, Hult, & Ketchen Jr. 2009; Defee & Fugate, 2010; Ketchen Jr & Hult, 2007). Thus, the need for greater research attention in understanding DC beyond firm boundaries, and to capture the role of the supply chain and supply chain network (Eckstein et al., 2015; Dubey et al., 2018). Hence, this paper's attempt to advocate for, and understand how the supply chain may be used to generate business insights for competitive strategy.

3. Literature review, research gaps and research aims

Firms focus on core competencies, skills and capabilities while relying on an external network of partners, suppliers, customers and other firms for other resources and capabilities that serve as sources of competitive advantage for the firm (Li, Ragu-Nathan, Ragu-Nathan, & Rao, 2006; Vanpoucke, Vereecke, & Wetzels, 2014). These often cut across inter-organizational routines, networks and processes (Dyer & Singh, 1998). Furthermore, supply chain partners operate in different environments and with different partners (Mentzer et al., 2001). As a result, they are exposed to potential opportunities and threats that may not be captured by the experiences of a single firm. Consequently, the supply chain

partners provide insights into such opportunities and threats that the single firm may be unaware of (Hult et al., 2007; Vanpoucke et al., 2014).

3.1 Competitive advantage, organizational routines and organizational capabilities

Competitive advantage has been referred to as superior performance, supranormal returns, pure profit, profits in excess of opportunity costs (Arend, 2015). Competitive advantage is the degree to which an organization is able to differentiate and maintain a defensible position over its competitors (Li et al., 2006). Theories of competitive advantage include perspectives that seek to explain heterogeneity in firm competitive strategies and performance differences (Powell, 2001).

Organizational routines are important aspects of organizations as they are regarded as the means through which organizations function (Feldman & Pentland, 2003). Underlying organizational capabilities are organizational routines (Eggers & Kaplan, 2013). Organizational capabilities, whether dynamic capabilities or operational capabilities draw on organizational routine elements (Feldman, 2000). Feldmand & Pentland (2003, p. 95) define organizational routines as "repetitive, recognizable patterns of interdependent actions, carried out by multiple actors". However, they are not necessarily static (Feldman & Pentland, 2003). Organizational routines do not constitute just habit and inertia (Gavetti, Greve, Levinthal, & Ocasio, 2012). They are also sources of organizational knowledge that facilitates learning and change (Feldman, 2000; Feldman & Pentland, 2003; Pentland, 2003). Pentland, Hærem, & Hillison (2011) elaborated on this perspective by providing empirical support for the duality of organizational routines as sources of stability, as well as agents of change in organizations.

Accordingly, Eggers & Kaplan (2013) define routines as "patterns of actions that constitute organizational skills" (p.302), and as such can foster stability and create a basis for evolutionary change of the firm (Parmigiani & Howard-Grenville, 2011). Knott (2001) also argued that in business reconfiguration, routines perform a dual role of creating change, and retaining operational routines. Organizational routines are built from a collective process that develops beliefs about peoples' interests and what activities should be carried out; enabling the firm to engage in processes of sensing, seizing and reconfiguring (Eggers & Kaplan, 2013).

Experience forms the basis of organizational routines through behavioural mechanisms such as the degree of success, familiarity, and regularity of experiences. However, the conversion of experiences to routine depend largely on cognitive frames that determines the interpretations of the value and usefulness of such experiences (Gavetti et al., 2012). Parmigiani & Howard-Grenville (2011) identified two views of routines: the capabilities perspective which focuses on how routines affect firm performance, and the practice perspective which is interested how routines are utilized by individuals and their internal dynamics. This paper draws on the capabilities perspective as the concern is on how routines constitute underlying elements of organizational capabilities.

Organizational capabilities have been referred to with terms such as 'organizational competencies', 'organizational resources', 'resource base', thus creating contradictions when not properly clarified (Wu, Melnyk, & Flynn, 2010). This paper adopts the term 'organizational capabilities'. Collis (1994) defines organizational capabilities as "socially complex routines that determine the efficiency with which firms physically transform inputs into outputs" (p.143). Organizational capabilities are concerned with the deployment, allocation and coordination of organizational resources, the functions of organizational routines and how they create value for the firm (Parmigiani & Howard-Grenville, 2011; Wu et al., 2010).

The development of organizational capabilities is driven by internal and external organizational processes of coordination, learning and transformation, and occurs gradually over time (Wu et al., 2010). Elevation of routines and resources to capabilities depends on the level of organizational learning that the organization engages in, and the decisions managers take overtime (Eggers & Kaplan, 2013). Hence, Eggers & Kaplan (2013) assert that the assembly of capabilities from the building blocks of routines is influenced by the cognition of managers and that, thus, organizational capabilities are firm

specific, time dependent, tacit, and path dependent ingredients for organizational success (Wu et al., 2010).

Organizational capabilities exist at different levels of the firm and can be classified as: operational capabilities – concerned with regular operations; or dynamic capabilities – involving modification and change with time (Winter, 2003). Examples of operational capabilities include human resource management capabilities, manufacturing capabilities, supply chain capabilities, etc. that enable firms to function and perform their daily tasks (Winter, 2003). The key distinction between operational capabilities and dynamic capabilities is one of regular repetitive operations versus those of modification, change, evolution and dynamism (Helfat et al., 2007; Winter 2003).

3.2 Dynamic capabilities, sensing, seizing and reconfiguring

Teece et al. (1997, p.516) define DC as "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environment". Winter (2003, p. 991) define DC as "those (capabilities) that operate to extend, modify, or create ordinary capabilities" in changing environments. Operational capabilities are the routines that enable the firm to perform its daily tasks effectively and efficiently in a repeated and reliable manner (Helfat & Winter, 2011). Whereas DC involves a process comprised of routines and practices through which operational capabilities are changed, modified, renewed or created (Helfat & Peteraf, 2003). By layering DC on operational capabilities, firms can maintain and extend competitive advantage through driving systematic changes in existing operating routines for the generation of future profits in response to, and in adapting to changes in the environment (Teece, 2010; Zollo & Winter, 2002).

In order to modify existing operational capabilities, firms engage in three processes of (1) sensing opportunities/threats (Teece, 2007), (2) seizing opportunities (Teece, 2007), and (3) reconfiguring the resource base (Teece, 2007). Sensing involves identifying and assessing opportunities and threats as they pertain to the proficiency of operational capabilities. Seizing refers to a process through which operational capabilities and related resources are mobilized to address identified opportunities and threats, and also to generate value from the use of those resources, while reconfiguring is the renewal of the firm's operational capabilities and resource base (Teece, 2007, 2010). In times of rapid change, the capability to sense and shape opportunities and threats, and reconfigure the firm's assets and resources in a quick and proficient manner in order to seize those opportunities is necessary to achieve, maintain and improve competitiveness (Teece, 2007).

While operational capabilities can be a source of competitive advantage at a given point in time, DC secure the sustainability of firm-level competitive advantage for the long term (Teece 2007, Pitelis & Teece, 2009; Protogerou et al., 2011). DC do not automatically emerge, DC requires the deliberate effort on the part of organizational managers and leaders in recognizing key developments in the business environment, delineating responses, and orchestrating clusters of skills and capabilities that enables the organization to respond, gain and maintain competitive advantage (Adner & Helfat, 2003). Other organizational factors such as the organization's values, culture, and structure may contribute to the strength or weakness of a firm's DC (Shuen, Feiler, & Teece, 2014). Firms must therefore be able to establish the ability to discern when to exploit or explore in order to avoid failures resulting from overreliance on past (successful) experiences and activities on one hand, and pursuing bad ideas on the other hand (O'Reilly & Tushman, 2008).

The sensing process is a key component of DC that provides the fundamental basis for firms to seize opportunities, reconfigure operational capabilities (Eisenhardt & Martin, 2000), and undertake organizational adaptation (Hambrick, 1981). Aslam, Blome, Roscoe, & Azhar (2018) reaffirmed the position that the capability to sense opportunities is a necessary condition for effective seizing and reconfiguring. Sensing involves the continuous generation of data about the business environment in order to identify opportunities and anticipate potential threats (Heusinkveld, Benders, & van den Berg, 2009; Winter 2018). However, it is not enough to simply generate data from the environment. The

sensing process requires evaluating and translating data generated into valuable insights by continuously engaging in information processing activities, supported by internal organizational capabilities (Galbraith, 1973).

Sensing extends beyond the boundaries of the firm (Teece, 2007). Sensing involves gaining insights about the internal and external environments of the organization, and making strategic decisions based on an evaluation of the insights (Teece, 2007). Sensing encompasses gaining insights about competitors, customers, suppliers and other elements of the business ecosystem. Sensing capability is the capacity of the firm to capture opportunities and threats in the environment through scanning, search and exploration activities across technologies and markets by harnessing the capabilities of customers, suppliers and R&D partners (Teece, 2007). Such opportunities have to be sensed before it becomes apparent to competitors (Teece, Peteraf & Leih, 2016). Sensing has been studied from different perspectives, majorly in the marketing and strategy literature and akin to scanning (Danneels, 2008; Zhou & Li, 2012), environmental scanning (Garg, Walters, & Priem, 2003), integration sensing (Vanpoucke et al., 2014), market sensing (Aslam et al., 2018; Day 1994; Heusinkveld et al., 2009; Murray et al., 2016; Slater & Narver 2000), systematic sensing and scanning (Day, 2011), strategic sense-making (Pandza & Thorpe, 2009), opportunity-recognizing integrative capabilities (Liao, Kickul, & Ma, 2009) and market-sensing capability (Bharadwaj & Dong, 2014; Fang, Chang, Ou, & Chou, 2014).

There is consensus that sensing nurtures and sustain DC (Aslam et al., 2018; Dannels, 2008; Teece, 2007; Wilden & Gudergan, 2015). Sensing involves paying attention to both the firm's internal and external environment (Garg et al., 2003). However, sensing as a component of DC is more external oriented focusing on detecting, identifying, filtering and calibrating market opportunities, while seizing and reconfiguring are internal-oriented focusing on exploiting opportunities through structures, procedures and processes within the firm (Liao et al., 2009; Wu, Chen,& Jiao, 2016).

As such, in turbulent environments, firms tend to rely on external knowledge for sensing; through relationships with customers, suppliers, educational institutions and professional bodies (Wilden & Gudergan, 2015), thus leveraging opportunities within those domains (Danneels, 2008). In addition, exploratory activities that extend beyond the boundaries of the firm have been argued to generate stronger impacts (Rosenkopf & Nerkar, 2001).

Seizing is when opportunities and threats have been sensed and firms need to seize these identified opportunities, and respond to emanating threats by evaluating investment options, engaging in strategic investment to develop new capabilities, and designing new business models, which may have long-term effects on firm performance (Helfat & Peteraf, 2015; Teece, 2007). Seizing processes involve the generation of alternative solutions to problems identified, and addressing opportunities sensed through creative activity with the aim of generating new processes to address such opportunities (Teece, 2007). Generation of alternatives and options may involve searching within the organization for solutions, or developing new solutions (Teece, 2007). Due to time pressures, routines, guidelines, operating procedures, and policies, generated alternatives are often limited (Miller & Lin, 2015). Of importance to the seizing process is effective decision making that captures opportunities while mitigating potential risks (Feiler & Teece, 2014; Hodgkinson & Healey, 2011). Effective seizing of opportunities requires the ability to overcome reliance on existing successful organizational strategies in order to minimize decisional bias, inertia and persistence which can lead to undervaluing new opportunities and innovative investments (Hodgkinson & Healey, 2011).

Reconfiguring ensures the sustenance of growth and profitability in dynamic markets and it involves aligning, re-aligning, combining, and enhancing the firm's organizational resources and capabilities (Helfat et al., 2007). In fast-moving markets such as in technology, firms need to engage in continuous renewal in order to create a fit with the opportunities they plan to address (Teece, 2016). Reconfiguring may involve recombining existing resources or acquiring entirely new resources, depending on the intensity of change confronting the organization (O'Reilly & Tushman, 2008). An incremental change may involve gradual transformation of the firm's resources, while rapid changes will likely require rapid

realignment of the firm's resources (O'Reilly & Tushman, 2008). The reconfiguring element of DC is sometimes referred to in the literature as 'transforming' (e.g. Feiler & Teece, 2014), or 'shifting (e.g. Teece et al., 2016).

On the other hand, commitment to existing procedures, routines and assets makes it difficult for firms to flexibly and responsively engage in sustained and continuous reconfiguring, especially if the firm is currently performing well (Teece, 2010; Teece et al., 2016). Associated costs and risks involved in the transformation process may also serve as barriers to firms seeking to reconfigure (Feiler & Teece, 2014). Consequently, effective reconfiguring requires the ability of organizational leaders to be change-oriented, willing to commit resources, and capable of motivating and inspiring organizational members on the need for change even when the need is not immediately obvious (Feiler & Teece, 2014).

Leveraging the supply chain for sensing can enrich the firms' market knowledge and better understanding of unexplored market segments, triggering engagement in reconfiguring processes thereby improving their existing operational capabilities such as their marketing and technological capabilities through reconfiguring their resources, capabilities, structures and processes; and ultimately improve firm performance (Vanpoucke et al., 2014; Wilden & Gudergan, 2015). As Teece (2007, p.1322) notes, sensing does "not only involve investment in research activity, it also involves understanding latent demand, the structural evolution of industries and markets, and likely supplier and competitor responses".

Research on the underpinning mechanisms and activities through which DC, DC elements of sensing, seizing and reconfiguring are actually identified and developed remain underexplored and thus limits understanding in DC related strategic supply chain management research (Pisano, 2017; Schilke et al., 2018). To improve the understanding of how DC may facilitate sustainable competitive advantage, it is important to understand the underlying processes involved in the deployment of DC and how they can be improved.

Thus, this paper explores the role of the supply chain (upstream and downstream) as regards DC and sensing. The upstream supply chain refers to the firm's supplier while the downstream supplier chain refers to the firm's customers (Mentzer et al., 2001). This paper makes important theoretical contributions to research on strategic supply chain management research, dynamic capabilities, and information processing. It advocates the importance of sensing, seizing and reconfiguring as important elements on which DC are developed. The paper demonstrates that the supply chain plays an important role in the sensing, seizing and reconfiguring process. By harnessing information provided by supplier and customers, through the key dimensions of supply chain sensing capability (SCSC) (data generation, data vetting, data assessment and data evaluation), firms can improve the development and deployment of DC through enhanced sensing. Thus, the paper investigates the activities and mechanisms through which firms develop their sensing capabilities and improve their sensing performance in order to boost their performance through onward seizing and reconfiguring.

3.3 Research aims

The research aims to: (1) better understand what sensing is through a review of the relevant literature; (2) explore the extent to which sensing is important to the development of DC through literature reviews, case studies and interviews with managers in the New South Wales manufacturing sector; and (3) develop, refine and validate a preliminary theoretical model of sensing, seizing, and reconfiguring to be tested in future research.

3.4. Development of a preliminary theoretical model

We first completed theory building activities involving a review, synthesis, and summarisation of extant literature on strategic supply chain, dynamic capabilities and information processing above from which we developed a preliminary theoretical model of how firms use information provided by their upstream supply chain (suppliers) and downstream supply chain (customers) in sensing, seizing, and reconfiguring activities (Fig 1).

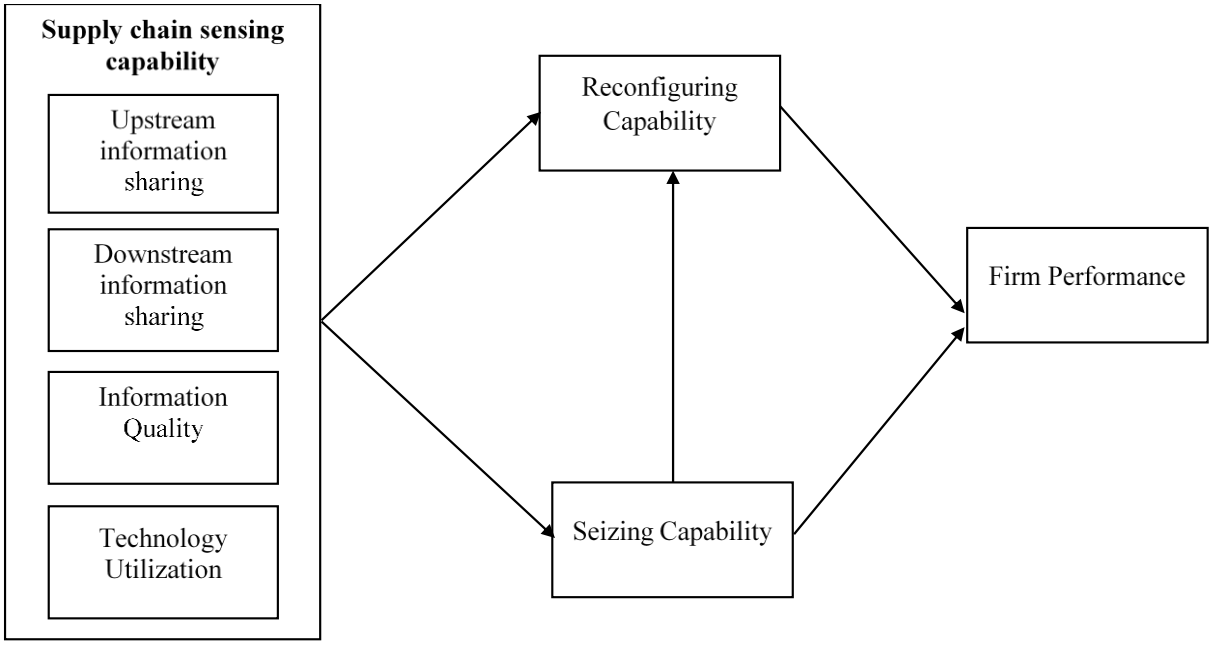

Figure 1 Preliminary theoretical model

The developed preliminary theoretical model in Figure 1 was built on the theoretical concepts of upstream information sharing, downstream information sharing, information quality, technology utilization, and the three DC elements of sensing, seizing, and reconfiguring. Extant literature provides a large number of activities involved in sensing and will be difficult and impractical to address all exhaustively (e.g. Danneels, 2008, Jantunen, 2005; Wilden et al., 2013). Thus, supply chain sensing capability (SCSC) (Fig 1) is conceptualized as consisting of four key components: upstream information sharing e.g. with the supplier base, downstream information sharing e.g. with the distribution and marketing channels and customers, information quality, and technology utilization. The choice of SCSC components is driven by the focus on the key supplier focal firm relationship and the key customer focal firm relationship. The developed preliminary theoretical model represents the interrelatedness between the firm's SCSC; the sensing, seizing, and reconfiguring dimensions of DC; and firm performance. The model argues that the SCSC impacts firm performance through the mediating roles of the seizing capability and reconfiguring capability. The developed preliminary theoretical model importantly, also includes the quality, relevance and timeliness of information being shared in the supply chain, and lastly, whether appropriate information and communication technology (ICT) that efficiently and seamlessly links the relevant upstream information sharing partners and downstream information sharing partners has been deployed (e.g. electronic point of sales systems). The preliminary theoretical model (Fig 1) was then presented to managers for their evaluation as discussed below in section 4 (methods).

4. Method, sampling and data collection and analysis

We presented the preliminary theoretical model (Fig 1) to eight Australian manufacturing firms in the Hunter region of NSW to evaluate, refine and validate through a qualitative multiple case study approach consisting of face-to-face interviews. Consequently, as a result and as an output of this evaluation, refining, and validating process with managers, we present a (new) refined and validated theoretical model (Fig 2) based on the emerging themes from the case studies and practical inputs from the manufacturing managers. The case studies involved face-to-face interviews of executives of eight Australian manufacturing firms in the Hunter Valley region of New South Wales, Australia. The eight Australian manufacturing companies were recruited through *Hunternet*, a professional association of manufacturers in the Hunter Valley region of New South Wales, Australia (www.hunternet.com.au). Data

collected from the case studies were analysed using through thematic analysis, with the aid of NVivo 12 (www.qsrinternational.com). This approach is consistent with the appropriateness of qualitative case-study approach in exploratory research (Yin, 2003). Data collected from the multiple case study was analysed using NVivo12, a Computer Assisted Qualitative Data Analysis Software (CAQDAS) produced by QSR international (www.qsrinternational.com). The research design and research instruments (interview guide) adopted was approved by the University of Newcastle Human Research Ethics Committee in accordance with the requirements of the *National Statement on Ethical Conduct in Research Involving Humans*. Accordingly, the research was conducted in strict compliance to the approved protocol on issues relating to consent, privacy and confidentiality of respondents and participants. The research was granted ethics approval number: H-2017-0427. All these documents are available on request due to word length constraints.

5. Results: Refined and validated model of supply chain sensing capability

Following in-depth analysis and comparing across the case firms, this section presents a refined and validated theoretical model grounded in the empirical evidence provided by the eight cases and informed by the DC theory and information processing perspectives. The refined model explains how the supply chain can improve the sensing element of the DC theory and in turn improve firm performance (see Fig 2 for the refined validated theoretical model).

This study began with the fundamental assumption that firms can sense opportunities in the environment better and quicker by leveraging their supply chain; particularly their suppliers and customers through downstream information sharing, upstream information sharing, information quality, and technology utilization. The preliminary model provided directions for the case study. The preliminary model shows four underlying elements of SCSC as initially presumed (Fig 1).

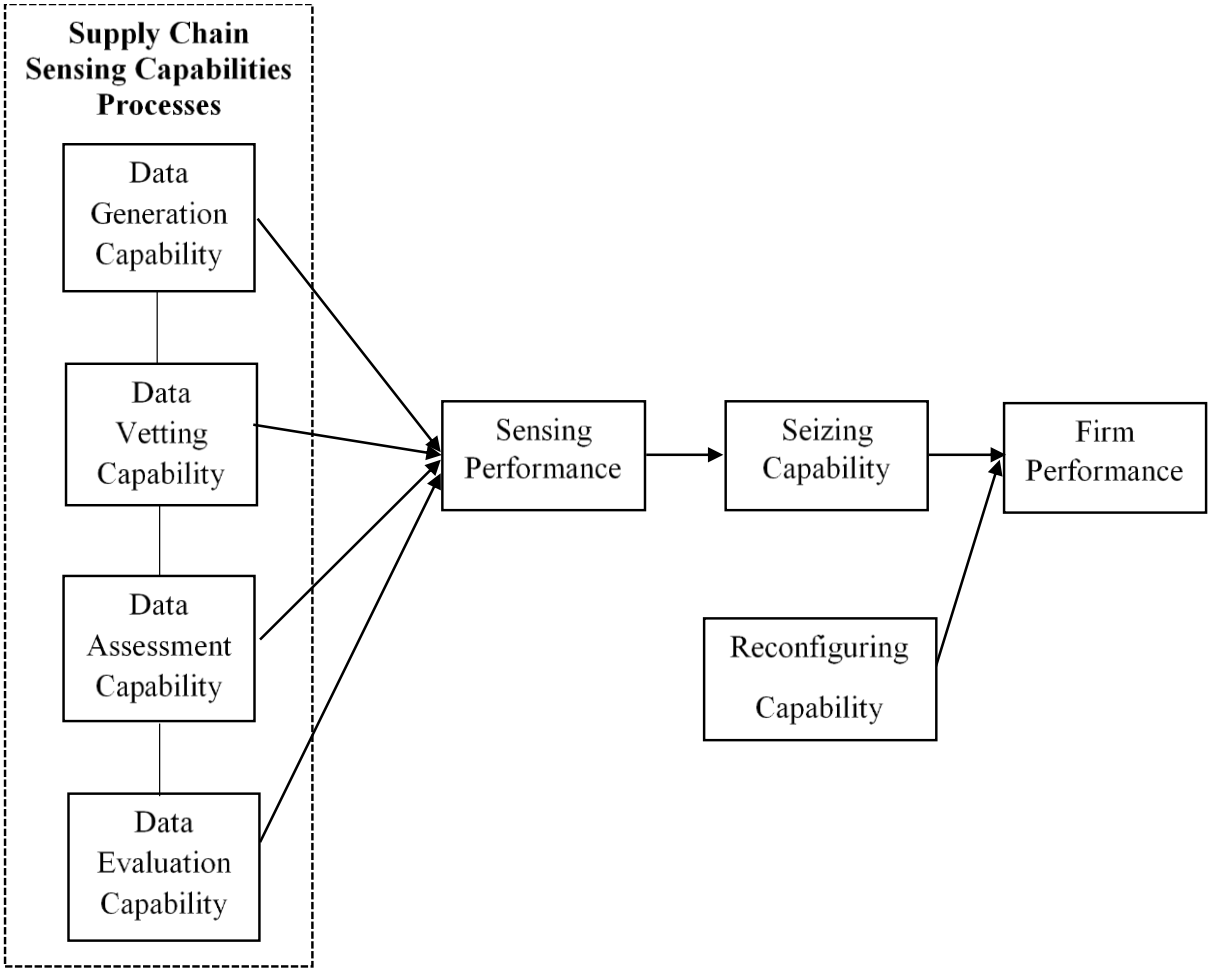

Figure 2. Refined and validated model

Findings form the case study indicate that there is a role for the supply chain in building DC. It shows that suppliers and customers can serve as sources of sensing mechanisms for the identification of opportunities and threats in the business environment. This is driven through supply chain sensing- supplier information sharing and customer information sharing. This notion is consistent with Teece's (2007, p. 1323) argument that opportunity creation and discovery requires access to information- not just through investment in research activity, but also by understanding customer, competitor and supplier responses. Information sharing is thus important to sensing capability. However, what is generated from the supply chain is actually data that is unstructured, voluminous and complex, and not information (nowadays, called big data). The concepts of data and information has been used interchangeably (Drucker, 1988). However, this study relies on the notion that a clear distinction exists between the two concepts. Data consists of characters, which may include word, text, and numbers in raw form and without specific contexts. On the other hand, information refers to data, which have been processed, organized, structured and presented in specific contexts to make them meaningful (Drucker, 1988). Thus, the challenge for firms is how to separate the hidden essential data from the non-essential data while minimizing time to insight in order to achieve clarity.

In order to address the challenge, this refined and validated model helps to understand how firms manage the flow and processing of data through the lens of the information processing perspectives (Galbraith 1973). The information processing perspective postulates that information-processing

mechanisms should be aligned with information processing capabilities in order to create an appropriate fit between an organization's ability to handle information and the required information.

In applying elements of the information processing perspective and drawing from the findings from the case study and DC literature, this study proposes the validated model shown in Figure 2. The study proposes SCSC as a higher-order, hierarchical model manifested in four first-order constructs:

(1) Data generation capability (2) Data vetting capability (3) Data assessment capability, and (4) Data evaluation capability. The study argues that data generation capability, data vetting capability, data assessment capability and data evaluation capability have significant impacts on sensing performance; which in turn influences firm performance either directly or indirectly through the mediating role of the seizing capability and reconfiguring capability.

5.1 Data generation capability, data vetting capability, data assessment capability and data evaluation capability

Today's supply chain is characterized by massive flows of data, thus transforming the design and management of supply chains (Hazen, Boone, Ezell, & Jones-Farmer, 2014). *Data generation capability* refers to the ability of organizations to gather data from their upstream and downstream supply chain. This involves data on business processes, technological innovations, changing needs and events, and opportunities and threats in the business environment. Data generation capability is supported by tools and technologies such as electronic point of scale scanners. Web transaction and ecommerce data is also important (Davenport, Harris, De Long, & Jacobson, 2001). The use of radio frequency identification (RFID) has resulted in generation of large amounts of data throughout the supply chain, and from sources such as ERP systems, customer demand patterns, global positioning systems (GPS), mobile devices, audio-visual sensors, and others (Govindan, Cheng, Mishra, & Shukla, 2018).

Data vetting capability refers to the ability of the organization to apply techniques aimed at sifting or filtering data generated from their upstream and downstream supply chain. In today's business environment, most organizations in the supply chain have access to large volumes of data from multiple sources (Hazen, et al., 2014). The challenge is on how to filter this data in record time in order to generate usable and valuable knowledge (Watts, Shankaranarayana, & Even, 2009). The paper finds that firms adopt four mechanisms in filtering data gathered from their upstream and downstream supply chain: (1) trust (2) nature of supply chain relationship (3) duration of supply chain relationship, and (4) regulatory compliance. This is in line with the assertion that the relevance and believability dimensions of data quality are difficult to evaluate objectively (Watts et al., 2009).

According to the case analysis, data generated from close trusted suppliers and customers are usually treated as more important and more credible compared to data generated from suppliers and customers who are not trusted by the firms. Data received from suppliers and customers that engage in collaborative relationships with the firms are usually treated as more important and more credible compared to data generated from suppliers and customers involved in transactional relationships with the firms. Data generated from long term suppliers and customers are treated as more important and more credible compared to data generated from new suppliers or customers who only share short-term relationships with the firms. In addition, firms tend to treat data generated from suppliers and customers that are known to comply with industry regulations and standards as more important, and more credible than data generated from suppliers and customers that do not conform to regulations and standards. The ability to transform data to useful information is made possible by the internal organizational capabilities that the firm possesses. These capabilities are required to understand, process, analyse the data, and use the information generated (Heusinkveld et al., 2009).

Data assessment capability refers to the ability of firms to evaluate the data generated from upstream and downstream supply chain through the use of information technology capabilities. It includes the hardware and software involved in data gathering, data filtration, data extractions, and data analysis (Davenport et al., 2001). Such capabilities may involve direct computer-to-computer links with supply chain partners and inter-organizational coordination using electronic links. The implementation of appropriate information and communication technology (ICT) and advanced information systems, and

having the required skill sets and experience required to evaluate supply chain data enables efficient transactions and data processing techniques, and most importantly makes actionable information available to managers (Watts et al., 2009). Firms harness tools such as decision support, executive information systems, online analytic processing and data mining in transforming data into information that can inform business decisions and create value. To effectively transform supply chain data into useful insights, firms need to have high levels of data assessment capability.

Data evaluation capability refers to the ability of firms to perceive, organize and process supply chain data gathered from their suppliers and customers. Research shows that human cognition is a key determinant on how organizations respond to external stimuli (Watts et al., 2009). Apart from technology tools and systems which can aid transformation of raw data into useful information that can inform business decisions, human/managerial intervention is a necessity in regard to interpreting data, and creating an enabling platform that leverages insights provided. This human element is important for enhancing the firm's sensing capability and performance as well (Kohli & Jaworski, 1990; Heusinkveld et al., 2009). Underpinning data evaluation capability are organizational and cultural factors. These involve creation of an organizational culture that supports the willingness and commitment to explore different or new perspectives, and other types of insights that are different from what the organization is used to (Cohen & Levinthal, 1990; Szulanski, 1996).

The validated model (Fig 2) does not however assume that supply chain sensing capability directly impacts firm performance. Specifically, the model shows how the firm's ability to engage in the activities of upstream information sharing, downstream information sharing, ensuring information quality, and effective use of technology serves as underlying mechanisms in harnessing the supply chain for sensing. The model proposes that engaging in these SCSC activities should lead to improved firm performance through the potentially mediating effects of sensing capability and reconfiguring capability.

Previous research suggests that time lag is an important contingency in the development of capabilities, and how such capabilities influence firm performance (D'Aveni, Dagnino, & Smith, 2010; Romme, Zollo, & Berends, 2010). Wu, et al. (2010) elaborated on this assertion by identifying time as one of the key features of organizational capabilities. They state that "organizational capabilities are tacit processes that emerge gradually over time" (Wu et al., 2010, p. 724). Research also indicates that time is a key attribute in the development of DC (Romme et al., 2010), and deployment of DC (Zott, 2003). In their conceptualization of DC, Romme et al. (2010, p. 1274) state that "dynamic capability... accumulate or deplete over time as a result of resource in- and outflows related to processes of building, integrating or reconfiguring". Consequently, this study acknowledges that time lags may exist between the processes of sensing, seizing, and reconfiguring; which may pose potential concerns in how SCSC ultimately influences firm performance.

5.2 Summary, conclusion and future studies

Our preliminary theoretical model (Fig 1) was a foundation for empirical studies and validation through case studies with managers in eight manufacturing firms in NSW Australia resulting in a refined validated model (Fig 2) which is explained above. In future studies, the refined validated theoretical model may be tested quantitatively through a much larger survey of managers to further test it as to its robustness, generalisability, and empirical validity. Nonetheless, as competition intensifies in the business environment, firms will have to develop new means of addressing uncertainties in a timely manner. This challenge remains a key concern for firms in the current business world. While there has been advances in DC research to understand how firms can sustain competitive advantage, deep understanding of the underpinning micro-foundations through which the DC processes are developed remains elusive. This study presents a new basis for understanding sustaining competitive advantage by exploring how the firm can explore its upstream and downstream supply chain to enhance its sensing capability-which is the primary and fundamental process of DC development. Information exchange across the supply chain could become a key source of competitive advantage, through provision of valuable insights which are unique to firms within their supply chain.

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THE IMPACT OF OPERATIONAL AND SERVICE CONSOLIDATION ON SERVICE QUALITY AND CUSTOMER SATISFACTION IN CONTAINER SHIPPING

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Introduction

Shipping is the backbone of the world's economy facilitating international trade and globalization with more than 90% of world trade by volume being transported by sea (International Chamber of Shipping, 2019). It is the major transportation provider of large volume shipments over long distances at low costs. In recent years, container shipping has grown tremendously bringing with it an expanded network of suppliers, customers, and is being integrated more intensively into supply chains (Yang, Yeo and Thai, 2014). Unlike other types of cargo ships, containerships sail according to published schedules to named ports and require huge logistics supports from a wide network of agents, ports and other suppliers such as bunker and parts suppliers, as well as other immediate customers such as freight forwarders (Stopford, 2009). Regardless whether there is sufficient amount of cargo in the next port of call, the containership still has to follow its published schedule, and therefore it is essential to maintain a good plethora of interrelationships with both suppliers and customers in container shipping so as to deliver a reliable service. As all these players are intertwined in a supply network which is required for the performance of the industry, this gives rise to the importance of supply chain integration in container shipping. This is supported by Frémont (2009) who argued that containerisation prepares the ground for the full vertical and horizontal integration of transport chains, while Panayides (2006) also suggested integration to be a central tenet in maritime logistics, particularly of the transportation modes and organisations along the global supply chain. In recent years, shipping companies have integrated horizontally through mergers, acquisitions, strategic alliances, and vertically through operating dedicated terminals and by providing integrated logistics and intermodal services (Gao and Yoshida, 2013; Merikas et al., 2011; Agarwal and Ergun, 2010; Van De Voorde and Vanellander, 2008; Midoro et al., 2005; Notteboom, 2004; Panayides and Cullinane, 2002).

On another note, like any other industries, service quality in shipping plays a critical role, contributing to customer satisfaction and thus retention, leading to other business success (Thai, 2008; Thai et al., 2014; Thai, 2016; Yuen and Thai, 2017). The management of quality is therefore essential to ensure that quality service and other business results are delivered to customers. This applies in many manufacturing and service sectors, and equally in the shipping industry, especially in container shipping. This is due to the characteristics of container shipping which are different from other sectors of the shipping industry. Specifically, containerships carry various types of cargo which are of high value but low volume, and thus the transport requirements are more on timeliness, reliability, connectivity, etc. rather than cheap freight rate. In other words, customers using container shipping are more concerned with quality aspects of the service, as these may directly affect their satisfaction. Thus, implementing quality management practices to ensure the delivery of quality shipping service is essential in container shipping. This is partly reflected through the existence of ISO and other industry standards in container shipping companies.

The horizontal integration in container shipping, in the form of operational and service consolidation, has been widespread in the past few years, especially during the period of 2016 – 2018. This is happening in not only the main routes but also the regional/feeder routes (port.today, 2018), in that "small players may be marginalised by the wave of consolidation now shaking the industry, reducing the overcapacity in the market" (Costas, 2016). Meanwhile, there have been concerns that such a consolidation will negatively affects container shipping lines' customers, raised by shipper councils globally such as the European Shippers' Council and the Global Shippers' Forum (Anonymous, 2016). Therefore, the question of how container shipping consolidation affects their service quality and

customer satisfaction deserves further investigation. The remaining of this paper is presented as follows. The next section presents a review of literature on container shipping consolidation i.e. rationale, recent developments, and its impact on shippers. This is followed by the methodology section which explains how the data were collected and analysed. The next section discusses the findings, and the paper concludes with a summary of findings, limitations and future research directions.

Literature review

The consolidation in container shipping, in the form of mergers, acquisitions and strategic alliances, has been a regular phenomenon in this business sector since the early days of the industry. An acquisition occurs when a container shipping line acquires all or part of the assets or business of a selling line, while a merger occurs when two companies combine into one entity. The merger and acquisition (M & A) strategy has been used by container shipping lines as an alternative for growth apart from the traditional method of growing organically through asset purchase and business development (Brooks and Ritchie, 2006). The container shipping industry has witnessed numerous mergers and acquisitions in its history of development, starting in 1977 when Malcom McLean acquired U.S. Lines, to the most recent deals in 2017 (COSCO purchased OOCL, Maersk acquired Hamburg Süd and Hapag-Lloyd took over UASC), apart from several other transactions in 2016 e.g. the three Japanese lines of "K" Line, MOL and NYK merged into ONE (Ocean Network Express), CMA CGM acquired NOL-APL while COSO merged with China Shipping (Salisbury, 2017). It is evidenced that the scale and scope of these container shipping conglomerates have become much bigger compared to those in the 1970s.

Meanwhile, strategic alliance refers to the cooperation agreements on a global scale between liner shipping companies which were mainly about the coordination of prices and capacity in the past but have been taking the form of slot chartering, vessel and other resources (e.g. containers, sailing schedules, terminals, etc.) sharing in the past two decades (International Transport Forum, 2018). It was argued that the traditional reasons for strategic alliances in container shipping are to take advantage of "operational synergies" between shipping lines i.e. the ability to achieve a better allocation of vessels, and market control i.e. the ability to increase market power (Cariou, 2002). Today, the popularly cited important rationale for alliances is to generate operational efficiencies and broader service coverage through economies of scale (i.e. the deployment of bigger vessels) and scope (i.e. offering a more comprehensive global shipping network via the combination of member shipping lines' services) (International Transport Forum, 2018). In this connection, container ships have progressively increased in size since the early ones in 1956 (Houston Kemp, 2019) of 500 – 800 TEUs to the currently biggest container ship in the world, the *OOCL Hong Kong* of 21,413 TEUs carrying capacity (Marine Insight, 2019). Figure 1 illustrates clearly that the size of container ships has especially been increasing since 1970, in terms of all capacity measures being examined.

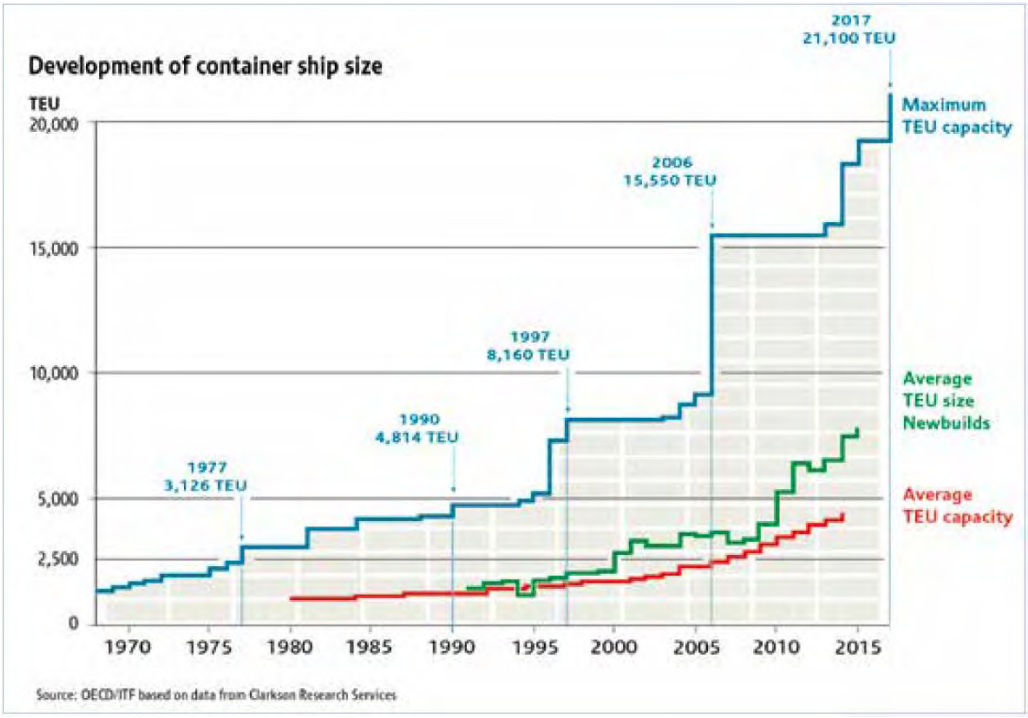

Figure 1. Development of container ship size
Source: Global Shippers Forum (2016)

The first formal strategic alliances in container shipping can be traced back to the late 1995 with the formation of Global Alliance (OOCL, MOL, APL, Nedlloyd), Grand Alliance (P & O, Hapag-Lloyd, NYK, NOL), Maersk-Sea-Land and TRICON (DSR – Senator, Cho Yang). It is argued that alliances in container shipping have undergone through four generations (Table 1) in which the latest generation includes three alliances which have been formed during the period of 2016 – 2018 (i.e. 2M, Ocean, THE) and dominate capacity on the major East – West (Asia – Europe) container corridor. These alliances observed since 2016 was a means for the container shipping industry to cope with the depressed market condition and the long-beleaguered financial returns since the 2008 financial crisis, as well as the overcapacity due to the arrival of very large container ships that had been ordered several years earlier (UNCTAD, 2018).

Generation	Alliances	Period	Characteristics
First	Global, Grand, Maersk/Sealand	1996-1998	Ambitious focus, instability
Second	New World, Grand, CKHY	1998-2012	Stability, used by mid-sized and smaller carriers.
Third	G6, CKHYE, 2M, O3	2012-2017	Transition: the largest carriers also become part of alliances. Instable alliance constellation
Fourth	2M, Ocean, THE	2017- ?	No alliance has one dominant carrier. The carriers in alliances are the eight biggest carriers globally

Table 1. Four generations of alliances in container shipping
Source: International Transport Forum (2018)

It has been unanimously agreed in the literature that there has been an increase level of consolidation in container shipping as the industry has been going through the reshuffling process, in which lesser shipping lines acquire higher global market share in terms of container carrying capacity, and this has become increasingly evidenced in the latest formation of strategic alliances. Specifically, while the top 10 shipping lines deployed 45% of container carrying capacity in 1996, the figure in 2017 stood at 70% (Tuscor Lloyds, 2017) while it is evidenced from Table 2 that the top eight lines in the latest three alliances currently control about 80% aggregate global market share. In addition, it was also observed that the number of container shipping lines providing services per country has declined by 38% on average during the period of 2004 – 2018 (UNCTAD, 2018).

Alliance	Carriers	Global market share	Aggregate Share
2M	Maersk	17.9%	33.5%
	MSC	15.6%	
Ocean Alliance	COSCO - OOCL	12.7%	29.8%
	CMA CGM	11.5%	
	Evergreen	5.6%	
THE Alliance	Hapag-Lloyd	7.2%	16.7%
	ONE	6.8%	
	Yang Ming	2.7%	

Table 2. Overview of the three strategic alliances in container shipping (as of September 22nd 2019)
Source: Own elaboration based in data from Alphaliner (2019)

The aforesaid market consolidation in container shipping has many implications for shippers. On the one side, it is argued that such a consolidation may lead to less freight rate fluctuation, more efficient and extensive services and lower rates if cost savings are passed on to shippers from the shipping lines (UNCTAD, 2018). Unfortunately, McKinsey & Company (2017) derived from their extensive engagement with shippers that a remarkable amount of dissatisfaction exists, in which shippers found a "widening gap" between the service they want to receive and the one they actually receive, and the decreasing schedule reliability. These findings are also in line with those in the report by International Transport Forum (2018), which cited the results from Drewry (2018), that transit times and reliability of booking were considered to have deteriorated since 2016, and that over 60% of respondents in the survey noticed deterioration in the range of different carriers available and over 40% observed a decreasing availability of different services. It was also observed in these reports that alliances can be generally associated with less choice, less service differentiation and less service quality for shippers.

Almost all existing studies about the impact of container shipping consolidation on service quality and customer satisfaction were conducted by industry associations, consultancy firms or haphazardly reported in industry magazines while thorough and structured academic research is scant. In addition, there has been no research in Australia to examine how container shipping consolidation may affect shipping lines' service quality and its resulting impact on their customer satisfaction, despite the criticality of maritime transport to the country in that nearly 99% of Australia's foreign trade in terms of volume go through her ports (Department of Infrastructure, Transport, Cities and Regional Development, 2019). Given the importance of this topic for both theory building and management practice, it deserves further investigation. This paper therefore specifically examines (1) which aspects of container shipping consolidation may affect shipping lines' service quality, (2) how these aspects of consolidation impact various dimensions of service quality, and (3) whether customer satisfaction has been influenced by the impacted service quality as a consequence of container shipping consolidation.

Methodology

As there are not many studies carried out to examine the effects of container shipping consolidation on service quality and customer satisfaction, further exploration needs to be done so as to enhance knowledge in this industry. Therefore, an inductive approach to theory building is suitable for exploring the research issues via a qualitative approach (Creswell, 2013). Meanwhile, an explanatory research is also required to examine the relationship between container shipping service quality and customer satisfaction. Therefore, a positivism study with a static design will be appropriate to help gain rich insights on this potential causal relationship by using quantitative analysis of the cause and effect, based on the understanding, explanation and prediction. The validity and reliability of variables and models can be derived from a quantitative study (Dinasarapu et al., 2011; Creswell, 2013). A deductive approach is thus necessary to address research questions in this study. This research aims to explore the effects of container shipping consolidation on service quality and subsequently customer satisfaction, and thus is of exploratory and explanatory nature. Therefore, a triangulation of qualitative and quantitative methods will be employed to collect data in order to answer the research questions and address the objectives.

Underpinned by the research philosophy of pragmatism and the combination of inductive and deductive approaches, this study employs the triangulation of methods, combining qualitative and quantitative methods as the research strategy. A qualitative method provides better understanding about the experience of participants, explores areas not yet thoroughly researched, discovers relevant variables that can be used in the quantitative method and offers a comprehensive approach to study the phenomena (Creswell, 2015). The qualitative approach helps to overcome limitations in the literature of container shipping consolidation, service quality and customer satisfaction. Meanwhile, the quantitative approach validates results from the qualitative method, and analyses how container shipping service quality may affect customer satisfaction in view of consolidation. In the context of this paper, only the procedures, data collection, analysis and findings are reported.

For the qualitative phase of this research, the main method of data collection is in-depth semi-structured interviews. As shippers and logistics service providers are the key customers of container shipping lines, the population targeted consists of senior managers who are working in freight forwarding/logistics service providing and manufacturing/trading (shippers) firms and in charge of operational transactions with container shipping lines. The geographical boundary for these participants is within Australia. Interview participants were approached by contacting relevant peak associations i.e. Australian Peak Shippers Association (APSA) and Chartered Institute of Logistics and Transport Australia (CILTA), which are the sampling frames for this research stage and asking for their assistance to forward the invitation letter to their members. The semi-structured interview allows the interviewees to express their views and ideas and also the researcher to collect in-depth information on how container shipping consolidation affects service quality and customer satisfaction. The interviews were conducted face-to-face at the participants' workplace and tape-recorded with the participants' prior consent. Before the face-to-face sessions, a cover letter detailing the project's background, objectives and research questions was sent to the interviewees so as to obtain their consent to participate in the research project.

By the cut-off date for the 1st phase of this research, seven semi-structured interviews were conducted, followed by a couple of follow-ups via emails. On average each interview lasted for about 90 minutes. Among the five interviewees, five are senior managers in various logistics service providers and two hold senior management positions at a couple of peak associations representing shippers and freight forwarders. The interview protocol consists of 11 open-ended questions categorised in four sections: personal information for classification, operational and service aspects of container shipping consolidation that may affect customers, how service quality of container shipping lines is influenced by various operational and service aspects of consolidation, and how may customer satisfaction is affected by the impacted service quality as a result of consolidation in container shipping. Upon completion, interviews were transcribed and analysed using thematic analysis. Table 3 provides a summary of profile of the interviewees who participated in the first phase of this research.

Interviewees	Designation	Experience	Organisation profile
LSP1	Director Air and Ocean Australia New Zealand	30 years in freight forwarding	Air freight, contract logistics, ground transport, ocean freight, supply chain solutions, vehicle logistics
LSP2	General manager, chairman of a state's logistics committee	27 years in logistics industry	air freight, sea freight, LCL, FCL, service consolidation
LSP3	Import & Customer Service Supervisor	14 years warehouse operations, import seafreight customer service	Bonded warehouse, freight forwarding, quarantine
LSP4	Branch manager, air & sea freight	24 years in freight forwarding, customs brokerage and logistics	Sea & air freight forwarding, inland transport, customs brokerage, logistics solutions
LSP5	Operations manager, contract logistics	5 years in current position, 15 years in the industry	Sea & air freight forwarding, inland transport, customs brokerage, contract logistics

PA-S	Secretariat of the peak association & director of an industry supply chain association	More than 20 years in freight forwarding and logistics	Representing the cargo and shipper owners in respect to liner services
PA-F	Branch manager of the association	Many years of experience in customs quarantine, import and export forwarding	Representing freight forwarders, logistics service providers, customs brokers; offering and promoting education and training for members e.g. conferences, etc.

Table 3. Summary of interviewees' profile

Notes: LSP – Logistics Service Providers; PA-S: Peak association (shippers); PA-F: Peak association (freight forwarders)

Findings and discussion

The cross-interviews thematic analysis compares views, perceptions and shared experiences derived from interviews toward the same three research questions that have been stated earlier. Findings are interpreted by comparing these views, perceptions and shared experiences with the equivalences in the contemporary literature. Analysis results show some similar patterns but also differ quite significantly between the 3PL service providers themselves, and similarities between the peak associations and 3PL service providers towards (1) which aspects of container shipping consolidation may affect shipping lines' service quality, (2) how these aspects of consolidation impact various dimensions of service quality, and (3) whether customer satisfaction has been influenced by the impacted service quality as a consequence of container shipping consolidation. These are elaborated below.

Aspects of container shipping consolidation that may affect customers

Across the 3PL service providers, interviewees shared some common opinions of aspects of container shipping consolidation that may affect their business. It is first perceived that such a consolidation may bring about some benefits to customers of container shipping lines. In this connection, a 3PL service provider (LSP1) indicated that logistics service providers and shippers may enjoy lower *freight rate* as a result of container shipping consolidation, if this is stabilised by shipping alliances. This view is echoed by the interviewee who work for the freight forwarding association (PA-F) who agreed that freight rate is not an issue, although he also warned that shipping lines could negotiate between themselves to fix freight rate and surcharges because they are protected to do so in Australia. It is also this interviewee who added that *capacity* may not be an issue for shipping lines as "they bring big capacity to Australia", a view which is not in common with the rest of interview participants. In this respect, the key argument is that arrangements such as "slot sharing" may limit the access of customers to a shipping service as a shipping line's capacity is now spread across other alliance members. A 3PL service provider (LSP3) illustrated this as follows:

> ... *Space is a main issue. If they are not consolidating with other lines, perhaps 100% of the space of that vessel is for our customers; but now they are sharing with others, so some get more options while others will lose slots.*

Meanwhile, it is unanimously perceived among interviewees in 3PL service providing firms that there are also other negative impacts that container shipping consolidation have on customers. First of all, both the interviewee who works for the shipper peak association and those in other 3PL service providing firms agreed that *freight rate* becomes an issue of concern as it is now consolidated and controlled by container shipping alliances. Indeed, while freight rate is generally decided by demand and supply factors, it can be controlled since larger, but fewer shipping lines are now in the same alliance and stabilised freight rate can be a common practice among them on some specific shipping routes. Even when this is not legally possible in some trading areas, shipping lines in alliances may still influence the pricing in terms of common surcharges applied in shipping routes and port areas within the alliance's networks where they provide their services.

The second visible negative impact is that customers now have *less choices of shipping lines* as well as *negotiating power*, since there is reduced competition between these lines, as typically highlighted

by LSP2. This view is in line with a finding in the literature in which the eight largest container shipping lines now control about 80% of global market share in terms of container carrying capacity. Having fewer choice of service providers may also put customers in the disadvantageous position when negotiating freight rate with shipping lines. Besides, this also implicates negatively for customers when it comes to risk management as the differentiation between various shipping lines has been fading out. This can be seen clearly in the case of Electrolux (Schoer, 2016) which reported on an accident in November 2014 in which two vessels collided and caught fire at Port Kelang in Malaysia. In this incident, it is ironic that while only 15 containers had initially been sent with one of the involved vessel operators, it turned out that 98 containers of the company's containers were on the same vessel although sent with different carriers, and that the number of containers made up more than half of the Christmas sales to Brazil.

The influence of consolidation on container shipping service quality

Service quality of container shipping services is a research topic which has received some attention of scholars in the last decade. Most of them adopted the SERVQUAL model (Parasuraman et al., 1988) while a few others argued that different industry sectors have their own distinctive characteristics, and thus deserve tailor-made models of measuring their service quality. In this study, the ROPMIS model of maritime transport service quality (Thai, 2008) upon which the impacts of container shipping consolidation are examined was adopted, given its application in this industry in the past years. In this connection, container shipping service quality is reflected through factors relating to *resources* (e.g. ships & containers, etc.), service *outcomes* (e.g. time & cost, etc.), *process* (e.g. experience with shipping line's staff, etc.), *management* (e.g. shipping line's efficiency, etc.), *image* (e.g. shipping line's reputation, etc.) and *social responsibility* (e.g. shipping line's safety & environmental operations, etc.).

When asked to comment about the six components of the model measuring service quality of container shipping, all 3PL service providers and peak associations agreed that they are all important, valid and are currently being used by customers to measure service quality of container shipping lines in practice. For example, this is evidenced through the reconfirmation of the interviewees that container shipping lines need to have "equipment availability and in good condition" (LSP2, LSP4), "quality of containers" (LSP5) "shipping schedule reliability" (LSP2), "reliability" (LSP3), "vessel leaving on time", "make as less errors as possible prior to vessels arriving" and "transparency in the booking process" (LSP4), "the attitude of the container line's staff" (LSP5), "interaction with customer when dealing with problems" (PA-F), "good relationship with customers" (PA-S), "environmental awareness" (LSP3). These clearly fall in the six dimensions of maritime transport service quality model elaborated earlier.

When it comes to how container shipping consolidation affect service quality of shipping lines, there is a high level of consensus among interviewees of 3PL service providers and peak associations on some key aspects. While acknowledging that the usage of technology by container shipping lines e.g. faster process due to 100% of electronic Bill of Ladings are now used in Australia, and some automated systems (LSP4), such a consolidation in container shipping also result in negative impacts to service quality. First, there are constraints to *resources* as customers may have less choice of ships and containers (which is linked to the *capacity* and *choice* issues mentioned in the previous section). Secondly, the biggest negative impact of container shipping consolidation is on the *outcomes* as interviewees noted that service outcomes are now increasingly becoming commodities and not much service customisation and differentiation can be provided due to the structure of alliances (LSP3, PA-S). In addition, another note-worthy result of container shipping consolidation is the possible *longer delivery time*. Although not being popularly indicated in the literature, this may be derived from the analysis that, as fewer but larger shipping lines join lesser number of alliances, together with the deployment of bigger ships, containers may have to wait longer so that the necessary load level can be achieved. This is especially true in the case of Australia as majority of containers destined to Australian ports are for local import and export demands. A 3PL service provider (LSP5) elaborated this as follows:

> ... *When consolidating, the shipping lines instead of putting containers daily onto different vessels to spread them over Australia, it already annoys customers because the containers now spend one week longer than it should have to since they have to wait for each other*...

Meanwhile, it was also perceived that the most significant negative impact on the *process* aspect of container shipping service quality as a result of consolidation is the lost of "human touch" in doing business with shipping lines. This is typically pointed out by almost all interviewees (for example, LSP2, LSP3, LSP4, LSP5, PA-S and PA-F). It is argued that since consolidation dictates more efficient process through automation and cost-cutting with less staff, this makes it more stressful for customers for dealing with shipping lines, especially when they have some issues with cargo and they want to find someone in the shipping lines to talk to, who in many cases are "very depressed, angry and grumpy" as indicated by LSP5 interviewee. This constraint also leads to issues with the *management* of shipping lines which is vividly elaborated by LSP4 as follows:

> ... *Flexibility of shipping lines are limited because in some situations, their departments are far from the dock/ port, which results in the fact that they don't have experience to handle the problems (e.g. their container load team is not at port, they are in Singapore).*

The implications of affected service quality on customer satisfaction

Given the impacts of container shipping consolidation on various aspect of service quality identified and discussed in the previous section, it was found consistently among interviewees that customer satisfaction is also negatively influenced as a consequence. This is expected given that consolidation gives more negotiating power to shipping lines and less so for customers. In addition, as the service outcomes are more commoditised and less customised to each customer's expectations, it is becoming harder for shipping lines to meet the satisfaction of specific groups of customers, as highlighted by LSP3 interviewee. It is however noted by LSP4 interviewee that this may differ for big logistics service providers who have large cargo demand, people and system to integrated with shipping lines and their own customers.

Conclusion

In this study, the impacts of container shipping consolidation on service quality and customer satisfaction specifically in the context of Australia are examined. It was found that such a consolidation i.e. M&As and strategic alliances among a few big shipping lines may result in negative influences on customers in terms of service quality aspects such as resources, outcomes, process and management as the consequence of capacity and choice constraints, which in turn negatively affect customer satisfaction. This research contributes to enhance knowledge of how consolidation as a business strategy may affect service quality, and may assist managers in shipping lines in designing and implementing strategies to improve quality and customer service management. As only 3PL service providers and peak associations were interviewed in this qualitative study, future work needs to also incorporate the viewpoint of shippers and employ the second stage of study – a full-scale survey with logistics service providers and shippers – in order to enhance the reliability, validity and generalisability of this important research.

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THE INFLUENCE OF TRUST AND POWER TO COLLABORATION ON VIETNAM FRUITS & VEGETABLES SUPPLY CHAIN

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Introduction

Vietnam's export fruits and vegetables supply chain starts from famers/ contractual farmers who are in charge of selecting breeders, fertilizers and performing the production, harvesting and preliminary processing stages. Then, traders often buy them from famers, who stay in the same area and deliver to purchasing centers/ wholesale markets or exporting firms. Fruits and vegetables from here will be exported to foreign import companies and reached to end consumers. The development of supply chain is considered to be beneficial for agricultural sector as well as the export of fruit and vegetables in Vietnam. However the number of Vietnamese firms in the supporting industry, which are able to participate in the supply chain, are still too few. Being unable to purchase raw materials for production means that there is no connection between production and raw material stages, that is, it has been cut off from the supply chain. This shows a loose, non-cooperative link between the participants in the export vegetable and fruits supply chain of Vietnam.

Trust and power can be seen as the premises of collaboration in general and in supply chain in particular (Cai &partner, 2013). They are a key component of collaboration to improve cultural competitiveness (Ireland and Webb, 2007). In a similar way, trust and power serve as the basis for collaboration to share certain production behaviors in a supply chain (Handfield and Bechtel, 2004). Trust and power go together as a measure to avoid abuse of power from a member in supply chain (Yeung and partners, 2009). Companies often use their strength and power to improve integration based on trust. Supply chain members need strength, not to impose power, but to share concerns and find effective solutions for certain problems as well. It can be seen that trust and power are two important premises to share knowledge and understanding between suppliers and buyers.

Thus, the factors of trust and power have a significant influence on the collaboration in the supply chain. The following research will study the degree of the impact of these two factors on the cooperation in Vietnam's export fruits and vegetables supply chain, thereby offering solutions related to these two factors to enhance the co-operation in Vietnam's export fruits and vegetables supply chain.

Literature review and Research model

The authors conduct research into the effect of these two factors on collaboration in the supply chain. The hypotheses about the effect of strength and trust on the collaboration of the fruits and vegetables supply chain are as follows:

Trust (is abbreviated to TRU): Trust motivates members of supply chain to coordinate in decision making and problem solving (Fawcett and partners, 2012). It is undeniable that trust takes time to develop. In addition, trust lies in the form in which chain members realize that their future depends on mutual interaction (Andaleeb, 1995). Firms often share information with the trust that supply chain partners will ignore opportunistic behaviours and use shared information in ways that are mutually beneficial. A number of studies suggest that trust is also a premise for joint venture cooperation (Monczka et al, 1998, Kwon and Suh 2004, Morton et al, 2006). As such, the trust factor significantly affects the collaboration of all parties in the supply chain. When trust among the parties in the chain increases, the level of cooperation between the parties will increase and vice versa. When interviewing Vietnamese vegetable and fruit enterprises, they all believe that high trust will create a good premise for cooperation between the components of the export vegetables and fruits supply chain in Vietnam, therefore:

H1: There is a positive relationship between trust and collaboration in the Vietnam's export fruits and vegetables supply chain

Power (POW for short):

When designing a supply chain and cooperating with other firm, one party must consider its position and influence in the chain. In a supply chain relationship, power can be defined as "the ability of one party (the influencer) to influence the intentions and actions of another (affected party)" (Emerson, 1962). Power is also defined as "the ability of a chain member to influence the behavior and decisions of other members" (Yeung et al., 2009). In general, the concept of power focuses on the ability of one party to influence the other parties. For the other party tends to act according to their wishes more. The member who is more powerful tends to be dominant over the other ones (Cox, 2001).

In the relationship between buyer and seller, the higher the degree of dependence of the supplier or the buyer on the partner, the higher the use of the contract (Lusch and Brown, 1996). As such, the power factor has a significant influence on the collaboration of all parties in the supply chain. As the power of the parties in the chain increases, the level of cooperation between the parties will increase and vice versa. The surveyed firms show that they have a strong influence on their partners' decisions and their actions are also affected by supplier. The hypothesis is given as follows

H2: there is positive relationships between power and collaboration in Vietnam's export fruits and vegetables supply chain

Based on that fact, the authors proposes the research model hypothesis as below. This hypothesis will be verified in the next step.

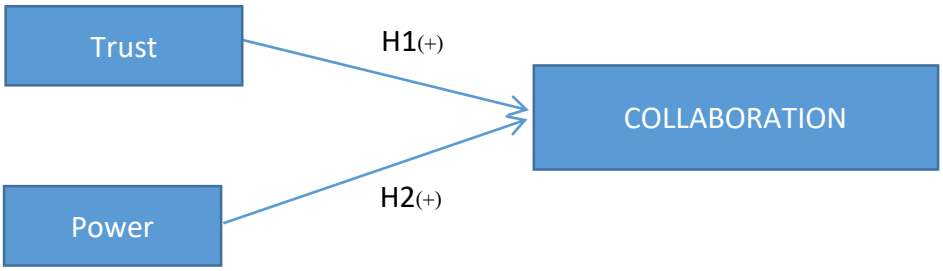

Figure 1: The offered research design

Methodology

3.1. Preliminary research

Preliminary research is conducted through 2 methods: Qualitative research and quantitative research. The purposes of qualitative research are to create a scale of measurement and to set up a questionnaire. It is conducted by discussing with lecturers with expertise in the supply chain, as well as 5 representatives in Vietnam's export fruits and vegetables supply chain. The result of this study was to develop an official interview questionnaire for official research. The questionnaire consists of 12 questions examining the influence of two factors: trust and power on the collaboration between the components in the Vietnam's export fruits and vegetables supply chain:

Table 1: Table of quantitative analysis content

	Variable Symbol	Content
Collaboration (COL)	COL1	Members of supply chain plan the chain's activities together
	COL2	Members of supply chain always collaborate to develop new markets
	COL3	Members of supply chain always collaborate to develop new products

	COL4	Members of supply chain always collaborate to perform
	COL5	Members of supply chain always discuss to solve arising problems.
TRUST (TRU)	TRU1	Members of supply chain are always open and do not hide business goals
	TRU2	Members in the chain always have a positive attitude in common agreements
	TRU3	Member of supply chain trust each other
	TRU4	Members of supply chain always respect each other.
POWER (POW)	POW1	Members of supply chain have similar power when making decisions on the chain's operation (production, distribution, sales, research and development, etc.).
	POW2	Suppliers and importers have influenced on firms' decisions (in production, distribution, sales, research and development, etc.).
	POW3	One party has an influence on other parties' decisions (in production, distribution, sales, research and development, etc.).

Based on that, the detailed quantitative questionnaire is designed with sections: introduction, content, personal information, and proposing solutions to improve collaboration with 12 questions represents for 12 observed variables.

3.2. Official quantitative research:

The official study was conducted by a quantitative research method implemented right after the questionnaire was edited from the preliminary research results. This study directly surveys manufacturing, trading enterprises, and cooperatives to collect survey data. These are considered as central enterprises in the supply chain, and assume the responses of businesses and cooperatives on supply chain collaboration are generalized for the entire Vietnam's export fruits and vegetables supply chain. The objective is to double check the scales of measurement in the research model. This is a detailed analysis of data collection through the survey, which containing quantitative questionnaires sent to the surveyed firms to determine logic and correlation among factors and thereby giving specific results on the research issue.

The survey was conducted through direct interviews with the firms' directors, firms' managers of import and export departments at their office in Hanoi, as well as at trade fairs in agricultural and vegetables sectors held in Hanoi. A number of other firms in Hanoi other provinces conducted the survey through phone calls and emails.

1.3. Research sample

The sample size depends on the analytical method, which uses EFA exploratory factor analysis, and multivariate regression analysis, so it takes the largest sample size needed among the methods. To achieve good results for regression analysis, sample size must be larger or equal to $50 + 8 * 2 = 66$ samples (Tabachnick & Fidell, 2007). The survey for this study received 100 responses from 124 questionnaires that satisfy the condition related the number of samples studied.

3.4. Methods of analyzing research data:

Preliminary assessment of reliability and values of scales of measurement by Cronbach's alpha reliability coefficient and exploratory factor analysis (EFA) through SPSS 20 processing software, to assess the reliability of the scales; thereby eliminating the observed variables if not appropriate, assessing the remaining factors and the appropriate factors as the basis for the adjustment of the research model and research hypotheses.

Using method of Pearson correlation analysis, multiple regression (RA) with linear relations to test the factors that have an important influence on the collaboration in Vietnam's export fruits and vegetables supply chain and the degree of importance of these factors.

Research result

4.1. Reliability Analysis and Factor Analysis:

Table 2: Results of Reliability Analysis and Factor Analysis

Variable/Factor (Number of questions)	**Cronbach's Alpha**	**Corrected Item - Total Correlation (Smallest Value)**	**KMO**	**Bartlett's Test of Sphericity - P-value**	**Variance Explained (%)**	**Factor Loading (Smallest Value)**
Trust (4)	0,767	0,473	0,751	0,000	59,382 %	0,679
Power (3)	0,702	0,444	0,652	0,000	62,946 %	0,725
Collaboration (5)	0,796	0,497	0,810	0,000	55,499 %	0,666

As mentioned above, the proposed research model consists of 2 independent variables and 1 dependent variable. In order to assess the internal consistency and uni-directionality of each research concept, the study performed reliability analysis and factor analysis.

According to the table above, the Cronbach's Alpha values of the three research variables are 0,767; 0,702; 0,796 exceeding the recommended cut-off point of 0.6. The smallest value of Corrected Item - Total Correlation of Trust, Power and Collaboration Scale are all higher than the allowable level of 0,3. Therefore, all scales meet the reliability requirement and are retained for factor analysis.

For the factor analysis, The Bartlett's test of sphericity is significant, with the p-value = 0,000 with all 3 scales and the KMO coefficients of trust, strength and collaboration are respectively 0.751; 0,652; 0,810 - above the cut-off value of 0,5. Total explained variance of all 3 factors is above 50% and the minimum factor loading values in 3 variables are respectively 0,679; 0,725; 0,666, implying that the loadings of all questions are greater than the allowed level of 0,5, so no observed variables are removed. In general, the observed variables of the factors are correlated with respect to the overall scope, so the appropriate EFA analysis results are used in this study.

4.2. Correlation analysis and Multi-variable regression analysis:

As stated, the scales for research concepts have been preliminarily assessed through Cronbach's Alpha reliability coefficient and EFA discovery factor analysis. Next, the authors conduct Pearson correlation analysis to check the linear relationship between these scales. The results of the analysis are shown in the below table:

Table 3: Results of Pearson correlation analysis

Variable/Factor (Number of questions)	Trust	Power	Collaboration
Trust (4)	1		
Power (3)	0,590 **	1	
Collaboration (5)	**0,475** **	**0,573** **	1

** Significance level: p = 0,000

The results above indicate that trust and power were all positively associated with collaboration (r = 0,475 ; p = 0,000; r = 0,573; p = 0,000 respectively). In detail, there is a stronger correlation between collaboration and power than between collaboration and trust (r = 0,573 > r = 0,475).

Next, the authors conduct a linear regression analysis to test the hypothesis and the research model (H1 and H2) with the collaboration in the supply chain as the dependent variable and trust, power as two independent variables. The results are as follow:

Table 4: Results of linear regression analysis

Variable/Factor	**Standardised Coefficient (Beta)**	**Significance (t)**	**VIF**
Trust	**0,209**	0,041	1,534

Power	**0,450**	0,000	1,534
R^2 = 0,357	**Adjusted R^2 = 0,344**	Significance (F) = 0,000	Durbin-Watson = 1,643

Looking at the table above, the test sig F = 0.000 <0.05 shows that the linear regression model is consistent with the data set, has statistical significance and can be used. The adjusted R2 coefficient is 0.344 indicating that the independent variables of trust and power in the regressive model affect 34.4% of the change in the supply chain collaboration. The remaining 65.6% of the change in the supply chain collaboration is due to other variables other than the model and random errors. Durbin - Watson coefficient is equal to 1.643 is in the range of 1.5 to 2.5, so no first-order autocorrelation occurs.

Next, the regression coefficients of the independent variables are significant (below 0.05 level), so all variables are meaningful and therefore, are not excluded from the model. VIF are less than 2 so there is no multi collinearity phenomenon. The standardized coefficients are all greater than 0. Thus, trust and strength positively affect to collaboration. Based on the magnitude of the standardized coefficient (or Beta), the order of influence from strong to weak of the independent variables to the dependent variable Collaboration is: Power (0.450)> Trust (0.209). The power factor has a stronger impact to collaboration in supply chain than the trust factor.

In summary, the hypothesis H1 and H2 we have proposed from the beginning are accepted. The results also show that the two factors of trust and power explain about 34.4% of the collaboration in Vietnam's export fruits and vegetables supply chain.

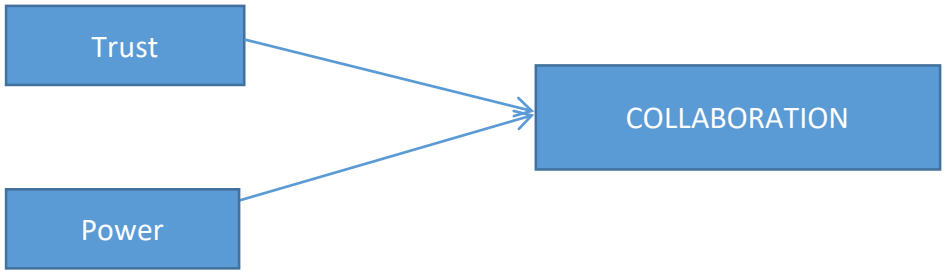

Figure 2: Results of the Research Model

Conclusion

The analytical results show that the two factors of trust and power, which are tested and meet all requirements of value, reliability, and conformity, contribute quite positively to the collaboration in the supply chain. In addition, these two components have a positive impact on the collaboration of the Vietnam's export fruits and vegetables supply chain through multivariate linear regression.

More specifically, the theoretical research results have contributed to demonstrate the relevance of the model of collaboration in the Vietnam's export fruits and vegetables supply chain. Two hypotheses about trust and power are accepted, thereby giving practical meaning to enterprises operating in the field of exporting vegetables and fruits in Vietnam. On the other hand, in terms of management practices, the trust and power factors explain nearly 35% of the impact on the collaboration in the Vietnam's export vegetables and fruits supply chain. Indeed, the detailed results of the observed variables belonging to the two components of collaboration show the degree of direct impact of each element is shown in the following table:

Table 5: The degree of influence of trust and power on collaboration.

Factors affecting collaboration	Beta coefficient standardized	The average value	Impact level (the bigger the stronger)

Trust	0.209	3.1925	1
Power	0.45	3.29	2

(Source: Summary of results of using SPSS 20.0 software)

In these two factors, the power factor has the strongest impact on collaboration in the supply chain (β = 0.45) and then on trust (β = 0.209). In terms of practical significance, this will partly help stakeholders in the supply chain to have a more specific and in-depth view of the process of collaborating with different partners in the chain. Firms, therefore, might have more appropriate strategies to enhance collaboration and improve the performance of the supply chain as a result The results of this study also help enterprises have more basis to re-evaluate their own internal capabilities, identify what they have done, and more importantly, identify factors that need to be improved to enhance further collaboration in the chain, bringing long-term benefits to the parties.

From the general assessments in the previous section, the authors propose recommendations related to the two factors of trust and power to enhance the collaboration between components in Vietnam's export fruits and vegetables supply chain as follows:

Recommendations related to trust:

The trust factor has a weaker impact in the two research factors because of the smaller Beta coefficient (β = 0.209). At the same time, the level of assessment of surveyed enterprises for this factor is also lower than average (the average value of the trust is equal to 3.1925, greater than the midpoint of the scale but not yet reached Agree = 4). Thus, the trust factor has a certain influence on the collaboration between the parties in the supply chain, but the parties themselves do not have a high level of mutual trust. Therefore, it is necessary to enhance mutual trust between the parties to improve the ability to collaborate in the supply chain.

Table 6: The average of observed variables of belief factor

Observed variables	Statements	Average Value
TRU1	Members of supply chain are always open and do not hide business goals	2,81
TRU2	Members in the chain always have a positive attitude in common agreements	3,33
TRU3	Member of supply chain trust each other	3,28
TRU4	Members of supply chain always respect each other	3,35

(Source: Summary of quantitative data analyses using SPSS 20.0)

From the table above, the surveyed enterprise has the lowest rating for the observed variable TRU1 (average value = 2.81, this value is below neutral level), the highest rating for the TRU4 variable (price mean = 3.35). As such, the chain partners are not really open and still hide their business goals. In addition, the observed variable TRU3 is the second most underestimated observation (after TRU1), which means that some parties in the chain still have doubts about the honesty of the partner. At the same time, all observed variables have average values below the level of Consent = 4, proving that the above statements are still somewhat unanimous from the subjects surveyed. Therefore, to enhance mutual trust among the parties, the following solutions may be implemented:

Towards a long-term cooperative relationship development with the basis of mutual trust, prestige is always the top priority for business operation. As a result, participants in a chain need to ensure the reliability, commit not to exploit each other, and share their vision and objectives towards common

interests. Particularly, it is aimed at sharing more vital information such as plan in production, plan in new market development to support and benefit each other, as well as the whole chain. Furthermore, effectively sharing difficulties and seeking solutions base on collaboration will bring a win-win relationship and enhance mutual trust.

In fact, as various agreements between exporters and suppliers are only set up orally that easily to be breached when one finds greater benefits from other party. Consequently, mutual trust will seriously be damaged, resulting to long-term benefits lessened. Thus, supply chain members shall comply with the common agreement until the end, rather than merely following short-term benefit. Moreover, supply chain members need to maintain a positive attitude and express a willingness to work together for a common agreement. When that spirit is shown through efforts to build up a mutual benefit, the other partners will similarly respond to that willingness. Since then, trust among members in the supply chain will be strengthened.

Besides, professional image of firms need to be developed to improve the reliability of establishing agreements with partners. Additionally, focusing on internal capabilities development and maintenance is also a strategy to be appreciated by stakeholders, which helps to enhance cooperative relationships.

Recommendations related to power:

Among the two research factors, the power factor has the strongest impact due to the largest beta coefficient (β = 0.45). In addition, assessment level of enterprises with this factor by average value is also larger than that of the trust factor (3.29 and 2.94, respectively, however, has not excess the Agree point = 4). Thus, the power factor provides significant impact on the collaboration among the parties in Vietnam's export fruits and vegetables supply chain. Nevertheless, at the same time, enterprises in this sector also realize that they do not have enough influence on their partners. As a result, improving the influence and power in the relationship between parties in Vietnam's export fruits and vegetables supply chain is also neccessary to accelerate intra cooperation among related parties.

Table 7: Average value of the observed variables for the power factor

Observed Variable	Statement	Average Value
POW 1	Members of supply chain have similar power when making decisions on the chain's operation (production, distribution, sales, research and development, etc.).	3,06
POW2	Suppliers and importers have influenced on firms' decisions (in production, distribution, sales, research and development, etc.).	3,36
POW3	One party has an influence on other parties' decisions (in production, distribution, sales, research and development, etc.).	3,45

(Source: Summary of quantitative data analysis results using SPSS 20.0)

Looking at the table above, we can see that the observed variable POW1 (average value = 3.06) was evaluated as the lowest by firms, followed by the variable POW2 (average value = 3.36) rand the variable POW3 (average value = 3.45) was the highest. Thus, firms can realize that the components in the supply chain do not have the same power when making decisions of the chain operation of the chain. Also, firms have better agreement on the variable POW2 and POW3, which means they have influence on the decisions of their partners, and the firms themselves are also partly influenced, by the suppliers and importers in making decisions. In general, firms' level of assessment for this factor by the average value = 3.29 is still low. Therefore, the following solutions can be implemented to enhance the common power of the parties in the supply chain.

First, it is necessary to reduce the imbalance of power between the components of the chain. The links of the chain need to be showed that they have equal power to make decisions related to the overall operation, in other words, they have greater power and influence in the supply chain. One of the first solutions that can be mentioned is internal improvement known as a long-standing corporate

governance problem. Some improvements include the continuous standardization and overall improvement of the workforce, the procurement process and the process of working with partners. Also, applying technology in all stages of purchasing and processing products and human resource training system should be considered. Hence, the improvement of the internal force is indispensable. Moreover, it is the most effective and sustainable measure, which requires lots of time in the companies' development process. If firms always focus on developing its own intrinsic values, they will gain very high appreciation from its partners. Thereby, the firms' power over other parties in the supply chain will grow and the collaboration will be improved as well.

In addition, in order to enhance their power in the chain, firms themselves must create a great impact on the partners' decisions. This requires information to be seamlessly shared between the parties. For example, in the supply chain of fruits and vegetables, companies need to have the information about importer's business plan as well as harvest plan for gathering products from traders. By doing so, firms can be able to match their activities with their partners and apply their own knowledge towards providing support in partners' business activities (eg. giving advice, sending technical support and so on). As a result, firms will influence their partners' decisions. The sharing of such information unconsciously has built up power for the parties, through taking advantage of the shared information to improve operational efficiency. Thus, the information sharing not only has a positive impact on the trust as analyzed above, but also increases the parties' power in the supply chain.

Another recommendation that can be implemented is business expansion. To expand the scale, firms can associate and merge with other businesses inside or outside the industry in the form of sharing orders or combining together with a view to facilitating negotiation with the suppliers. In addition, businesses can also call for investment in many forms, from individuals (domestic or overseas), credit institutions, investment funds, or by issuing stocks (if eligible). Moreover, firms need to understand the importance of the frequent upgrades of processing equipment for agricultural product. Also, firms should constantly explore and apply new technological advances.

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THE ROLE OF RELATIONSHIP IN INFORMATION SHARING AND COMMUNICATION BETWEEN ORGANIZATIONS: A CONCEPTUAL FRAMEWORK

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Introduction

In a highly competitive, globalized and turbulent business environment where rivalry is no longer between individual companies but entire supply chains, firms are increasingly aware of the need to effectively manage supply chain activities beyond their boundaries (Patnayakuni et al., 2006). Since satisfying diverse customer requirements could not be achieved through the effort of any individual firm, companies are confronted with the need to work and collaborate closely with their business partners (Lejeune and Yakova, 2005, Mentzer et al., 2000). In this instance, collaborative relationship helps firms improve performance and sustain joint competitive advantages (Dyer and Singh, 1998, Mohr and Spekman, 1994, Jap, 1999, Mentzer et al., 2000, Stuart and McCutcheon, 1996). In the supply chain context, a business partnership is formed by at least two autonomous firms working together in planning and executing supply chain activities (Simatupang et al., 2004, Cao and Zhang, 2011, Fawcett et al., 2008). The essence of business partnership is to nurture a mutual relationship in which participants are willing to share information and communicate together towards common goals (Samaddar and Kadiyala, 2006, Simatupang and Sridharan, 2008).

According to the literature, the two major concerns for inter-firm business partnership are the technical compatibility relating to information technology (IT) and the relationship issue relating to human interactions (Gunasekaran and Ngai, 2004, Prajogo and Olhager, 2012, Wei et al., 2012). It is emphasized that IT can only support but not replace human interactions which are considered a critical criterion of collaboration (Sanders and Premus, 2005, Sanders, 2007). Further, in the era of Internet, IT is well defined and widely adopted in most business organizations (Wu et al., 2014) and thus may not be considered a high barrier to be overcome. Meanwhile, the relationship issue, which could lead to meaningless communication and unwillingness to share information between partners if not properly resolved, is more vital to the success of collaborative relationship (Wu et al., 2014, Sanders and Premus, 2005) especially in the context of supply chains which involve multiple players with complex relationships.

Taking into account the difference in terms of business culture between Asian and Western countries, there were two different approaches to developing relationship i.e. it can be developed at both inter-personal level (Fan, 2002, Wang, 2007) as well as at inter-organizational level (Gummesson, 1996, Morgan and Hunt, 1994). In this connection, Shaalan et al. (2013) contended that these approaches could simultaneously affect the mutual relationship between firms and emphasized the need for inter-personal approach in building the mutual relationship at inter-organizational level in Asian firms. Notably, experiment studies conducted by Cadilhon et al. (2005) and Cadilhon and Fearne (2005) provide evidences that inter-personal interactions could be a critical success factor for the effective and high-quality information sharing and communication in business coordination. However, previous studies have not examined the impact of relationship attributes on business partnership components such as information sharing and inter-firm communication at both inter-personal and inter-organizational levels simultaneously.

Consequently, this study proposes a conceptual framework for investigating the role that relationship attributes play as antecedents of information sharing and communication between suppliers and suppliers in the Asian context. The relationship attributes are identified based on social exchange theory. The remainder of this paper is structured as follows. The next section reviews the extant literature on information sharing and communication, followed by a discussion on the theories which underpin how relationship attributes may affect information sharing and communication between organisations in the

supply chain context. Subsequently, a conceptual framework with hypothesis development is presented. Finally, conclusion, implications and suggestions for further research are discussed accordingly.

Literature Review

Information sharing and inter-firm communication

Information sharing is identified as a key element of business partnership (Zaheer and Trkman, 2017, Paulraj et al., 2008) while inter-firm communication can foster and maintain mutual relationship which in turn would enhance the benefits for all participating organisations (Mohr et al., 1996, Anderson and Narus, 1990). Frequent and open communication not only nurtures these value-enhancing relationships (Christopher, 2016) but also encourages knowledge development through information sharing (Kotabe et al., 2003, Takeishi, 2001). Specifically, the high frequency of information exchange on strategy and operations facilitates closer cooperation (Anderson and Narus, 1990, Anderson and Weitz, 1992), and may reduce transaction cost but maximizes transaction value (Dyer, 1997, Zajac and Olsen, 1993).

Although some behavioural factors such as trust and motivation are identified as enablers of information sharing between collaborative partners (Zaheer and Trkman, 2017), majority of the previous studies are underpinned by a unifying theory (Van Weele and Van Raaij, 2014). Furthermore, only a handful of studies relating to the nature of business partnership investigate the inter-personal factors as antecedents of sharing willingness (Zaheer and Trkman, 2017), and it was found in the study of Croom et al. (2007) regarding supply chain partnership that the willingness of sharing information is often "overlooked". Hence, there is a considerable need for further research applying interdisciplinary theories to understand which relationship factors have impact on information sharing and communication in inter-firm partnership (Narayanan and Raman, 2004, Tokar, 2010, Cheng, 2011, Zhao et al., 2013). Based on previous studies, the components of collaborative partnership between firms are defined and summarised in Table 1.

Factors	***Definition***	***Authors***
Information sharing	Information sharing refers to the exchange of confidential information among supply chain partners which focus on the accuracy, relevance and completion of information in timely manner	Simatupang and Sridharan (2002), Simatupang and Sridharan (2005a), Simatupang and Sridharan (2005b), Simatupang and Sridharan (2008), Sheu et al. (2006), Angeles and Nath (2001), Cao and Zhang (2010)
Inter-firm communication	Inter-firm communication refers to frequency, direction, mode, and influence strategy of contacting and message transmission between collaborative partners	Mohr and Nevin (1990), Paulraj et al. (2008), Prahinski and Benton (2004), Cao and Zhang (2010)

Table 1: Components of Inter-firm Partnership

Theoretical foundation

Traditionally, transaction cost economics (TCE) and resource-based view (RBV) are identified as the dominant theories applied to understand collaborative relationship (Clifford Defee et al., 2010). However, these theories fail to fully explain collaborative relationship because (1) they focus on the formation but not the effective management of inter-firm relationship (Barringer and Harrison, 2000, Gulati, 1998), and (2) their primary approach to inter-firm partnership is from the organizational level thus overlooks the inter-personal factors that are involved in business partnership (Wang et al., 2018), which are important especially in the Asian business context. Meanwhile, business research adopting social exchange theory (SET) has identified the role of relationship attributes in Asian business partnership at both inter-personal (Barnes et al., 2015) and inter-organizational levels (Wu et al., 2014). Thus, SET is adopted in

this study as the theoretical lens to investigate the impacts of relationship attributes on inter-firm business partnership, which is denoted by information sharing and inter-firm communication.

According to SET, the interaction between organizations or individuals with others can be explained based on the expectation of benefits derived from the relationships (Emerson, 1976). In business management, SET argues that the development of business partnerships is based on the long-term mutual benefits gained from the relationships (Wei et al., 2012, Kwon and Suh, 2005). Moreover, from social exchange perspective, an interaction between humans is based on trust and is through their willingness (Stafford, 2008). Therefore, it is argued that the investment of social aspects based on trust, mutuality and respect could create long-term benefits for involved parties such as corporate innovativeness and well-being (Widén-Wulff and Ginman, 2004).

Although the core factors affecting collaborative relationships such as trust and commitment have been extensively investigated through different theoretical lens in the literature (Zaheer and Trkman, 2017), the use of SET gives the appropriate theoretical background to these relationship attributes in this study. SET has been adopted for studies on inter-firm relationships such as manufacturer-distributor, supplier-buyer and strategic alliances among supply chain partners (Chao et al., 2013). Furthermore, the use of SET has considered the formation and development of collaborative relationships in several studies (Griffith et al., 2006, Wei et al., 2012, Kwon and Suh, 2005).

In this connection, the study of S. Tsanos et al. (2014), Yang et al. (2008) and Kwon and Suh (2005) contended that trust creates incentives for cooperation and also the reliability atmosphere among partnering firms while commitment leads the participants to "mutuality" in terms of goal and respect. Moreover, Kwon and Suh (2005) argued that although commitment is the key factor in the success of supply chain relationships, partnering firms cannot achieve commitment without trust. Meanwhile, power, justice (Griffith et al., 2006), and dependence (Narasimhan et al., 2009) also exert significant effects on supply chain relationship in terms of attitudes and behaviours between supply chain partners. However, Wu et al. (2014) identified the similarity in definition between reciprocity and justice, and also power and dependence from the SET perspective. Their research therefore identifies four SET key issues regarding collaborative relationship: trust, commitment, reciprocity and power. This study adopts these key issues from the study of Wu et al. (2014) then re-classifies them to fit the Asian business context.

Among these, inter-personal trust has long been identified as the irreplaceable factor in Asian business practices. For example, in China and countries with similar business culture, business transactions between a firm and another business entity cannot happen if the firm's individual does not trust his counterpart (Yau et al., 2000). Later on, the study of Cadilhon and Fearne (2005) and Cadilhon et al. (2005) on business partnerships in the retail sector in Vietnam indicated that business partnership in this context was trust-based relationship which starts from inter-personal trust. Besides, through an in-depth review and synthesis of research on business relationship formation and development, Shaalan et al. (2013) proposed that the influence of inter-personal factors on business relationship in local Asian firms can be direct or indirect through inter-organizational factors .

Based on the study of Hofsteds (1980) on the comparison of cultural dimensions between Western and Eastern societies, Barnes et al. (2015) used SET as the theoretical lens to explain the key role that inter-personal relationship plays in explaining the inter-firm partnership in Asian context. Specifically, trust in Asian firms is built up from the personal interactions between an individual in a firm and the counterpart in its business partner, resulting in better inter-firm relationship quality. Hence, based on the review of literature, five key SET variables are derived in this study, namely, inter-personal trust, inter-organizational trust, commitment, power, and reciprocity, for the development of relationships with business partners and investigation of their influence on information sharing and inter-firm communication in Asian context. These relationship attributes, as antecedents of business collaborative partnership, are summarised in Table 2.

Factors	*Definition*	*Authors*
Inter-personal trust	Inter-personal trust refers to the extent of trust of an individual in a focal firm on the counterpart in the supply chain partner	Zaheer et al. (1998), Ha et al. (2011), Lobo et al. (2013)
Inter-organizational trust	Inter-organizational trust refers to the extent of trust placed by a focal firm in the supply chain partner	Zaheer et al. (1998), Cai et al. (2010), Chen et al. (2014), Lee et al. (2010), Wu et al. (2014)
Commitment	Commitment is defined as an exchange partner's belief that an ongoing relationship with another is so important as to warrant maximum efforts at maintaining it, that is, the committed party believes that the relationship endures indefinitely	Morgan and Hunt (1994), Kwon and Suh (2004), Zacharia et al. (2009), Lee et al. (2010), Wu et al. (2014)
Power	Power refers to the interdependence between partners, in which the decisions and behaviors of partners can be affected by the member with more power	Gaski (1984), Wu et al. (2014)
Reciprocity	The concepts of reciprocity in supply chains relate to the perception of common goals and mutual benefits which are core elements in constructing collaboration. Further, the belief of gaining reciprocal benefits in long-term facilities information sharing between supply chain partners	Humphreys et al. (2001), Wu et al. (2014)

Table 2: Antecedents of business collaborative partnership

Research Hypotheses and Conceptual Framework

Based on the literature review, we propose a conceptual framework including information sharing and inter-firm communication, and relationship attributes as their antecedents (Figure 1). Hypotheses about the linkages between these variables are also put forward.

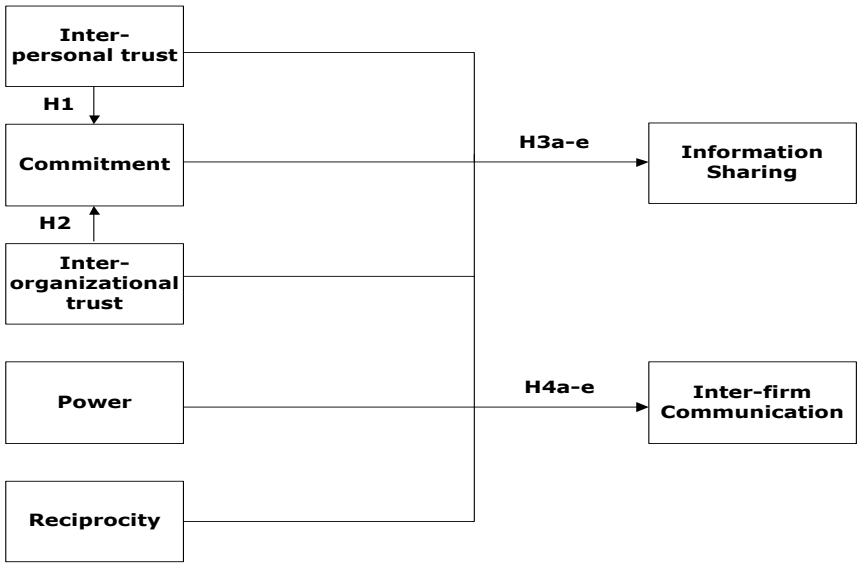

Figure 1: The conceptual framework

Trust has a significant positive impact on inter-organizational commitment (Morgan and Hunt, 1994, Ryu et al., 2009, S. Tsanos et al., 2014). Trust can be regarded as inter-personal or inter-organizational relationship (Zaheer et al., 1998, Morgan and Hunt, 1994). Morgan and Hunt (1994) theorized the

relationship between trust and commitment in marketing relationship. The commitment-trust theory contends that, for sustainable mutual benefits, a firm should commit and develop the long-term relationship with other trustful supply chain partners. Besides, the study of Gulati and Sytch (2007) found that inter-personal trust also has a positive effect on commitment between business partners. Therefore, both inter-personal and inter-organizational trust must be considered in inter-organizational commitment and the relationship between trust and commitment can be hypothesized as follows:

H1. Inter-personal trust has a positive effect on commitment between collborative partners.

H2. Inter-organizational trust has a positive effect on commitment between collaborative partners.

Several studies have suggested that inter-organizational trust is an antecedent of business partnership (Chen et al., 2014, Cai et al., 2010). Based on inter-organizational trust, business partners intend to fulfil their obligations in order to not only achieve mutual objectives but also maintain and develop strategic alliances, inter-organizational interactions and communication (Chen et al., 2014). A firm's trust in its supplier facilitates information sharing and collaborative planning between them (Cai et al., 2010). This expectation leads to the following hypotheses:

H3a. Inter-organizational trust has a positive effect on information sharing.

H4a. Inter-organizational trust has a positive effect on inter-firm communication.

Meanwhile, inter-personal trust is considered an antecedent of inter-firm collaboration in a number of studies (Ha et al., 2011, Lobo et al., 2013). Ha et al. (2011) constructed inter-personal trust from affective trust and trust in competency, and confirmed the positive relationship between inter-personal trust and collaboration components including information sharing, joint decision making, and benefit/risk sharing. The study of Lobo et al. (2013) indicated that inter-personal trust in Chinese culture has significant positive effects on collaboration and inter-organizational relationship. Hence, the following hypotheses are put forward:

H3b. Inter-personal trust has a positive effect on information sharing.

H4b. Inter-personal trust has a positive effect on inter-firm communication.

It has also been argued in many studies that commitment positively improves important business activities including information sharing and collaboration (Wu et al., 2014, Lee et al., 2010). Moreover, commitment plays an important role in maintaining the long-term relationship between trading partners and facilitates business partnership (Morgan and Hunt, 1994). Thus, the following hypotheses are proposed:

H3c. Commitment has a postive effect on information sharing.

H4c. Commitment has a postive effect on inter-firm communication.

In a business partnership, a firm intends to exercise power over other firms if the firm perceives the possibility of inequitable distribution of relationship resources and inputs into the relationship (Griffith et al., 2006). Hence, power is suggested as the parameter of exchange in business partnerships (Narasimhan et al., 2009). A more powerful firm in business relationships may control over other business partners in information sharing and communication, resulting in more effective collaboration (Hart and Saunders, 1997). Accordingly, the following hypotheses are proposed:

H3d. Power has a positive effect on information sharing.

H4d. Power has a positive effect on inter-firm communication.

Besides, based on the SET, it has been argued that business relationships are formed and developed because a firm can gain reciprocal benefits from others over time (Narasimhan et al., 2009). In the supply chain context, for example, reciprocity helps a supplier access accurate and up-to-date information through frequent communication with downstream partners to facilitate production management. As a result, responsiveness, which relates to the benefit of buyers, can be improved (Wu et al., 2014). Hence, the following hypotheses are postulated:

H3e. Reciprocity has a positive effect on information sharing.

H4e. Reciprocity has a positive effect on inter-firm communication.

Conclusion

This study conceptually establishes the connections between various constructs relating to business partnership relationship in the supply chain context which have previously been researched individually or in group but not in a holistic manner. In this respect, the issue of relationship has been identified as the key enabler of inter-firm collaboration (Gunasekaran and Ngai, 2004, Prajogo and Olhager, 2012, Wei et al., 2012). However, in different business cultures and contexts, relationship could be built and developed at different levels including firm and individual (Shaalan et al., 2013), and business partnership is no exception. The existing literature shows that business partnership could be examined at both inter-organizational level (Chen et al., 2014, Wu et al., 2014, Lee et al., 2010, Cai et al., 2010) and/or inter-personal level (Ha et al., 2011, Lobo et al., 2013). The implications of these two approaches in examining a business-to-business relationship need to be investigated simultaneously in different contexts (Zaheer et al., 1998), and especially in Asian countries (Shaalan et al., 2013).

Based on this background, the conceptual framework developed in this study investigates the role that relationship attributes at inter-organizational and inter-personal levels play as antecedents of business collaborative partnership, as denoted by information sharing and inter-firm communication within supplier-buyer collaborative relationships in the Asian context. Based on social exchange theory, various factors such as trust, commitment, power, and reciprocity are identified as key attributes of relationship. In particular, both inter-personal and inter-organizational forms of trust would need to be considered. Further, the relationship between each form of trust and commitment is proposed based on the commitment-trust theory developed by Morgan and Hunt (1994). This provides a theoretical foundation to examine the role of trust towards relationship commitment between firms.

This study therefore contributes to advance the understanding of the role that relationship attributes play in enhancing business collaborative partnership in the supply chain context. It also specifically examines how trust at both inter-organizational and inter-personal levels would influence information sharing and inter-firm communication through commitment, an area that has not been well researched in the literature. Upon being empirically validated, this study can provide insights and guidance for business practitioners in Asian countries on the relationship factors that may positively influence information sharing and inter-firm communication with their business partners. As a result, appropriate policies and strategies to enhance these relationship factors and subsequent business collaborative partnership for mutual supply chain benefits can be designed and implemented accordingly.

Nonetheless, this study is conceptual at this stage and the empirical validation of the proposed conceptual framework needs to be conducted at the subsequent stage of the study. This can be done in future studies using quantitative research techniques such as surveys. Another limitation of the current study is that it focuses only on supplier-buyer relationship in Asian countries. Future research should therefore include other business partnerships in different industries so as to enhance the validity and generalizability of the proposed conceptual framework.

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THE STUDY OF AIRPORT'S PASSENGER FLOW: CASE OF THAILAND

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Introduction

In recent year, airports play a significant role in economic growth, connecting cities and nations. Number of passenger is increasing rapidly. According to the International Air Transport Association (IATA, 2018), the latest update to IATA's 20-Year Air Passenger Forecast, shows that over the next two decades, the forecast anticipates a 3.5% compound annual growth rate (CAGR), leading to a doubling in passenger numbers from today's levels. According to IATA (2017) report, figure 1 shows that the number of passenger expected to grow in double-digit from 4 billion in 2016 to 7.2 billion passengers in 2036. For Asia region, in 2034 China will account for some 1.19 billion passengers, 758 million more than 2014 with an average annual growth rate of 5.2%. Traffic to, from and within the US is expected to grow at an average annual growth rate of 3.1% that will see 1.16 billion passengers by 2034 (523 million more than 2014). India will displace the United Kingdom as the third-largest market in 2026, with Indonesia rising to number 5 in the world. Japan, Spain, Germany and France fall relative to their competitors, Italy falls out of the top 10, while Brazil moves from 10th place to 7th (IATA, 2015).

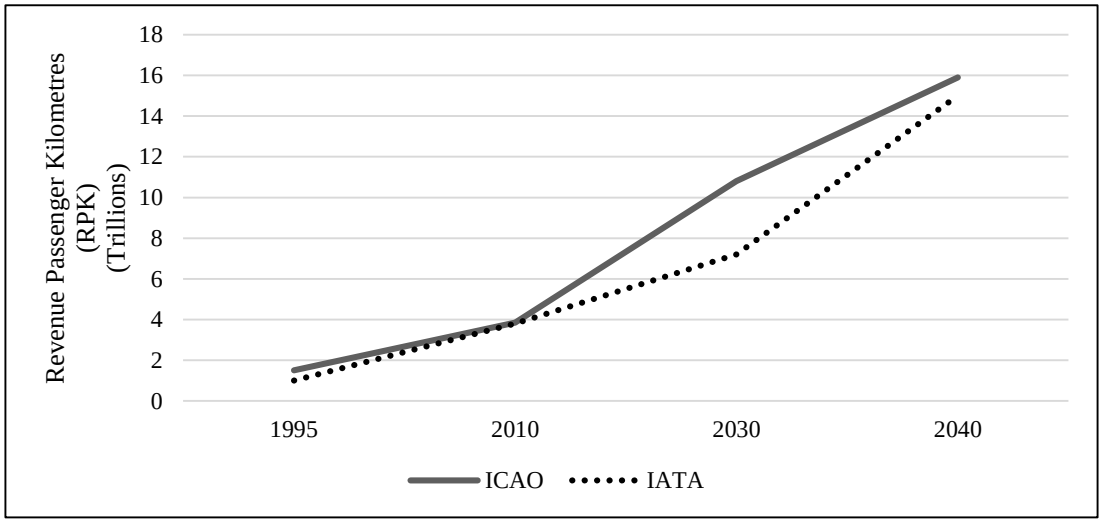

Figure 1: Top ten air passenger market in the future

Source: Organized by Author; (IATA, 2017) and (ICAO, 2016)

Due to the annual growth of passengers and flights, Airport terminals have many problems that can impact passenger handling flows. Safety concerns in recent times have caused many changes to security screening procedures and this impacts passenger throughput times. Beside security, another problem that faces modern airports is limited infrastructure capacity, including the available number of resources such as numbers of common check-in counters and number of personnel available. Airport terminal capacity is forced to heavy performance. (Barnhart, Fearing, Odoni, & Vaze, 2012; Manataki & Zografos, 2009). Airport does not only suffer the significances of the growth, but also has to cope with many social and political changes that have an effect on the passenger handling.

Airports are complex systems, airport handle two types of passenger flow systems, the first is departure passenger flow and the second is arrival passenger flow. Each one of these systems has its own procedures. The departure procedures include airport access facilities, check-in security screening, immigration and custom and boarding. While the arrival procedures include disembarking procedures, immigration, baggage claims, custom and quarantine and leaving the airport. According to (De Neufville, Odoni, Belobaba, & Reynolds, 2013) the departure process, which sometimes involves services

provided to transit passengers, typically requires a significantly longer time than the arrival process. Some airports have a slightly different process and new airports to be designed in the future may require further changes to the standard process in light of the new security concerns being faced in our modern world. Recently an investigation of passenger experience and airport operational efficiency found that that "The less time the customer spends in the systems, the higher the satisfaction" (Guizzi, Murino, & Romano, 2009).

This paper, therefore, focus on departure passenger flow because departure flow of passenger's system is more important because it has the ultimate impact on the entire operation of passenger terminals and other elements of the airport.

Literature review

Many researchers have faced issues concerning the optimization of an airport terminal. This section reviews the related research on airport passenger flow, focusing mostly on departure system to measure the performance of workstations and to understanding which factors affect passenger flows.

According to (Wu & Mengersen, 2013) existing airport models can be categorized into four sets "capacity planning, operational planning and design, security policy and planning, and airport performance review". These models can be analytic, simulation, and hybrid approaches as well. They involve different levels of detail and have deterministic and stochastic characteristic (Wu & Mengersen, 2013; Zografos & Madas, 2006). The models capture diverse performance metrics for 'operational efficiency', including service time, queue length, and congestion. In recent years, simulation modelling has become widespread not only for passenger flow analysis, but also for integrating and simulating two or multiple systems/components (Pitchforth, Wu, Fookes, & Mengersen, 2015). Takakuwa & Oyama (2003) developed a microscopic simulation model to investigate passenger flow in an entire airport terminal building with a primary focus on international departures. They noted that check-in time is the highest, at about 80% of the whole terminal waiting time. In addition, (Ma, Fookes, Kleinschmidt, & Yarlagadda, 2012; Ma, Kleinschmidt, Fookes, & Yarlagadda, 2011) and (2012) provided a similar microscopic simulation model represented by an agent-based model and mainly focused on human factors (i.e. passenger characteristics). The proposed model was used to study check-in operations of passengers and their use of discretionary facilities. Holding advanced passenger traits in the agents were found to make the simulations more realistic, hence, the peak check-in queuing times could be reduced by distributing passengers over the full range of facilities. Hybrid approaches have been seen in the literature repeatedly. For example, (Olaru & Emery, 2007) have employed both simulation models and genetic algorithm (GA) optimization to model and analyse departure procedures. They used this model as a process of organizational adjustment to evaluate airport operations efficiency, infrastructure impacts and operational changes.

In addition, process models are often used to give a complete view of terminal operations with respect to passenger capacity and processing time. An example of process models is discrete event model, accordingly (Verbraeck & Valentin, 2002) stated that "DES is often used to model system where complex processes are combined with a limited infrastructure of capacity". One of best definitions for DES was given by (Dorton & Liu, 2015), they defined DES as "a general collection of theories, methods, and applications to replicate behaviour of real systems for assessment or experimentation". Several authors, each with different aims, proposed that DES be utilised to analyse departing passenger flows (Guizzi et al., 2009; Novrisal, Wahyuni, Hamani, Elmhamedi, & Soemardi, 2013; Rauch & Kljajić, 2006). Guizzi, Murino et al. (2009) believed that passengers behave differently at the airport due to their experiences; therefore, it is difficult to forecast delays and priority. Their simulation model aims to predict delays in a logical and rational way, in the area of check-in and security check point. This would take into account the available capacity and the volume of passengers, based on time of day and passenger behavior. The Nagoya University has conducted a simulation using the software Arena on departing flow passengers from the International Kansai airport in Japan, in order to reduce the number of passengers, because of long waiting times in peak periods and because of unavoidable delays, they lose their flights. Preliminary analysis on passengers waiting times showed that the total time spent by passengers in the airport: the 48% is spent moving from place to place within the terminal, the 25% is waiting and only the 4% is doing formalities such as process acceptance, embarkation, and so forth.

(Joustra, P., and Van Dijk, N. (2001), Verbraeck, A., and Valentin, E. (2002), Appelt S., Batta R., Lin Li, Drury C. (2007)) The Rockwell Arena simulation software tool was used in this study to provide the results of the average queue length and waiting time. Alternatively, Rauch & Kljajić (2006) constructed their model by General Purpose Simulation System (GPSS), a simulation programming language. To identify system bottlenecks the authors aimed to analyze departure processes, from check-in to boarding, at a specific time before departure. Key factors such as passenger arrival pattern, passenger service time, and operating process were measured. Similarly, Novrisal et al (2013) developed their model to analyze congestion problems in departure process at Soekarno-Hatta International Airport in Indonesia. The model's objectives were to reduce processing and waiting time in the system. It was found that the number of check-in counters needed to be increased, with approximately 61% of total time spent in check-in queues during the departure process.

Methodology

In this section, the framework of passengers through the outbound processes of airport is introduced. Each system has its own particular flows, and each needs different infrastructure and service. With the increasing demand for air transportation and new security policy, there are many operations that re subjective by limited resources and infrastructure. These constraints can generate significant bottlenecks, long passenger queues, congestion and also the overall delay.

As an airport operator, they are responsible for the infrastructural capacity and processes that facilitate passengers, airlines, cargo and also baggage. The complete passenger flow in the terminal building, from check-in to boarding, as seen in Figure 2, has been modeled into the simulation environment ARENA. Two subsystem have been distinguished, Check-in and Security Border Control. This paper focus on these two subsystems because it considered as the bottle neck for most of the airport, in term of departure passenger flow.

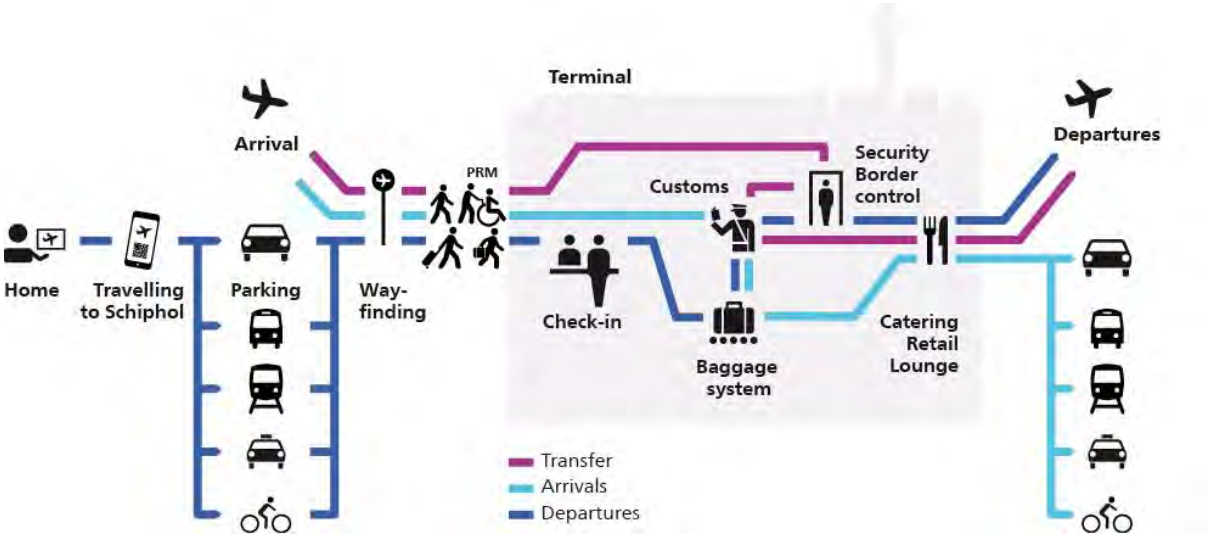

Figure 2: Passenger Journey
Source: Schiphol annual report (2018)

The development of framework for analyzing airport system performance is important because each entity within the system is inter-dependent with each other. This paper considered to develop the simulation model to simulate the bottleneck of airport's departure flow. The performance metrics of interest in this paper are average waiting time and processing time. The simulation is well suited to complex system with limited infrastructure capacity constraints.

Model architecture

The simulation for passenger's flow within an airport terminal allows the detection of any critical issues that could arise in the real flow management. The simulation was conducted considering the condition of congestion based on flight operations of a regular working day. The design of a model is particularly important because if not employed correctly, the model may not correctly represent real life events and may provide incorrect result. The simulation run time needs to be long enough to represent a complete cycle that the airport experiences.

The structure of the model is built around the basis of a hierarchical model structure as presented in figure 3. In detail, the main processed before the flight for departing passengers essentially are there:

- Arrival characteristics, including distribution of arrivals, method of arrival (any transportation mode), number of bag, class of travel, and travel time.
- The check-in operation at check-in desks, where the passenger delivers the baggage and receives the boarding pass. In recent year, airlines set up alternatives for the passenger at the check-in process; either web check-in or kiosk. The check-in online and the kiosk are used only to accept passengers with no luggage, then the passenger having already obtained the boarding pass, can go directly to the security boarder control, otherwise the passenger should go to the inside check-in desks in order to send the luggage.

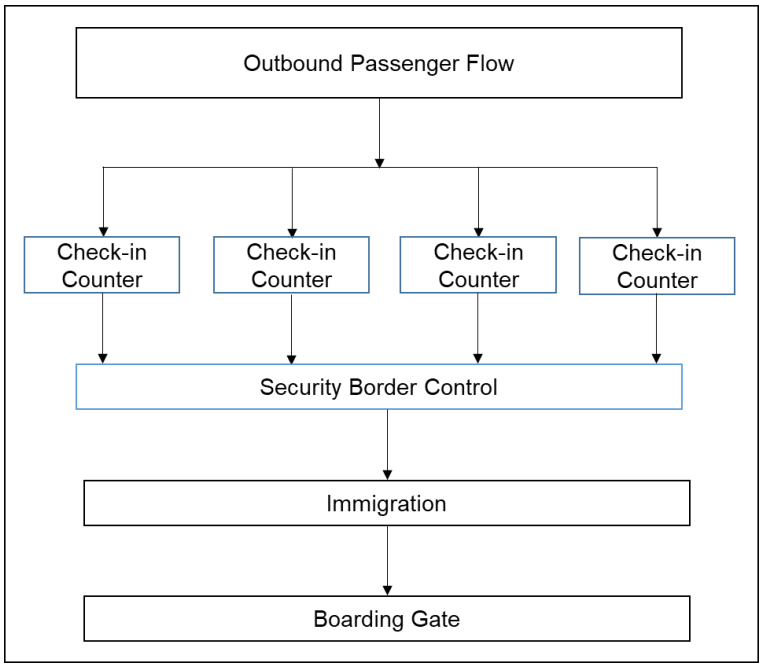

Figure 3: Outbound passenger flow
Source: Organized by Author

- Security border controls - x-ray check for the common security screening line. Security controls are made one by one for each passenger. The queue near security control checkpoint is managed at just as common check-in, in other words only one queue for much more available checkpoint.
- Immigration processing, including smart gate service, and the common counter for passport control
- Boarding procedure - the boarding operations on the aircraft.

Case study

The simulation framework has been applied to the one international airport in Thailand. A model has been developed that includes the main characteristics of the airport with regards to passenger flow and processing, and also with respect to a variety of functional area and facilities. This paper considered only the check-in process and security border control because this two process generate more problems in term of passenger's waiting time.

Parameters and assumptions of the model

- Check - in counter: we divided into two groups which are international and domestics. The number of the check – in counter for international is 25 and 33 for domestics. Processing time is 4.85 Minute/person for international and 3.15 Minute/person for domestics.
- Security border control: This process also divided into two groups which are international and domestics. The number of X-ray is 2 for international and 3 for domestics. Processing time is 3.72 Minute/person for international and 1.35 Minute/person for domestics
- The capacity for this airport is 1100 people/hour
- The operation time is 6 am to 12 am

Simulation

This paper use Arena program to analyze the as-is and to-be result because this program is one of the efficient and well-known for analyzing the simulation model. Figure 4 is the flow from the Arena program.

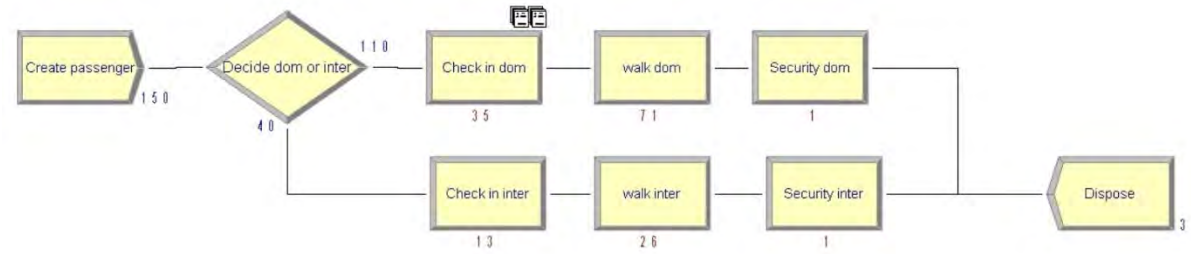

Figure 4: Passenger flow in Arena program

For as-is analysis: the type of capacity is fix type. The average processing time is 8.05 minute/entity and the average waiting time is 12.83 minute/entity. The number of check-in counter is 33 and 25 for domestics and international, respectively. The number of X-ray is 3 and 2 for domestics and international, respectively.

For to-be analysis: Since the security boarder control is the bottleneck for the airport, we added 1 X-ray machine for both domestics and international and run the program again. The result show that the average processing time is decreased 6.45% which is from 8.05 minute per entity to 7.53 minute per entity. The waiting time also decrease from 12.83 minute/entity to 11.45 minute/entity or 10.76%.

Discussion and Recommendation

The results of the simulation suggest that the number of passengers misconnected their flights can be drastically reduced by increasing numbers of X-ray machines for security check by aviation security agency supporting the standard working group. The results obviously show that bottleneck is located at the security check point for screening outbound passengers either at the center security point or in front of passenger gates at some airports. The delay of passenger flow is indicated. Therefore, the increase of x-ray machines is significant to improve or eliminate the weak point of airports. This is the solution already adopted by several airports for both domestic and International passengers. Particular attention has been shown to the security border control process, considering that the long waiting time is unpleasant to passengers at airports where are equipped with limited security facilities especially x-

ray machine. To provide much shorter waiting time is mandate to airport authorities or governments to invest in more x-ray machines to expedite passenger handling flow. The better flow will also support on time performance for airlines and sections at airports. The airport service level will also be highly improved with faster flow which is beneficial to maximize the terminal space and passenger satisfaction.

Consequently, by the result, airport authorities including Airports of Thailand (AOT) and Department of Airports (DOA) in Thailand will acknowledge this recommendation and know exactly that sufficient numbers of x-ray machines are significant to their passenger handling flow. The more x-ray machines are provided the much faster handling flow is facilitated and served to passengers and airlines. Then, to either improve the current airport facility or invest in new airports, AOT and DOA should consider the investment in adequate x-ray machines located security check point in every airport infrastructure investment project to enable to achieve their quality and satisfactory service guarantee to passengers and relevant users.

Reference

As per request

UNDERLYING SOCIAL FACTORS IN URBAN FOOD SECURITY

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Introduction

Cities worldwide face the challenge of planning and managing their resources in order to meet the needs of the inhabitants (Lynch et al., 2013). As opportunities for livelihood become scarce in rural areas, people flock to urban centres in search of employment and increased quality of life. As a result, urbanization often occurs at a pace that proves impossible for planning; placing poverty and urbanization among the biggest development challenges of the 21st century (Frayne et al., 2014). Urban food insecurity is one of the most serious consequences of the prevalent rates of urbanization and poverty. As over half of the global population currently resides in cities and the figure is expected to hit over two thirds by 2050 (United Nations, 2015), urban issues, including food insecurity in cities, should top development agendas.

The FAO (2009) considers food security for all people to include having access to sufficient, safe and nutritious food to maintain a healthy and active life. Even though this widely accepted view of food security refers specifically to *access*, it is ensuring *availability* of food largely through increased production that garners attention in policy (Battersby and Crush 2014). Maxwell (1999) argues this situation results from a persisting rural bias in food security issues, downplaying urban dwellers' nutritional challenges due to seemingly ample availability of food in urban markets. The access factor is particularly relevant here, as food may be physically available, but spatial and financial constraints prevent many urbanites from accessing it (Battersby and Crush 2014). Maxwell (1999) also maintains that urban food security is overshadowed in urban management by other urban challenges such as unemployment, overcrowding and infrastructure. In urban environments, food insecurity is usually experienced on a smaller scale, i.e. neighbourhood or even household scale, which adds to the 'invisible' nature of the urban food crisis (Maxwell, 1999).

A useful lens for conceptualising socio-economic and environmental factors that underlie urban food insecurity is the food desert, considered to be an area where fresh and healthy food at affordable prices is either difficult or impossible to obtain (Myers and Sbicca, 2015). Most studies on urban food deserts have been done in developed nations such as the UK and US, but the concept is becoming increasingly relevant in emerging economies and hence provides one motivation for this study. Battersby and Crush (2014) argue that while a food desert is useful for spatializing food insecurity, it fails to grasp the complexity of the foodscapes affecting many urban poor, especially in a developing context. It is not uncommon for a poor urbanite to work far from their place of residence, meaning that a lot of their household expenditure is done in transit, as food retail outlets are much more likely to be located around transport hubs and business districts than in poorer communities. Understanding this context provides a second motivation for this study. In summary, we have adopted the food desert concept for this paper, which reports on an exploratory empirical study of societal factors influencing urban food security in the food supply chain in poor neighbourhoods of a developing nation, South Africa.

Literature Background

The grocery retail market and urban food security in South Africa

South Africa is an emerging market economy, with a well-developed agribusiness sector. According to the USDA (2018), the sector provides a significant amount of jobs and is the largest exporter in Africa. Grocery retail in South Africa is highly concentrated, five large chains (both domestic and international) dominate the market with some independent companies challenging in certain areas (Competition Commission, 2019). The USDA (2018), using Euromonitor data, estimated the grocery retail market to be worth almost $45 billion in 2017. They divide the sector into 'modern grocery retail', which consists

of supermarkets of different sizes and convenience stores, and 'informal' or 'traditional' retail, which consists of spaza shops (neighbourhood tuck shops) and other independent grocery retailers. While it is widely acknowledged that South Africa, along with many other emerging and developing economies, has been undergoing a transition towards modern grocery retail (Battersby and Peyton, 2014), traditional retail still holds its ground with 38% of the market share (USDA, 2018). A lot of the traditional retail sector is still informal, so exact numbers are difficult to come by. For example, Greenberg (2017) indicates that estimates of the number of traditional outlets run anywhere between 80000 and 400000, depending on which data one is looking at. That is a fivefold difference, exemplifying the heterogeneity and complexity of the sector. Consumer surveys and interviews also indicate that the traditional sector plays a major role in the grocery shopping of the poor population in South Africa (Competition Comission, 2019; Tuomala and Grant, 2019).

Despite the modern agricultural and retail sector, South Africa still suffers from high levels of household food insecurity (Mushunje *et al.*, 2015). Food security is defined by the FAO (2009) as 'all people having physical, social and economic access to sufficient, safe and nutritious food to maintain a healthy and active life'. Household food insecurity is especially sensitive to access constraints, spatial and/or financial (Battersby and Crush, 2014). The urban context exacerbates the significance of access, as urban dwellers are net food buyers. Financial capability and the spatial distribution of food retail outlets are therefore deciding factors in who is food secure and who is not. Additionally, the retail market in South Africa is highly divided among the living standards measurement (LSM), which is a unique market research tool in the country. The measurement divides people into ten segments, based on a set of criteria regarding e.g. financial stability and living situations, one being the lowest. Township dwellers are generally considered to be in LSMs 1-4.

Even though over half the global population now resides in cities, the urban context is underrepresented in food security agendas and policy (Crush and Frayne, 2011). The question of access is overshadowed by fundamental availability, the emphasis being on increasing production rather than strengthening distribution networks (Battersby and Crush, 2014). South Africa for example produces enough food to feed its citizens, but marginalisation prohibits access for a notable population (Mushunje *et al.*, 2015). Wealth distribution is highly unequal in South Africa, which leads to high levels of urban inequality and marginalisation of individual people or even entire neighbourhoods. In a study conducted in Cape Town, it was found that there are eight times as many supermarkets in wealthier areas than in poorer areas of town (Battersby and Peyton, 2014). In supermarkets located in places easily accessible to poor urban dwellers, the selection was significantly worse and limited in nutritional options like fresh produce.

Core, periphery and alternative flows

World-systems analysis divides global society into a 'core' and a 'periphery' based on their stage of development, power dynamics and dependence on one another for resources (Wallerstein, 1974). Dependency theory for example examines the core-periphery relations from the perspective of who is dependent on whom. The "official rules of its order" dictate that the periphery is dependent on the core, but when examined critically, the roles appear reversed (Biel, 2006, p. 116). This perspective is highly used in critiques of neo-liberalism, positing that without resources from the periphery and the periphery acting as a 'sink' for emitted waste, wealth accumulation in the core would be impossible. As wealth is the source of the core's power over the periphery, the order of dependency is debatable (Biel, 2006). According to Biel (2006), the environmental ramifications of the periphery being on the receiving end of the core's disorder have been examined more than the core-periphery relationships that exist in class, gender, geo-political and other social orders as well.

Greenberg (2017) posits this dynamic into the South African grocery market, juxtaposing the corporate, or formal, grocery retail with the informal. Corporate retailers are the core in this instance, wielding centralised economic and political power and therefore dominating the market. The periphery, i.e. the informal and traditional retailers that are abundant in townships, is fragmented and unorganized around a central entity (Greenberg, 2017). Like in world-systems theory, this dynamic prevents the periphery

from developing to their full potential, due to the restrictions the unequal power distribution brings forward. As per Greenberg (2017), the traditional retailers are seen as a backwards system, but at the same time, the core views them as a threat to their business model.

Adapting this perspective to the urban context brings forward the socioeconomic flows that make up the urban environment (Swyngedouw and Heynen, 2003). The formation of an urban core and periphery is a result of these flows, and urban political ecology (UPE) is a useful tool to examine these complex relationships. Political ecology at its core is about the power relationships which mediate the use and distribution of natural resources. Urban food security is fundamentally about unequal distribution of resources, which is why UPE lends itself well to examining this phenomenon (Agyeman and McEntee, 2014). Food also intertwines different elements such as social, economic and environmental. The concept of a food desert has been widely used to spatialize urban food insecurity (Battersby and Crush, 2014). It was originally developed in the UK (Wrigley, 2002) and was at first mostly used in developed contexts. According to Battersby and Crush (2014), the concept needs to be updated from the focus on access to food retail as the defining factor, to a more fluid concept encompassing social elements as well. In the US, food deserts are used in conjunction with inner city neighbourhoods where the food supply is scarce in fresh produce, but unhealthy options are usually available (Weatherspoon *et al.*, 2015). This refers more to spatial access, i.e. the fundamental absence of fruit and vegetables in a neighbourhood, rather than financial or other more ambiguous constraints. In South African context, the lack of retail outlets is less of an issue, thanks to the active traditional market functioning in poor urban neighbourhoods. The socio-political situation in South Africa, stemming back to the days of apartheid, is extremely complex with racial politics still dominating the social order. Spatially, food insecurity is still concentrated into the townships, predominately inhabited by black Africans (Battersby and Crush, 2014). Many township dwellers' lives take place in an alternative society, where everything from dwelling to employment is defined by informality. The traditional and informal supply chains for food are relevant sources of nutrition for townships, and are often more in tune with the dynamics of such contexts (Nandonde and Kuada, 2016; Tuomala and Grant, 2019). The traditional market is one of the reasons why the food desert concept needs to become more fluid and about more than just spatial access.

Methodology and Research Design

The data for this paper was collected in the Western Cape, South Africa following a qualitative research design. A total of ten semi-structured interviews were conducted with experts in various fields. Six interviewees work in the South African grocery retail industry, ranging from corporate managers in large international grocery chains to a community shop owner. The remaining interviews were conducted with social workers working in a poor urban neighbourhood, or township, in the Western Cape. This paper is part of a larger research project, which also included interviews with the residents of the township, with a focus on the demand side. However, this paper focuses more on the supply of groceries and the types of social issues that may affect people's access to food and its distribution to such areas. Table 1 provides a list of the ten interviewees.

Retail experts	RET 1	Corporate manager, grocery chain
	RET 2	Corporate manager, grocery chain
	RET 3	Corporate manager, grocery chain
	RET 4	Store manager, grocery chain
	RET 5	Grocery supply chain expert
	RET 6	Spaza owner
Social workers	SOC 1	Dietician
	SOC 2	Health worker
	SOC 3	Livelihoods consultant
	SOC 4	Independent social worker
Total interviews	**10**	

Table 8 Summary of interviewees

Out of the six retail interviewees, four were employed in the same group, which is one of the largest in South Africa with operations reaching across the African Continent. Three of them worked in managerial positions in the corporate office or large distribution centres and the fourth interviewee was a store manager in one of the outlets. The interviews were all conducted in English following a semi-structured interview guide. While there were questions similar for each interviewee, the semi-structured format made it possible to delve deeper into specific knowledge of each expert. For example, a manager in the corporate offices would know more about companywide strategies than the average shopping basket in a certain store. Social workers 1-3 work for a livelihoods-based NGO in the township, which assists people with food parcels, job searching and different educational workshops and programmes. At the core of the NGO is the school feeding programme. Children in primary schools in the area are measured and if this indicates malnourishment, the family is considered for the NGOs assistance. Most of the participants in the programmes are unemployed women and mothers. SOC 5 is an independent social worker with various projects around the township.

Findings

Health and Poverty

South Africa was recently named the unhealthiest nation in the world by the Indigo Wellness Index (Global Perspectives, 2019). Food security has significant health implications and it is specifically referred to in the FAO (2009) definition. Many of the factors that the Indigo wellness index looks at are food related; obesity in South Africa is extremely high, as are diabetes and blood pressure issues. "*People don't have money so they purchase what they can afford and what they can afford is carbohydrate. That's why you have obesity rising*" (SOC1). A lot of the health issues faced by the urban poor derive from the lack of diversity in their diets, which mostly consists of starchy staples and very few fresh vegetables or protein sources. The lack of financial access is at the heart of this, but also knowledge about what constitutes a healthy meal is limited. Most township residents rely on what is referred to as a 'hamper', which is a bundle of staple groceries such as maize meal, flour, sugar and oil purchased for a discounted price (Tuomala and Grant, 2019). This makes up the nutritional base which is potentially supplemented with fresh produce, i.e. meat and/or vegetables. For many it is a choice between the two. "*So because of the money, some would have that hamper and just buy maybe meat*" (SOC2). Cultural and educational issues also play a role in the nutritional profile. While many would like to eat more fresh produce "*Healthy food is so expensive and then unhealthy food is so cheap*" (SOC1).

The cycle of unhealthy, starchy foods dominating as sources of nutrition does not only originate from the demand side, but the supply side perpetuates this as well. The NGO gives out a food parcel for the beneficiaries participating in their programmes. The contents of the parcel are donated by a large grocery brand and the NGO has little, if any, say in the nutritional profile of the parcel, which is predominantly made up of carbohydrates. "*So this food parcel was made by a nutritionist in Johannesburg who just decided this is what's healthy*" (SOC1). For many of the beneficiaries, the food

parcel is the only source of food in a month, which means interfering in the donor's offering could lead to an impossible choice. "*You choose, either you have obese mums or you have hungry mums. You take a pick. And I'm sitting here and I'm thinking what can I do, there's nothing I can do!*" (SOC1). The interviews with the retail experts point in a similar direction. "*In their marketing they will talk about that they want to make sure that health is affordable. But back at the ranch it's a cut throat, to a large extent an adversarial type environment.*" (RET5). Starchy carbohydrates have demand, so it makes financial sense for companies to keep selling them, even if they are seemingly focussing on the health of their consumers. "*What should be and what it is aren't necessarily the same thing… it's about rand and cents and their own profitability. I don't necessarily believe that there is a significant focus on doing what is right. It's about shareholder value, it's about growing market share.*" (RET5)

"*If you come from poverty you're going to be stuck in poverty… the rest of your life.*" (SOC3). Poverty is the underlying factor in most urban issues, including food insecurity. Both financial and spatial constraints are tied to poverty. Financial more obviously due to the lack of entitlements and therefore limited access to nutrition. Spatial constraints are more complex and derive from the socio-economic climate. "*There isn't a broader world picture in* [the township]. *And that's due to poverty and dislocation of people*" (SOC3). Factors such as the legacy of apartheid still heavily influence where people live, and what kind of opportunities they have. The missing *broader world picture* is a limiting factor as well. Starchy staples have culturally been such a significant part of the diet it is not easy to convince people to shift their diets. In a study of grocery shopping habits of township dwellers, what people purchased remained similar regardless of their financial status (Tuomala and Grant, 2019). Whether or not it is a voluntary course of action or not, people seem to be quite set in their ways. According to SOC1 it is very difficult to coach people about eating, not to mention attempting to shift entire cultural paradigms. Comforting, familiar foods bring some ease into people's rather rough lives. Convincing someone to give up sugar, a simple everyday luxury, for health's sake is difficult. "*That frustration of, everything else is just so bad that, and food for many is a comfort*" (SOC1). The health implications seem like a fair exchange for a few moments of joy.

Retail

The division into LSMs permeates the South African retail market. "*The [grocery] group has a targeted approach in branding for these stores, the LSM groups.*" (RET1). This targeting has significant implications in where different stores are located, which in turn affects the access to different products. The grocery group has three different types of outlets. A higher end supermarket targeting the upper LSMs would sell e.g. imported items, perishables and a much wider selection of brands. Most of South Africa, i.e. the mid-LSMs are covered by another brand, where the selection is less luxurious but still varied. The stores that target the lowest end of the echelon gear their selection toward staple products such as maize (millie) meal, flour, rice, sugar and cooking oil, most of them store brands. Comparing the average baskets bought at the different outlets the difference is significant, R80 (€4.70) at the low-end store and R150 (€8.81) at the higher end. The average basket nearly doubles. "[people] *are accustomed to a certain quality, and for that you are willing to pay a certain premium. Now we can't expect someone from* [the township] *to buy that kind of product. It's not discrimination, but you've got to be real*" (RET2). This would indicate that the difference in average baskets does not derive merely from the *quantity* of products that people buy but also very significantly the *quality*. This correlates with statements from the dietician interviewed, starchy staples are all many people in townships can afford.

Financial constraints on the demand side notwithstanding, the lower LSMs represent "*the real bulk of the income*" (RET2) in South Africa. The high-end supermarkets are there to appease the higher LSMs, but they are not where big money is being made. This manifests in the South African grocery market in many ways, but one of the most significant has been the increase of formal retail outlets in poor areas, such as townships. The township where this study was conducted for example did not have its own formal supermarket until less than a decade ago. The traditional way of grocery shopping, i.e. having specialty shops for meat, dry goods and fresh produce was still the principal shopping pattern some years ago, but supermarkets are becoming significant sources of groceries for all of the LSMs. "*Retail,*

formal retail as we know it have gone into [the townships]. *And have challenged those what we call down the street sales significantly*." (RET5). Having formal retail near the townships is likely to have increased the selection of goods in these areas, but the intentions from the retailers are less than wholesome. The lucrativeness of the lower LSMs as a market is significant, due to volume, and therefore financial incentives outweigh any notion of improving nutritional access for people. "*It is not primarily or necessarily geared towards the needs of people because that's the right thing to do… but because it is a significant opportunity*." (RET5).

The spaza shops in the townships are holding their ground over the formal retailers encroaching on their market. Their biggest advantage is their location in the neighbourhoods where people live. Many modern supermarket locations are in places only reachable by private vehicle. The supermarket in the township of this study was located at the bottom of a hill at the very edge of the neighbourhood and was difficult to reach for many residents and also return home with an uphill climb. There is public transportation into the township from nearby towns and cities but not within the community itself. The spaza shops are mostly used for everyday items, such as bread, milk, mobile data, and paraffin for those who do not have electricity. The monthly hampers of staple household goods are also purchased from the spazas. The packages of e.g. 'millie' meal and flour can be up to 10kg each, so location close to the home is relevant. Some spazas also sell fresh produce and meat, but storage can be an issue. Spaza shops are generally very small and located in shacks. They may also be located in areas that do not have electricity. The spaza owner (RET6) interviewed for this study stocks her spaza with dry goods once a month, but replenishes fresh goods every week, more often in the hot summer months if necessary. The spaza owners use wholesale companies for their goods, some of them deliver to your shop if necessary or one can go and pick up at the store. RET6 uses a delivery service for her shop. Many of the other spaza owners in the township are from elsewhere in Africa, Somalia for example, and they have formed a cooperative of sorts, which allows them to benefit from economies of scale and cut costs on delivery/transport. They have also been accused of selling expired goods, which is said to be one of the ways they keep prices low. There has been quite a bit of xenophobia and even violence targeted at the foreign spaza owners. RET6 does admit that it is difficult to compete with them as an individual business.

Previously the formal retailers have been moving into the townships with their regular supermarket concepts, but the grocery group is trying a more flexible, spaza like-concept in a few townships around the country (Mathe, 2019). The concept consists of small, mobile stores placed into harder to reach areas in the townships selling the same products as the permanent supermarkets. The brand knowledge and trust are an advantage the grocery group possesses and according to Mathe (2019), one of the shops has already taken 80% of a nearby spaza shop's customers. While this is a positive development on one hand, on the other it does encroach upon a great many individual entrepreneurs' livelihood. However, because it is a formal retailer the quality of products it sells are more reliable and this is appreciated by the residents. They do not sell fresh produce, but the project is still in trial phase. Then again, this venture is likely to be more motivated by the Rands it will bring to the grocery group's annual report than the desire to improve the nutritional access of the townships' residents.

Conclusions

Urban food insecurity encompasses themes from several different disciplines within the social sciences but suffers from a lack of coherent interdisciplinary discourse. Issues of retail networks and design, the expansion of food supply chains into developing nations, and related retail business challenges feature in extant retail and management literature. Conversely, research in urban/ human geography and development/ food studies describes the manifestation of urban poverty and the causes and effects of food insecurity in cities. Thus, there remains a disconnect between these two foci which is worthy of study to ensure the entire food supply chain is considered in planning and design. Further, a lot of past work on food insecurity has focused on rural areas and the fundamental unavailability of food as the cause. In urban environments this is not a relevant approach, as food is usually available for purchase, but inaccessible to many. Marginalized populations like the urban poor, are either financially or spatially constricted from buying food, rendering them food insecure. Spatial and financial constraints are

summarised within the food desert concept, which represents an area where nutrition-rich food at affordable prices is difficult to find. Food deserts are often located in low-income areas or neighbourhoods typically inhabited by ethnic minorities. The underlying political, historical and economic connotations here frame the entire food insecurity discourse and are vital in the formation of solutions.

Regarding this study, underlying factors to food security in the South African township investigated were found to be varied and complex. While food is readily available, access to it requires a financial stability not many residents in townships have. The government grant system assists those with the least means, such as single unemployed parents, but the grants are meagre and many, such as immigrants, do not qualify. Further, issues stemming from larger societal structures, such as the legacy of apartheid, have significant effect on the food security of people living in townships. Access to more nutritious food is a serious issue in this township setting. Staple foods that make up a township dweller's diet are predominately carbohydrates and contain very little protein or fresh vegetables. Improving retail in and around townships is an important step in increasing food and nutrition security in these areas. The spaza shops and other micro retailers have an important role to play, as their business models fit into the dynamics of townships better than large supermarkets. Unfortunately, data from the spaza shops was limited as the shopkeepers are very hesitant to talk to outsiders about their businesses, likely due to the apprehensive and xenophobic treatment they have received in South Africa.

Contributions to theory

UPE is a useful tool for analysing urban food security, but the results can be quite ambiguous and detached from practice. Concepts like socio-economic flows provide important information regarding underlying factors in urban issues, but including concrete flows of goods, such as the food supply chain, in the discourse enhances its credibility. Examining what people actually buy and why gives valuable insight into the theoretical flows. The motivations of the retailers also gave interesting insights. As per Greenberg (2017), the formal retailers are the core on whom the periphery is dependant. However, the core of retailers are reliant on the periphery of lower LSMs for business, which supports the reverse social order. These types of findings contribute to the social approach of the core-periphery dynamic, which has previously been overshadowed by the environmental perspective. Urban food security is a nexus of different factors, social as well as environmental and economic. Urban food security research suffers from the lack of empirical and interdisciplinary research, and this study contributes to both. Using the SCM angle to study food security brings a novel and practical angle to the stream.

Contributions to retail practice

The South African market for groceries is highly divided and the dynamics of the lower LSMs are not that well known. For retailers there is significant opportunity in the lower LSMs, as the majority of the South African population belongs to this segment. Research such as this study and data gathered from the residents of the township (Tuomala and Grant, 2019) is valuable for retailers in planning the type of retail format with which to approach townships. A large centralised supermarket may not be the best arrangement in sprawling township with limited transport options, but rather small and frequent outlets scattered throughout the neighbourhoods. The spaza shops already function with this model and continue to draw business. There is also a certain responsibility for retailers to offer nutritionally sound food. There is a strong cultural paradigm affecting food choices, but retailers have the potential to influence that.

Limitations and future research

As with all research, this paper has limitations as it only investigated ten actors in retail food distribution in one South African township. Consequently, further empirical research across a broader geographic and demographic spectrum will provide better external validity. Nevertheless, we believe that the study has provided a good look at the issues surrounding societal factors influencing urban food access, availability and security in the food supply chain of poor neighbourhoods.

Acknowledgements
The authors would like to thank and acknowledge the Hanken Foundation for funding the research trip to South Africa, as well as Professor Jan Havenga for hosting the researcher. A special thanks goes to the wonderful NGO who despite being busy with their own work provided a welcoming and extremely helpful atmosphere to conduct this research.

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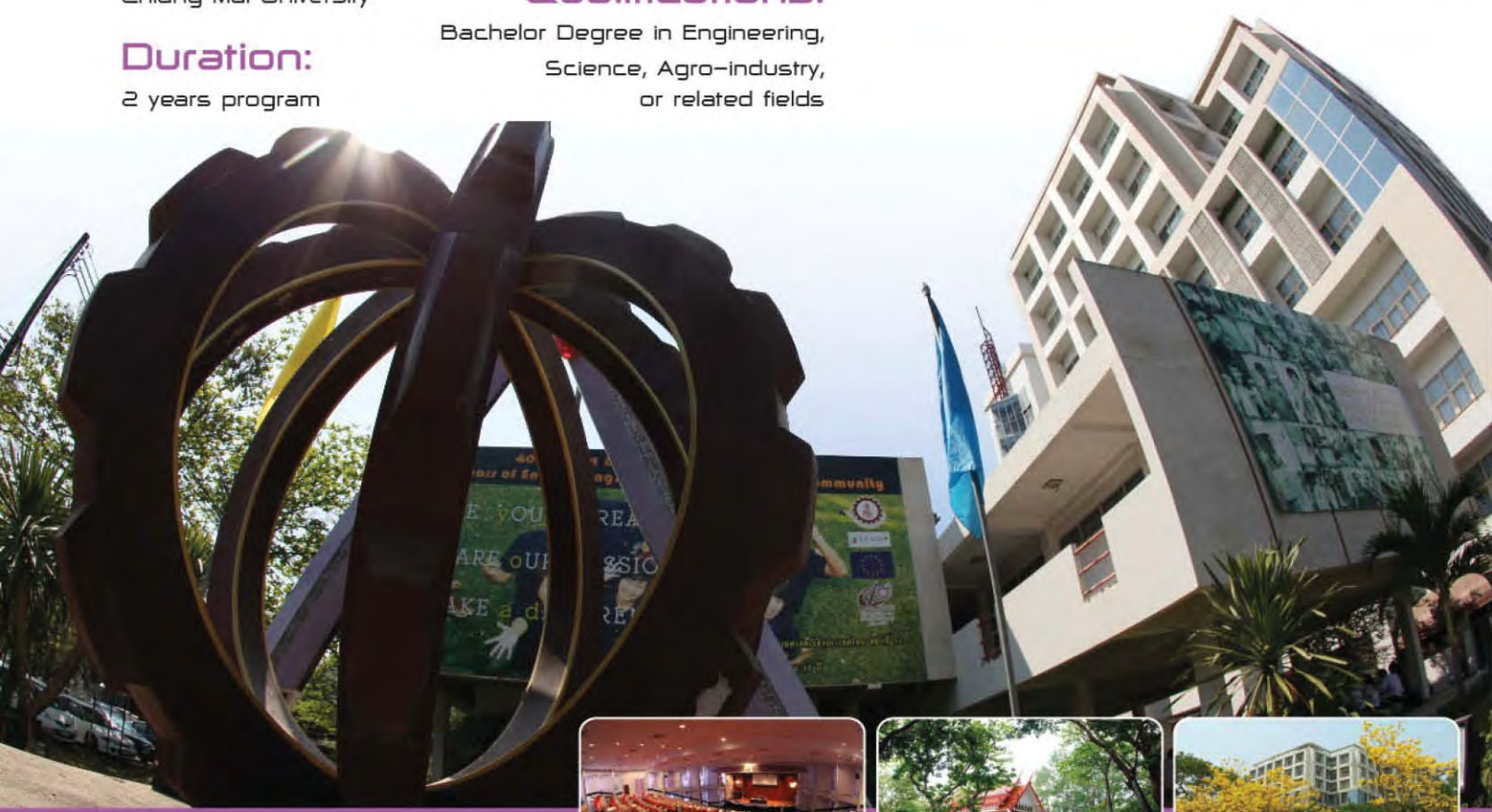

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