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The 9th International Conference on Logistics and Transport 2017

" Supply Chain 4.0: Challenges and Prospects "

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INTRODUCTION

This is the 9th 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. The conference has now become a major event for researchers in transport, logistics, supply and value chain management, especially in the Asia Pacific region. This year's event in Bangkok (Thailand), is a continuation of past successful conferences held in Chiang Mai (Thailand) 2009; Queenstown (New Zealand) 2010; Male (Maldives) 2011; Chiang Mai (Thailand) 2012; Kyoto (Japan) 2013; Kuala Lumpur (Malaysia) 2014; Lyon (France) 2015 and Singapore 2016. This year's event is held during November 1st to 4th, 2017.

Under the theme of "Supply Chain 4.0: Challenges and Prospects", 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 (ICLT2017). It has been 9 years since the first conference was hosted in Chiang Mai (Thailand) and this year we are back in Thailand. 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 46 papers from 16 countries from Australia, Austria, Finland, France, India, Indonesia, Japan, Mexico, New Zealand, Singapore, South Africa, Taiwan, United Kingdom, United States of America, and Thailand.

The theme for this year's event is "Supply Chain 4.0: Challenges and Prospects". Industry 4.0, Thailand 4.0, logistics & supply chain 4.0 highlights the importance of information and communication technology in shifting management paradigms. These are exciting times for our research field as current best practices may become obsolete in the near future due to this new revolution.

The accelerated digitization of supply chain and many new technologies developed have now become issues for further investigation. Organization can benefit from the real-time availability of big data and automation of processes. Internet of Things, Smart Factory and Big Data are three key aspects of Industry 4.0 that impact the whole supply chain.

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

CONTENTS

A CONCEPTUAL FRAMEWORK OF WEIGHTED MODIFIED OVERALL VEHICLE EFFECTIVENESS.

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ABSTRACT
Purpose: This paper aims to improve the original Modified Overall Vehicle Efficiency (MOVE) to make it become more appropriate in different perspective in each industry. MOVE can be helpful for monitoring and measuring vehicle performance for road freight transportation. To achieve this effectively, this paper proposed a newly calculating methodology by using a simpler weight setting method in every single elements of MOVE model.

Design/methodology/approach: First, literature review of vehicle performance measurement and weight setting method are conducted. Second, the suitable measurement tool are selected for interested industry to adapt the formula to be more appropriate. Finally, the proper weighting method are added into the calculating formula to make it fit for industry goal.

Findings: This paper shows list of tools that developed from Overall Vehicle Effectiveness (OVE) and weighting method used in similar measurement.

Research limitations/implications: (if applicable): This paper only focused on OVE based measurement tool and none complicated weight setting method to make it easier for the industry to be implemented.

Practical implications: (if applicable): The proposed of this modified model will allowed industry to be able to measure the specific interested measurement by combining the appropriate tool for their interesting.

Originality/value: This conceptual framework shows the newly calculating method combined the traditional MOVE approach with the weighted MOVE approach. This can solve the problem of MOVE which is each element in model are not equally important, the different weight in each element in MOVE model should be taken into account to increased effective of measurement.

Keywords: Modified Overall Vehicle Effectiveness, Rank Order Centroid, Combined Series and Parallel Systems, Transport, Performance Measurement.

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 a 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 literature review base on the three primary objectives, to understand the evolution of MOVE which is base on OVE, identify weighting method and the concept of combined series and parallel system of reliability function.

Evolution of MOVE

Model	Overall Vehicle Effectiveness (OVE)	Modified Overall Vehicle Effectiveness (MOVE)	Transport Overall Vehicle Effectiveness (TOVE)	Overall Transportation Effectiveness (OTE)
Author	Simon et al. (2004)	Guan et al. (2003)	Villarreal (2012)	Dalmolen et al. (2013)
Develop from	OEE	OVE	OVE and Value Stream Map (VSM)	OEE and OVE
Formula	OVE(%) = Availability (A) x Performance (P) x Quality (Q) : all of components expressed in unit of tonne-km and percentage. **A:** Actual operating time divided by plan operating time **P:** Operating speed rate multiply by Net operating rate. **Q:** Good successfully delivered divided by Total of goods delivered.	MOVE(%) = Vehicle utilization (V) x Route efficiency (R) x Time efficiency (T) x Quality (Q) : all of components expressed in unit of tonne-km and percentage. **V:** Required capacity divided by Available capacity. **R:** Minimum route cost divided by Actual route cost **T:** Shortest possible time on best possible route divided by the Actual time taken.	TOVE(%) = Administrative availability efficiency (Adm.) x Operating availability efficiency (Optg.) x Performance efficiency (P) x Quality efficiency (Q) :all components are expressed as percentage. **Adm.:** Available for route divided by calendar time. **Optg.:** Available in transit divided by Available for route. **P²:** Capacity efficiency divided by available in transit.	OTE(%) = Availability (A^3) x Performance (P^3) x Quality (Q^3) : all components are expressed as percentage. **A^3:** The real driving time for truck drivers divided by the period that orders can be scheduled and executed, transport is available or other transport activities. **P^3:** The real time operation driving time divided by

		Q: Goods successfully delivered divided by Total goods to be delivered.	**Q:** Capacity efficiency minus quality loss (%) divided by capacity efficiency.	real running time. **Q³:** Time that orders are executed on-time divided by used time.
Characteristic	•OVE does not reflect to the optimal fuel efficiency. (W) •Round trip problem in OVE. (W)	•Round trip problem does not occur. (S) •MOVE might not be able to give the optimal solution when considering the overall fleet performance which involves in more than one vehicle . (W)	•TOVE can be use only which own private fleet of transportation vehicles due to the calendar time consideration. (W)	•OTE is more detailed in identifying losses for LSPs and provides solutions to the efficiency round trip problem. (S)
Previous implementation	Mustaffa (2009) used OVE and MOVE to determine the total cost in the periodic "can-deliver" of Inventory Route Problem (IRP) model.		Villarreal et al. (2013) applied TOVE and VSM to carried out in the routing operation of bottled beverage in Mexico by identify and eliminate specific waste associated with the transportation of goods to improve its efficiency.	

Table 1. The evolution of OVE
Source: Compiled by the Author.

The table 1 is shown the list of tools that has been developed from OVE which is included namely, author, formula, characteristic and previous implementation. Nakajima (1998) propose the Over Equipment Effectiveness (OEE) as a tool for measures machine performance in manufacturing which is based on three main aspects which is Available Rate (A^1), Performance Efficiency (P^1) and Quality Rate (Q^1), each element concerns which the different losses via benchmarking technique. Simon et al. (2004) was adapted the concept from OEE to OVE. OVE is developed form the holistic measuring the effectiveness of transport operations from the proportion of value-added activities in transport operation unlike other transport measure, such as Vehicle Utilization and Energy Efficiency Measuring (McKinnon, 1999). OVE used the three aspects of OEE are applied to benchmark the total performance of vehicle effectiveness expressed in the units of weight-distance (tonne-km). Manson et al. (2001) converted six big losses in manufacturing which is equipment failure or breakdown loss and set-up (and adjustment losses) in A^1, idling (and minor stoppage losses) and reduced speed losses in P^1 ,and defect (and rework losses) and start-up losses in Q^1 to the five big losses of OVE in table 2. OVE aims to reduce these five loose activities by using lean thinking approach and it is useful when determining area for potential improvement. Table 2 shows the losses are defined as the five big losses in OVE and definitions are described as follows:

Performance aspects	Relating losses	Definition
1. Availability	Driver breaks	Statutory breaks taken during a journey are considered a loss. If the statutory break is taken at the end of a journey or when somebody else is loading/unloading then it is not a loss.
	Excess load time	A standard time is allowed to load and unload a

		vehicle. When loading/unloading exceeds the standard time, for reasons outside the control of the vehicle driver, then excess load time occurs.
2. Performance	Fill loss	Ideally the vehicle will be full; either by weight or volume, whichever is the lower constraint. Fill loss occurs when the vehicle is not fully loaded.
	Speed loss	Ideally the vehicle will be full; either by weight or volume, whichever is the lower constraint. Fill loss occurs when the vehicle is not fully loaded.
3. Quality	Quality delay	Goods damaged in transit or poor/invalid paperwork would both be examples of quality issues that impact adversely on the OVE measure.

Table 2. Performance aspects of OVE and relating losses adapt from Simon et al. (2004).

However, OVE has faced the round-trip when case is multiple destination, which OVE gives a higher value to lower efficient route (Guan et al., 2003). Due to OVE consider the alternative of carrying goods in longer distance as higher value-adding to the end customer while it is obvious that this alternative is less fuel efficient then less effective (Guan et al., 2003). Therefore Guan et al. (2003) attempted to developed MOVE to solve this problem which provided a better fit to characteristics of transportation and also the sensible objective of performance metrics of transportation operation.

MOVE is a method is to measuring a single vehicle for road transport. To be able, MOVE to reflect the efficiency route Guan et al. (2003) was added a factor of minimum route cost or route efficiency into the equation so that the round-trip problem can be overcome. MOVE was dividing the performance factor into two components which is route and time efficiencies. The four aspects concern of MOVE metric are:

- Vehicle Utilization or Vehicle Available in OVE is the ratio of the minimum route cost and the available capacity. It is based on available capacity and required capacity.
  Available Capacity = Maximum Load x Distance
  Required Capacity = the minimum route cost
- Route Efficiency is the ratio to evaluate the efficiency of route. The ratio is between the actual route for shipment against the most efficiency route which is minimum route cost.
- Time Efficiency is the ratio between the actual time taken for a vehicle to complete the shipment against "the shortest possible time" required for that vehicle to complete all value-added activities for that shipment. It requires two components which is shortest possible time and actual time taken.
  Shortest Possible Time = Time taken assuming the optimal speed + Statutory break
  Actual Time Taken = Travel Time + Unloading and loading Time + Queue Time + Break Time + Break Time – Break taken while loading and queuing
- Quality is unchanged from OVE. The ratio of the goods which are delivered to the customer within promised conditions, without any damage or losses against the total goods delivered.

Next, Villarreal (2012) developed tool based on OVE which is TOVE. TOVE is a modified overall vehicle efficiency measurement that aim to measured its effectiveness. Start with vehicle waste identifying with VSM approach then combined TOVE and VSM, it calls Transportation Value Stream Map (TVSM). Dalmolen et al. (2013) create OTE based on OVE to measure efficiency of Logistics Provider Services (LPS).

Weighting method

In 1994, Raouf introduced weighting method of OEE. This methodology assigns weights to three elements of OEE which is A^1, P^1 and Q^1 but the paper did not shows how to setting the weight. Raouf (1994) assumed that A^1 has a weight of k_1, P^1 has a weight of k_2 and Q^1 has a weight of k_3 where $0 \le k_i \le 1$ and sum of k_i must be equal 1. This is called Production Equipment Effectiveness (PEE) and can calculated as:

$$PEE(\%) = (A^1)^{k_1} \times (P^1)^{k_2} \times (Q^1)^{k_3}$$

Raouf (1994) was states that this method is an effective tool to enhancing the capital productivity by effective controlling the maintenance systems. The different weight setting of each single element has proved to be more reasonable than the original OEE, as importance in each element is different (Raouf, 1994). Wudhikarn (2010) also designed the Overall Weighting Equipment Effectiveness (OWEE). OWEE proposes a simpler weight setting method which Rank-Order Centroid (ROC) to identify different weight in each element of OEE. Whudikarn (2010) mentioned that ROC methodology is easy method for company to collected the weight by interviewing a top manage who has a total authority of the company of the company management. ROC is a method that proposed by Barron and Barrett (1996). This technique would like to give more relative weight important to the highest ranked attribute and less relative weight important in exponential differentiation not linear (Roszkowska, 2013). The calculating formula of the ROC is defined as:

$$W_i = (1/K)\sum^{K}_{j=I} 1/r_k$$

Where r_k is the rank of the k^{th} objective, K is the total number of the objectives, and W_i is the normalized approximate ratio scale weight of the i^{th} objective.

Then, the Overall Weighting Equipment Effectiveness (OWEE) is calculated as the following formula (Wudhikarn, 2010).

$OWEE(\%) = w_A A^1 + w_P P^1 + w_Q Q^1$

Where w_A is the weight of the A^1, w_P is the weight of P^1 and w_Q is the weight of Q^1.

Wudhikarn (2010) also compared the original OEE, Raouf's OEE and OWEE method, the result from original OEE is different from Raouf's OEE and OWEE which are almost similar.

Basic Elements of System Reliability

According to Myers (2010) suggested 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. The series system operationalize depends on all its elements operationalize (Lisnianski and Levitin, 2003) as figure 1.

Figure 1. Block diagram for elements in series.

The Figure 1. Shown the reliability of the system made up of elements P_1, P_2 to P_n, It is the probability that all elements are operational. Where P_i represent the respective reliability of element P_1 to P_n. This relationship should made clear that the calculation is easily calculated as:

$$R_S = \prod^{n}_{I=1} P_i$$

Where R_S represents the total reliability of the systems that comprises component P_i to P_n.

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 2.

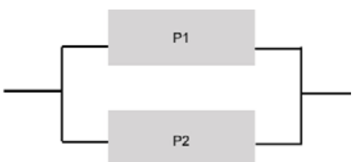

Figure 2. Block diagram for elements parallel.

The general relationship for a system of n components arranged in parallel is

$R_p = 1-\prod_{i=1}^{n} (1-p_i)$

Finally, to combine the all element in series and parallel as figure 3.

Figure 3. System with element in series and parallel.

The formulation will be as follow:

$R_P = P_1(1- (1- P_2)(1- P_3))P_4$

Methodology

In the light of the above, the selected model is MOVE due to its ease of use that easy, not too complicated and cover most of interested area for the company in future case study which Royal Project Foundation in Thailand as agricultural business who focused on quality of good, cost and delivery time for their vehicle usage in both own private vehicle and outsource.

After done selecting vehicle performance measurement tool, this paper uses the ROC weighting method that suits with the selected case study due to its easiness. The case study company has to give rank order on importance of attributes in MOVE which is V, R, T and Q. Relative important weight for the 1st to 4th will be 0.52, 0.27, 0.15, 0.06 respectively, no matter what each attribute ranking is placed according to the rule and formulation of ROC.

Table 3. shows the prioritized order and result weigh of each element by using the ROC method. This paper assume the weight of each element as shown in table 3.

Element	Ranking	Numerical calculation	Weight
V	4	$W_V = (¼)/4$	0.06
R	3	$W_R = (⅓+ ¼)/4$	0.15
T	2	$W_T = (½ + ⅓ +¼)/4$	0.27
Q	1	$W_Q = (1 + ½ +⅓+ ¼)/4$	0.52

Table 3. Weight setting by ROC method.

The newly calculating method combined the original MOVE approach with the weight setting by ROC method are calculated by concept of reliability function from Myers (2010) arranged in combined series and in parallel systems. In this paper, the element in parallel is a system that composed of MOVE elements which is V, R, T and Q ,with the weight of element. Myers (2010) suggested that the parallel system consists of 2 operational functions can be combined together as the following equation:

$$R_p = 1-\prod_{i=1}^{n} (1-p_i)$$

Where p_i represent the reliability of element i and R_p is represent the reliability of the system that compose of n element. Therefore, the adaptation of the proposed said model with MOVE, ROC and the parallel system can be formulated as:

$V_w = 1-(1-V)(1-w_V)$

$R_w = 1-(1-R)(1-w_R)$

$T_w = 1-(1-T)(1-w_T)$

$Q_w = 1-(1-Q)(1-w_Q)$

Where V_w, R_w, T_w and Q_w is V, R, T and Q including weight of each element from table 2.

Finally, the value of V_w, R_w, T_w and Q_w are combined by multiply each value together as the rule of combined series which similar to the original MOVE as:

$$\text{Weighted MOVE}(\%) = V_W \times R_w \times T_w \times Q_w$$

<u>Discussion</u>

This part of research will discuss based on three objective, first is weighting method, second is each formulation implication and the last is result of MOVE in each formula.

In weighting method, ROC is the easy method for company to understand and easy to calculate, However, in some case of company where relative weight important of some element are equal, ROC may not be able to reflect the different and determine the appropriate weight which is supposed to be similar (e.g. decision maker can not decide which element is more important). Analytical Hierarchy Process (AHP) are suggested to use instead ROC but the process of AHP should be clear explain to make should that company understand its process correctly due to complicatedness of the tool itself.

For the calculated formula, the original MOVE does not reflected interesting on each element of MOVE model which is reflect to prioritize the problematic of vehicle performance for the company. However, the approach of Wudihikarn's method also not reflect to the overall of performance due to the formula which is sum all of element that including weight, this means each element are not related. For Raouf's method is appropriate due to the multiplication of each element that reflect the relation in mathematical term. But, the result does not reflect the realistic of the performance that will discussed

Table 4. Show that results of four method which assume that 40% of Vehicle Utilization, 80% of Route Efficiency, 70% of Time efficiency and 40% of Quality Rate are all expressed in unit of tonne-km, with weight from table3.

Model	Formula	Result (%)	Weight
Original MOVE	MOVE = V x R x T x Q	20.16%	
Raouf's method	MOVE = $V^{w(v)} \times R^{w(r)} \times T^{w(t)} \times Q^{w(q)}$	54.1%	✓
Wudhikarn's method	MOVE = $W_V V + W_R R + W_T T + W_Q Q$	53.76%	✓
Weighted MOVE method	MOVE = $V_W \times R_w \times T_w \times Q_w$	20.12%	✓

Table 4. Numerical results of MOVE from four methods

From table 4., the results from those four different method have been calculated and outcomes are represented in percentage. The result of the original MOVE is 20.16% because the original formulating keep multiplying percentage of each element, it will result in less and less finalize value. However, 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. As the formulation in MOVE, the relative weight of each element are equally important but in table 3. this paper assume the highest weight important is belong to the lowest value which is 40% in quality, the outcome on other model should give a lower result that the original MOVE but the actual calculation of Raouf's and Wudhikarn's give a higher outcome which is contrast to what it should be.

The newly calculation of MOVE shown the result which is 20.12% is close to the original MOVE with less value than the original as it is supposed to be due to the unimportant element got the highest performance percentage. Therefore, the wighted MOVE is more accurate and appropriate method than the other two method that including weight and also the original MOVE as in table 4.

<u>Conclusion</u>

The aim of this research is to improve MOVE model for more appropriately measuring vehicle effectiveness in company and satisfy what the company need. The four elements of MOVE which is Vehicle Utilization, Route Efficiency, Time Efficiency and Quality Rate is still unchanged from MOVE. However, the equation is integrated with weighting method in measurement. All the element affecting weighted MOVE are not equally important in all industry and as such different weights should be established using ROC which is an easy and accurately technique for decision makers. Afterward, using the concept of combine series and parallel system of Reliability Function to formulate newly equation of MOVE in percentage.

Future work

The future work will be able to adapt the weighted MOVE model into agricultural business in Thailand which is Royal Project foundation. Finding should determine the interested topic for the specific company to adjust the weight for the model and the calculating formulation used in the model should be modified in order to make it fit with particular company limitations. Furthermore, the formulation in the model should be modified in order to measure the whole fleet, not only just a single vehicle. Lastly, the characteristic and behavior of the particular industry should be investigated deeply to understand more in model modification.

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A RESEARCH AGENDA FOR THE ENVIRONMENTAL IMPACT OF HUMANITARIAN LOGISTICS

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Introduction

It has been estimated that 5,5% of the total amount of greenhouse gases (GHG) generated by human activities can be attributed to the logistics and transport sector (World Economic Forum, 2009). The increasing amounts of GHG emissions to the atmosphere create imbalances in the eco-system, known as climate change, and is being considered the root cause of many natural disasters such as flooding and hurricanes, as highlighted by Halldórsson and Kovács (2010). It should therefore be of interest for the humanitarian organisations responding to these events, to take steps on greening their own logistics activities in the wake of climate change (Klumpp et al, 2015).

Humanitarian logistics activities have grown over the past years as the number of disasters and related activities in managing the disaster response has increased rapidly (Vanajakumari et al, 2016). Disaster relief is furthermore expected to increase as it is forecasted that both natural and man-made disasters will rise five-fold over the next 50 years (Thomas and Kopczak, 2005). The annual spending worldwide on logistic operations for disasters has reached USD$15 billion (Christopher and Tatham, 2011) and literature underlines how logistics can affect up to 80% of the humanitarian operations effort (Van Wessenhove, 2006), hence being one of the most important factors.

The aim of this paper is to set a research agenda on the subject Greening Humanitarian Logistics. The research contribution is to show the actual environmental impact, in terms of emissions of carbondioxide, from humanitarian logistics of an ongoing continuous operation, to create a baseline for current state of affairs. The case study presented in this paper shows the level of vehicle utilization on the two last legs of a transportation chain, before the goods reach the end users.

Mapping and reducing greenhouse gas emissions from transportation activities has been on the agenda for several years in the commercial logistics sector (McKinnon et al, 2015). The humanitarian logistics is however considered unique in several ways and therefore distinguishes itself from its commercial counterpart. Holguín-Veras et al (2012) discuss the characteristics of disaster relief logistics as opposed to commercial logistics. Disaster relief logistics is said to be informal and improvised, with low emphasis on transportation costs and acting on unknown demand. Commercial logistics, on the other hand, takes place under conditions that are relatively stable and functional, with established decision making procedures and with known demand, and those factors enable optimisation for best use of resources at low cost. Holguín-Veras et al (2012) place “regular humanitarian logistics” (RHL) somewhere in between the two. RHL takes place in the long-term recovery phase following the response phase after a disaster or it be can be ongoing operations responding to a slow-onset disaster, such as a refugee crisis or the effects of an escalating draught in a region. RHL is not so much about saving lives, but more about “doing more with less”. With this paper the author wants to share the findings from a case study on RHL and to set a research agenda for examining the environmental impact of humanitarian logistics.

The UN (United Nations) has, on a strategic level, decided to take action and limit environmental impact from operations and to “lead by example” (UNEP, 2012, p. 3). These decisions are however quite recent and have therefore not yet been implemented by all the organisations, agencies, funds and bodies, working under the UN umbrella. Although the humanitarian organisations have climate change adaptation on their agenda, little attention has been paid to adjusting their own operations in terms of greening the supply chain management (Haavisto and Kovacs, 2014). Sarkis et al, (2012) highlight that “the need to introduce green supply chain principles and practices in the relief supply chain is evident, however, no studies have so far addressed the greening of the relief supply chain” (p. 205). Since this aspect has not been prioritised, it seems likely that there is room for improvements in how to organise the activities.

This paper is divided into five sections. After the introduction it outlines a literature study on the streams of interest. A methodology section follows whereby the details of the case study is explained. The findings/discussion section is devoted to analysis of the empirical data. Finally there is a concluding section where the consequences of the findings are further elaborated upon and recommendations for future research is suggested.

Literature review

The issue of environmental impact of logistics and supply chains has been on the agenda since the early 1990s. A growing amount of academic literature on the subject has emerged on what is now commonly referred to as “green supply chain management” or “green logistics” (McKinnon et al, 2015). Green logistics encompass a range of streams for academics to engage in. Topics include; strategy/policy considerations, procurement criterias, how the supply chain is organised, freight modes, the efficiency of activities, fuel consumption, reverse flows, warehousing and product design (Grant et al, 2015) (McKinnon et al, 2015). In order to determine to what extent the greening dimension has been addressed in humanitarian logistics literature to date, a literature review was performed. Literature searches were made on humanitarian logistics with added combinations on key words such as sustainable, sustainability, green, greening, environment, emission, emissions. The word humanitarian was alternated by relief and the word logistics by supply chain to get an exhaustive outcome of the searches.

The search was limited to peer-reviewed publications only, while book sections, conference proceedings, reports and practitioner journals were excluded from the selection. Furthermore was it limited to articles from 2004-2017, as almost no research on humanitarian logistics was carried out prior to 2004 (Kunz and Rainer, 2012). The different databases used were Scopus, Emerald, and Google Scholar. Several papers were found but very few of these were relevant to the topic in question. By using the search keywords, the result of the searches varied from 0 hits up to the excess of 300 hits. The different search criterias were then filtered for duplication. The abstracts of the articles were reviewed and the ones not relevant were discarded. After this exercise was finalised, only 8 articles remained of relevance for the topic in question.

Literature

There are very few peer-reviewed articles on the subject of sustainable humanitarian logistics. Dubey and Gunasekaran (2015) have made an attempt to provide a sustainable humanitarian supply chain definition by way of delineate humanitarian supply chain management from commercial supply chain management. They recognise concerns over climate change and eco-system vulnerability but do not explicitly look at just how the supply chain activities affect these factors. They recommend for further research directions to integrate disaster relief supply networks with ecological footprints.

Haavisto and Kovács (2014) undertook a content analysis of annual reports from 11 major humanitarian organisations. Their analysis concludes that although sustainability is addressed in a societal and programme perspective, little attention is paid to greening of products, services, and operations. They recommend further research to identify best practices for greening of the humanitarian supply chain. The closed loop supply chain was investigated by Battini et al (2016) in their study on regular humanitarian logistics, by providing a model to evaluate the different material flows, including reverse channels, to optimise resource allocations and prepositioning decisions.

Research on reverse logistics in humanitarian operations has been carried out by Peretti et al (2011) in their analysis of the challenges and opportunities for the application of reverse logistics in a humanitarian logistics context. They claim that their research represents a first look at a new sub-topic within the overall humanitarian logistics field. The importance of secondary packaging in developing countries with a humanitarian logistics perspective was the subject of Sohrabpour et al (2012). In their qualitative study they explore supply chain needs regarding packaging in an embedded case study, by linking supply chain thinking in developing countries to long-term development and disaster relief logistics.

Eng-Larsson and Vega (2011) combined the literature on temporary and permanent supply networks and green logistics in the humanitarian context and to explored how green logistics considerations can be incorporated into temporary organisations without compromising short-term objectives. They found five main gaps that need to be targeted to reduce the environmental impact from disaster relief logistics: better matching of supply and demand; reduce transport volumes; reduce transport distances; increase vehicle fill rate; decrease vehicle impact. Another two studies (Balcik et al, 2008) (Battini et al, 2014) have looked at optimising the last-mile by means of modelling. Both studies aim to optimise resource allocation and vehicle routing decisions in a humanitarian context.

From an examination of the relevant literature it is however evident that no studies so far has investigated the emissions from humanitarian logistics operations that contribute to climate change. Applied research is missing on empirical measurements of actual GHG emissions from a real life case in a humanitarian setting.

Two extensive literature reviews on humanitarian logistics research have been carried out during recent years. Kuntz and Rainer (2012) analyse 174 papers and conclude that empirical research is underrepresented in the existing literature and that few papers focus on the continuous humanitarian aid operations in the reconstruction phase following the disaster response phase. Similar conclusions are drawn by Leiras et al, (2014). After analysing in total 228 papers they found that there is a need for more studies on the disaster recovery phase and a need for closer relationships between academia and humanitarian organisations to increase the number of applied research.

There is thus a need to investigate the actual environmental impact of humanitarian operations in order to increase our understanding as to what extent it is a matter of concern. By collecting empirical data from real life operations in a field setting, the width and depth of these issues can be verified and a baseline created. This article is a first step in a process to highlight this field of study and to advocate for further applied research on greening humanitarian logistics.

Methodology

Following the calls for real-life measurements and calls for further research on humanitarian logistics of long-term ongoing operations, a case study seemed the most appropriate way forward. Kovács and Spens (2011) argue that researchers should gain a true understanding of the reality of field operations and conduct practice-oriented research in humanitarian logistics, while Yin (2013) argue that a single case allows one to gain more in-depth understanding of the studied phenomenon. With this in mind, a reputed organization active in the humanitarian sector was selected to investigate the transportation movements in detail. As Van Wessenhove and Martinez (2012) point out: “by rigorously gathering primary data from field operations, we can identify interesting research problems with real impact” (p. 5).

During autumn 2016 the author spent two weeks with United Nation High Commissioner for Refugees (UNHCR) in Lebanon at the country office in Beirut and also conducted a field trip to the sub-office in Zahle, in the Bekaa valley. In order to measure the environmental impact of UNHCR Lebanon operations in terms of GHG, measurements of the carbon emissions from all freight transportation movements in-country from the “port of entry” to the end beneficiary, had to be carried out. Vehicle utilization rate was added to the terms of measure, to verify the extent of efficiency in the transport movements.

The object was to measure the total emissions from freight transport movements during one full year of operation. The study concerns CO2 as it accounts for around 96% of all direct GHG emissions from road transport (McKinnon et al, 2015 p.68). Data on the distance, weight and volume of each transport movement was needed, together with the type and size of vehicles being used and estimated fuel consumption of these. This data was however only partly captured in the system in use by UNCHR, therefore a lot of manual work had to be carried out. Getting reliable data for analysis in the humanitarian context is extremely hard, according to Van Wessenhove and Martinez (2012). The data needed was what Santén (2016) refer to as “missing data”, meaning data that is not reported in any system, and “data that is inaccessible”, meaning data that is stored with another actor, and “incorrect or inconsistent data”, meaning data that has been entered the system but needs to be verified for accuracy.

In concert with one logistics staff at Beirut country office and one staff at each of the three field offices, scanned copies of every Waybill and Goods Received Note for 2015 was arranged. A visit to two of the four warehouses, in Beirut and Zahle, was conducted and a sample of goods were measured and weighted to verify accuracy in the data given. A visit to the transport vendor showed what kinds of vehicles were being used, their size and loading capacity. The owners or drivers of the vehicles provided the estimated fuel consumption of each type of vehicle, apart from the 8 tonne trucks which had to be estimated.

With this information on hand, an analysis could be carried out if only knowing the correct distances. Origin and destination, as indicated on each Waybill and Goods Received Note, was noted on a spreadsheet and distances for most of the relations were found by use of Google maps. The remaining distances of locations not found in Google maps where given by the logistics staff at each of the four offices, by estimate of approximate distances based on knowledge of nearby places or by means of estimating an average distance most likely to correspond to reality.

The transport vendor provided information on return journeys, almost always empty running, and the normal parking place for each type of vehicle where from starting each journey before arriving to the warehouses for loading (installation distance, empty running). In addition, data on the chemical content of the fuel used in Lebanon was obtained from the fuel company.

With this, the needed input information was complete and the analysis of emissions could be carried out. In order to measure the vehicle utilization, the fill rate in terms of Volume and Weight has to be known. The data on quantities was available on the Waybills, volume and weight had been obtained for each kind of item and was consequently added to the spreadsheet for each movement. Knowing the size and capacity of each vehicle type gave the possibility of calculating the fill rate in terms of volume and weight for each movement.

Background to the case

UNHCR is one of the major actors in the humanitarian field, with many ongoing operations across the globe. UNHCR work in 128 countries, employs some 10,800 staff, and have an annual budget (funds available) of about USD 3,7 billion. UNHCR is mandated to assist refugees and internally displaced people and is sector leader in emergency shelter and camp management. The largest current operations are in Asia, Africa, and the Middle East (www.unhcr.org). Lebanon is one of the top hosting countries of refugees in the world. Following the Syrian war, more than a million people has fled across the border to seek refuge in neighboring Lebanon since 2012. These refugees constitute some 235,000 households and make up about 20% of the people living in Lebanon. There are no formal refugee camps set up for the Syrian refugees, instead they live in formal or informal settings spread all over the country (UNHCR sharing portal).

UNHCR Lebanon has set up a warehouse network to be able to receive, store and distribute goods, such as shelter material, and core relief items (CRIs) to the refugees. Movements of goods are being carried out daily. The warehouse network is traditionally arranged for a humanitarian operation with the primary hub located close to the “Port of Entry” and secondary hubs in other corners of the country. Supplies that are available for procurement at reasonable prices in-country are received from the suppliers to the central warehouse (CWH) for inspection and documentation. Supplies from other countries arrive in containers at Beirut port (“Port of Entry”) and is transferred to the CWH for the same purpose. In the case of UNHCR Lebanon, supplies are being stored at four strategic locations; the CWH just north of Beirut, Zahle regional warehouse (ZWH) in the Bekaa valley, Qoubaiyat regional warehouse in the north, and Tyre regional warehouse in the south. All four hubs are being used for distributions to the surrounding areas.

Lebanon is a small country. Driving distance from north to south is only 250km and some 100km from east to west. Every corner of the country can be reached within a few hours drive from Beirut. Security restrictions and weather conditions can however occasionally disrupt accessibility to some parts of the country temporarily. The regional warehouses are therefore used not only as hubs for distribution purposes but also to keep stock for contingency purposes. Main items distributed during 2015 were shelter materials, such as timber, tools, and plastic sheeting, followed by core relief items (CRI) such as mattresses, blankets, hygiene kits, kitchen sets, etc. All in all some 35,300 cbm of supplies departed the CWH, weighing some 9183 tons, divided on 1966 truckloads of various sizes.

Findings/Discussion

Examining the Waybills one can see that UNHCR Lebanon handles some 39 different item categories in their supply flow. The weight and volume for 32 of these categories was known, and some samples were measured to verify dimensions, while assumptions, together with the logistics staff, were made on the remaining 7 categories. Having access to such detailed volumetric data on road freight flows is unusual. As McKinnon (2000) points out; “Very little research has been done on space utilization of vehicles, and few attempts have been made to collect volumetric data on road freight flows”. Since much of UNHCR goods is low weight, it means that the available vehicle space often is filled before the maximum permitted weight limit is reached.

The environmental impact of a transport movement is however commonly measured as KgCO2 per Ton-Km, meaning that it is the weight of loaded goods and the distance it has travelled that is calculated in relation to the emissions it has created (McKinnon et al, 2015). A road shipment of light-weight mattresses will thus have a high impact of emissions per ton of goods, since the truck will be fully loaded in terms of volume but have a low weight. The issue is to balance the loads with heavy goods below and mattresses on top, to make use of both maximum weight and volume for the shipments. Looking at the figures for UNHCR Lebanon, it appears that the logistics staff has been successful in combining these two factors when arranging warehouse-to-warehouse (WH-to-WH) shipments. These movements are made to replenish stock at the regional warehouses from the CWH. During 2015, 257 trucks were used (approximately one truck per working day on average) to transport 9949 cbm or 3257 tonnes of freight. Two-thirds of these movements, 176 to be precise, were by means of 40ft trucks, with an average fill rate for volume of 67% and for weight also 67%.

Comparing these values to the commercial logistics sector for movements between terminals can reveal interesting facts in terms of efficiency in vehicle utilization for UNHCR Lebanon. Although few studies of filling rate have been presented on general freight transport, a study by Pahlen and Borjesson (2012) can be used for comparison. They measured 263 departures for terminal-to-terminal transportation in Sweden, executed by three of the leading freight forwarding companies during one week of operation. The study found an average fill rate for volume of 61,2% and for “payable weight” of 64,3%. The results were concluded to be well in line with the few previous studies found on fill rates and vehicle utilization. Emissions for the outgoing movements have been compiled in Table 1. The warehouse-to-warehouse movements created some 43,800 KgCO2 during one year of operation while the distribution from a warehouse to the end user accounted for some 130,000 KgCO2 for the one year of operation. These figures are based on the assumption that 2,67 kg of CO2 is created for every burned litre of diesel fuel.

	Warehouse to Warehouse	Warehouse to End user
Total number of movements	257	1709
Total Volume of goods	9949 cbm	25354 cbm
Total Weight of goods	3257 tonnes	5925 tonnes
Total distance driven	36600 km	140760 km
Total fuel consumption	16400 liter	48690 liter
Total Carbondioxide emissions	43800 KgCO2	130000 KgCO2
Average CO2 emissions per ton	13,45 KgCO2 per ton goods	21,93 KgCO2 per ton goods
Average fill rate - volume	64 %	56 %
Average fill rate - weight	64 %	47 %

Table 1. Outcome from one year of operation

Efforts to optimize the distribution from warehouse to end users can be troublesome because of many reasons. There are many factors to take into consideration when trying to optimize the distribution such as; infrastructural limitations, coordinating the timing to recipients, timing for when receiving the requests, knowing the quantities, knowing weight and volume of the various products, knowing truck capacities, etc. In addition to trying to have all this information at hand, a systematic way of making use of it is also needed. Logistics officers at UNCHR Lebanon unfortunately do not have the appropriate IT software to support their day to day work in an optimal way. Instead they rely on basic spreadsheets, manual calculators, and let common sense guide them in their decision making. To integrate data on weight and volume of the products into the business system would be one step ahead towards a more optimal distributon.

Proposed Research Agenda

The literature review clearly showed that the greening aspects of humanitarian logistics has not yet been addressed much by academia and there are several calls following previous studies for engaging in this subject. Apart from transport efficiency and carbon auditing, as this case study focus on for the in-country operations, mainstream logistics research has identified several streams of interest that could also be investigated in the humanitarian context from a greening perspective, such as: The supply chain network design, Green procurement strategies, Collaboration with local logistics services providers, Packaging options and recycling possibilities, and Improved coordination between different stakeholders.

Although it is in the response phase of a disaster that logistics plays the largest role, it is also when the complexity and urgency of operational needs takes precedence. This is not the appropriate time to develop, test, or implement new ways of working. Research on aspects of sustainability, including investigation of emissions as in this case, is best suited to be carried out in the preparation phase or in the longer-term recovery phase of an operation, when conditions are more stable and predictable. This is the time when humanitarian organisations can plan strategically and develop their supply chains. New ways can be tested, staff in the organisations can be involved and provide needed data for analysis, trainings and simulations can be executed to raise the awareness internally, and greening initiatives be implemented.

Donor interests and donor regulations will determine the course of action within this field in future. Whether the donor community show interest in this side of operations will be crucial in making progress happen. Will they require from the organisations to audit, monitor and present data on their environmental performance in coming years? Will they provide funding and direction for the organisations to develop more sustainable ways of working? The donors are to a humanitarian organisation similar to what shareholders are to a commercial organisation. It is the managements role to implement shareholder decisions. Research with a focus on the different stakeholders' (donor, organization, beneficiary) perspectives in this respect could be valuable and has also been called for in previous research (Haavisto and Kovacs, 2013).

It is the author's intention to take up the research calls as outlined above, and initiate a research agenda to address these important issues as follows:

A. To continue to make more measurements on emissions from real-life operations to gain a better understanding and more balanced picture on the current state of affairs.

B. To conduct interviews with both donor representatives and senior managers in the respective organisations on their perspectives and intentions for implementing greening policies in future. To clarify what is needed to get the "ball rolling" in the desired direction.

C. To investigate what various greening initiatives have already taken place in the humanitarian logistics sector. To record the different projects and alternative ways of working that have been tested and to elaborate on whether these can be copied and upscaled to be of use in other operations and by other organisations in future.

Conclusion

The environmental impact of humanitarian logistics is a new field of research. The literature review clearly show that no studies so far has investigated the emissions from humanitarian logistics operations that contribute to climate change. Applied research has so far been missing on empirical measurements of actual GHG emissions from a real life case in a humanitarian setting. A single case study is certainly not enough to get a full understanding of the GHG contribution from in-country transportation in the humanitarian sector. Additional studies will have to contribute with mapping the climate impact from humanitarian operations, across the supply chain, to get a more balanced picture of the scale and depth of the issue in order to create a more comprehensive baseline for current state of affairs.

Humanitarian logistics is considered unique in several ways as it is triggered by a disaster and is normally funded by donors instead of the end receiver. The donor community therefore have an undisputable role to play on implementing policies and monitor the environmental performance of the organisations they provide funding to. The greening aspect needs to be considered at different levels, strategic, tactical and operational. Different projects can be launched at small scale to test new concepts to help improve activities.

Since the UN, as mentioned in the introduction, has committed to “lead by example” in terms of showing the way on how to reduce climate impact from operations, the “business as usual” alternative can no longer be considered as a viable option. Sustainable development considerations needs to be more fully integrated into the management practices and operations made more efficient (UNEP, 2012). Further research can enhance the understanding of environmental performance in the humanitarian context, where the UN organisations often are the lead agencies and set the scene for the humanitarian community at large.

Several major challenges face the humanitarian logistics academic community. This article is a first step in a process to highlight the window of opportunity to this field of study and to advocate for further applied research on greening humanitarian logistics by setting a research agenda on topics of concern.

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A STUDY OF APPLICATION OF THE VIRAL REALITY TECHNOLOGY IN VIETNAMESE SUPPLY CHAIN

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ABSTRACT
Although being used for many years in different research applications, the viral reality (VR) technology has only recently been universally applied in supply chain management. Its application brings many remarkable breakthroughs in the whole supply chain from its production, distribution and operation. This paper focuses on analyzing the operation of a VR supply chain, the benefits of applying this technology in supply chain and giving some examples of its models around the world. The paper is also the first research applying VR supply chains in Vietnam. It is shown that VR technology has boosted sales configurations by giving customer complete and detailed experiences before making any purchase decisions, simplifying and improving the speed and quality of the order fulfillment cycle, and thus helping the companies to increase its sales and profitability. An important contribution of this research is that it examines factors affecting VR applications in Vietnamese supply chain to propose solutions for the development of this technology in the future.

Keywords: VR technology, VR technology, VR supply chain, application, production, distribution and operation of VR supply chain, Vietnam.

Introduction

Industry 4.0, referred to as the "Forth Industrial Revolution", with main trends such as digitalization, the internet of things (IoT), internet of services (IoS), and cyber–physical system have been transforming industries by transforming the way goods are designed, manufactured, delivered (Bauernhansl, 2014). This industrial revolution is predicted to have a direct and lasting impact on global logistics system. In particular, Industry 4.0 brings opportunities in terms of decentralization, self-regulation, and efficiency. With the use of Industry 4.0 applications, Just-in-Time/Just-in-Sequence systems, reduced bullwhip effects and integrated supply chain as well as the improvements of production planning are among the potential benefits. Besides, implications of Industry 4.0 help companies optimize value–creation in terms of real time information flows, end–to–end supply chain transparency, and improvements in flexibility (Hofmann & Rusch, 2017). Nevertheless, impacts of this revolution on logistics systems are different among countries, depending upon the level of economic development.

VR is one of important advanced formations and communication technologies which are widely applied in the era of Industry 4.0. This technology has been developed since the early 1960's. However, rapid advancement in the development of VR has not been seen until the first fifteen years of the 21st century. Computer technology, especially small and powerful mobile technologies, have exploded while prices are constantly driven down. The rise of smartphones with high-density displays and 3D graphics capabilities has enabled a generation of lightweight and practical VR devices. The unique features and flexibility of VR give it an extraordinary potential for use in work-related applications (Brown, 2017). It permits users to experience and interact with life-like models or environments, in safety and at convenient times, while providing a degree of control over the simulation that is usually not possible in real life. These characteristics make it indispensable in applications where planning and testing are necessary for decision making. Applications that appear to be most promising are those that employ VR for visualization and representation, distance communication and education, hands-on training and orientation, and navigation.

VR is already used in various areas such as entertainment, design, psychology, and simulation training. In fact, VR technology has been used in logistics system in numerous forms. Logistics is the process of planning, implementing, and controlling the cost effective processing of materials and human potential. In logistics, the adjustment of time, place and capacity plays a central role. Insight on dependency and risks is essential for high-quality decisions. VR plays a key role in these decisions. Fields of interest for VR in logistics include layout planning and concept creation, production simulation, training of operators and operational use. In fact, VR applications in logistics are becoming more and more popular and significant, so researches on logistics should gain a greater understanding of VR to take advantages of the opportunities that it presents.

This paper explores the primary uses for VR within supply chain management, evaluates the actual situation of applying VR to the supply chain in Vietnam, analyzes factors affecting VR applications in Vietnamese supply chain to solve the chief questions and challenges related to VR integration into supply chain and suggests some ideas for future research. The numerous-supply chain-related uses for VR are illustrated through a description of VR technology for four sub-areas of supply chain: planning and management, manufacturing, distribution and customer services, and transport and warehousing. VR will certainly influence many other aspects of supply chain but the abovementioned sub-areas were selected because those appear to bring about apparent benefits. The potential development of VR technology in Vietnamese supply chain is analyzed by examining factors that affect VR application, therefore suggesting solutions to innovate this technology. Finally, some ideas for future research are presented.

What is Virtual Reality?

There are indeed different definitions of VR, depending on the features considered necessary to constitute a Virtual Reality experience. This paper utilizes the most popular definition that has been used in books related to this subject. As such in this paper, VR is defined as the use of computer-generated 3D environment – called a virtual environment (VE) – that one can navigate and possibly interact with, resulting in a real-time simulation of one or more of the user's senses (Vince, 2004). "Navigate" means that the user can move around and explore the virtual environment and "interact" means that the user can select and move objects within the virtual environment (Burdea and Coiffet, 2003). However, for this paper, we consider interactivity as an optional component, this more flexible definition permits a wider research scope. This paper also accepts augmented reality (AR) as a type of VR. AR is a technology that layers computer-generated enhancements atop an existing reality in order to make it more meaningful through the ability to interact with it. VR and AR do not always operate independently of one another, but, in fact, are often blended together to generate an even more immersing experience.

In every VR system, user's actions can be interpreted by some sort of input devices such as a mouse, interactive gloves, and voice recognition software. In response to user's input data, a VR system will present an appropriate view of the Virtual Reality. To do this, VR systems must account for the collision between the objects, use 3D clipping process, improve image quality and respond to user's movement in a millisecond. A VR system can stimulate different senses effectively; however, this ability varies depending upon how the system being used. Although the visual aspect of VR draws the most attraction, other elements can also be very significant in the creation of the realistic virtual enviroment (Gutiérrez et al, 2008). For example, high-quality tactile feedback would be most important for a VR system simulating surgery for doctors in training, while high-quality audio would be most important for a VR system simulating an orchestra in a concert hall. With regard to supply chain, visual and auditory aspects of VR will often be the most important.

Actual applications in Vietnamese supply chain

Research on the supply chain applications of VR and AR is definitely a strong and growing area. VR technology has been used throughout supply chain process, from planning, procurement to detriment, and customer service. Advancement in computer and communicating technologies has provided suitable interfaces to allow users to interact directly with the supplier's information associated with the manufacturing processes. AR can provide users with an intuitive way to interact directly with information in production processes. It also allows the operators to use their natural spatial processing abilities to obtain a sense of presence in the real world with virtual information.

Distribution and customer services

The VR technology has been applied mostly in the distribution of the whole Vietnam's supply chain. A lot of potential customers also have opportunities to test the VR technology in a completely different way. In particular, VR simulates the physical presence of customers in virtual space in which they have a clearer, more productive vision and multi-dimensional interaction with the product (touching, changing position and color of objects...) in an authentic way. This experience helps shorten the decision-making time of customers and save cost effectively. For example, some leading car manufacturers such as Audi and Mercedes have adopted VR to introduce the attributes, functionality, and above all the fantastic experiences that customers will have when using their car models. Another example is IKEA, which found that consumers often find it difficult to make furniture purchasing decisions, as they can hardly imagine whether products that they intend to buy fit their homes in terms of style or color. IKEA has launched an electronic catalog application, an AR application on a mobile device that allows customers to preview furniture to see whether it matches their home before coming to the final decision. Therefore, customers simply need to launch the app on their smartphone or tablet, and use the camera functions to capture an image of a room in their home in advance. After that, they can choose different items from IKEA stores to see how they will look like when placed in their home.

Previously, VR was a less well-known technology and its application was predominantly in large companies because it required more terminals. However, in the past two years, VR has become a booming trend in Vietnam in the technology area. In 2016, Pho Xinh furniture chain store launched its 3D showroom system at phoxinhonline.com, Mini Cooper Vietnam virtualization showroom that introduces the latest models, Rever.vn 3D home sales, ALC Corp (Kitchen Casta) that does marketing activities by 3D model and a series of real estate project owners that make 3D model houses such as Vinhomes Real Estate Group, BIMgroup or FLC along with some businesses that are boldly jumping into the VR reseller market for businesses such as Holomia, Rever or Horus. In the last two months of 2016, according to a representative of Rever, a VR provider, they have implemented more than 3,000 VR scenarios for businesses and their individual customers. Moreover, their service was also used by more than 1,000 marketing staff in various fields to introduce products to their customers. Many experts have stated that VR in Vietnam will become a technological trend in the coming years with a dramatically rapid growth rate of over 20% per year.

Manufacturing
VR as a simulation tool was first reported in the 1960s. Since then, many different forms had appeared, from 2D monitor-based to 3D immersive and sophisticated setup. In recent years, Augmented Reality (AR) technology has matured and proven to be an innovative and effective tool to address some of the critical problems to simulate, guide and improve manufacturing processes before they are launched. Activities such as designing, planning, and machining can now be done right-the-first-time without the need for subsequent re-work and modifications. In fact, Virtual and Augmented Reality have been widely applied to common manufacturing activities such as product design, robotics, facilities layout planning, maintenance, CNC machining simulation and assembly planning. Recognizing that VR technology was not only capable of rendering an exact 3D virtual copy of their vehicles produced in their plant, allowing for dynamic manipulation and visualization of products and parts from all angles, but that it also allowed for an exact rendition of production processes, Ford Motor Company have developed and applied this technology to their manufacturing process since 2012.

The most common application of VR in Vietnam is the CNC machining simulation system. This machine is used in the processing of paintings or sculpture on wood, bronze, or microscope according to the drawings already programmed on the computer. The application of this technology helps to produce high-precision products, as well as save time and labor. Augmented Reality CNC systems are becoming a trend in mechanical engineering in Vietnam. If previously, this system was mainly imported, now many companies in Vietnam have successfully researched and manufactured many machines such as 4-axis CNC machines. In addition, AR and VR technology has also been applied in assembly operations. VR technology plays a vital role in simulating advanced 3D human-computer interactions, especially for mechanical assemblies, by allowing users to be completely immersed in a synthetic environment. Many VR systems have been proposed successfully to assist assembly activities.

Planning and Management
AR and VR technology applications in planning and management are based on its simulation function. Effective simulation of an actual operation will ensure that it can be carried out right-the-first-time, eliminating many trials and re-works, saving materials, energy, and labor. VR has been used in creating

product design as it provides very intuitive interaction with the designers in terms of visualization and the interfacing with downstream processes. A hybrid immersive modelling environment merging desktop CAD was created by Stark et al (2010), Wiese et al (2009) and Israel et al (2009). They noted that the current modelling media using paper and CAD system is complementary but it lacks interaction. Digital media offers the great freedom of exploring different dimensions and features, using stored forms and shapes from the library, and the advantage of integrating a product model with associated physical properties. In addition, some downstream processes, such as process planning, machining, and inspection can be fully integrated. AR is becoming a major part of the prototyping process in product design in many industries, for example, in the automotive industry, AR has been used for assessing interior design by overlaying different car interior mock-ups, which are usually only available as 3D-models in the initial phases of development, on real car bodies (Fründ et al., 2005). However, few systems can support product creation and modification in AR using 2D or 3D interaction tools.

Transport and Warehousing

The application of AR in transportation and warehousing will completely transform logistics in Vietnam. These changes are shown in some areas including: warehouse planning, picking and packaging services, and final delivery.

- Warehouse planning: when warehouse operations change with more functionality than just storage and distribution, the layout will have to be changed to fit different business areas such as product assembling, and labeling. With AR, new arrangements can be planned on a large scale to precisely check the location and workflow before deployment.
- Selective and packaging services: for many warehouses, picking and packaging services, especially during the high season, are completed by temporary workers. Implementing an AR solution for selective and packaging activities has shown significant improvements in productivity by shortening the test curve and providing continuous validation to update WMS in real time. Operatively, AR can be used to overlay bales in the repository to display selected items and reduce the time needed to manually define them. When the package is ready for shipping, AR tools can be used to get the information of the ordering time and handling instructions whenever the carrier arrives.
- Last-mile delivery: the most expensive step for retailers in e-commerce. As the customer base grows and expands, delivering cost-effective products to customers has become a top priority for many retailers. According to a report by DHL Trend Research, it is estimated that drivers spend 40-60% of their time finding the right bales in their trucks for the next delivery. For many people, this process depends on their memory of how the truck is loaded. An AR application can be used to streamline the time it takes to identify a package for delivery and reduce the time to find out where a package is delivered.

Factors affecting VR's application potentials in Vietnam

It can be seen that VR has a lot of potentials for practical application in the supply chain in Vietnam. However, in order for this technology to develop to its full potential, we need to have appropriate orientations of development. In the next part of this paper, the author went deep into analyzing and finding out the factors that affect the application of VR in Vietnam. The author then conducted a survey of a number of Vietnamese enterprises and in-depth interviews with a number of experts in this field and did a regression analysis to determine the different levels of impact of each factor on job performance. Since then, the results of research are the basis for promoting solutions to bring VR technology closer to businesses in Vietnam. After conducting the survey via the internet and distribution of questionnaire, the author has collected 178 valid questionnaires from enterprises including those operating in the product and service supply chain. The scale used for measuring the observed variables in the model is the likert scale of 5 points. This type of scale that is commonly used in many current researches is in accordance with the design of this study.

Through the process of analyzing and evaluating opinions from businesses and experts in Vietnam, the author has selected four key factors affecting the application of VR in the Vietnamese supply chain, including: level of employees, technology infrastructure, VR's development in the world and technology development policy of the government. The level of labor is a factor influencing the application of VR to the supply chain because no matter how advanced the technology is, human remains a decisive factor.

Moreover, Vietnamese workers are considered to have a relatively low level of qualifications, thus improving their level of employment is an important goal to keep pace with the worldwide technology trend. As mentioned in the previous section of the study, VR technology is always associated with endpoints and the development of technology platforms such as the internet, computer systems and the popularity of smartphones will help bring the technology closer to reality. The government policies on technology development are also an important factor. In recent years, the government of Vietnam has paid special attention to the application of advanced technologies through investment in research, organization of scientific seminars, encouragement, and support for start-ups in the field of technology. Following is the research model proposed by the author:

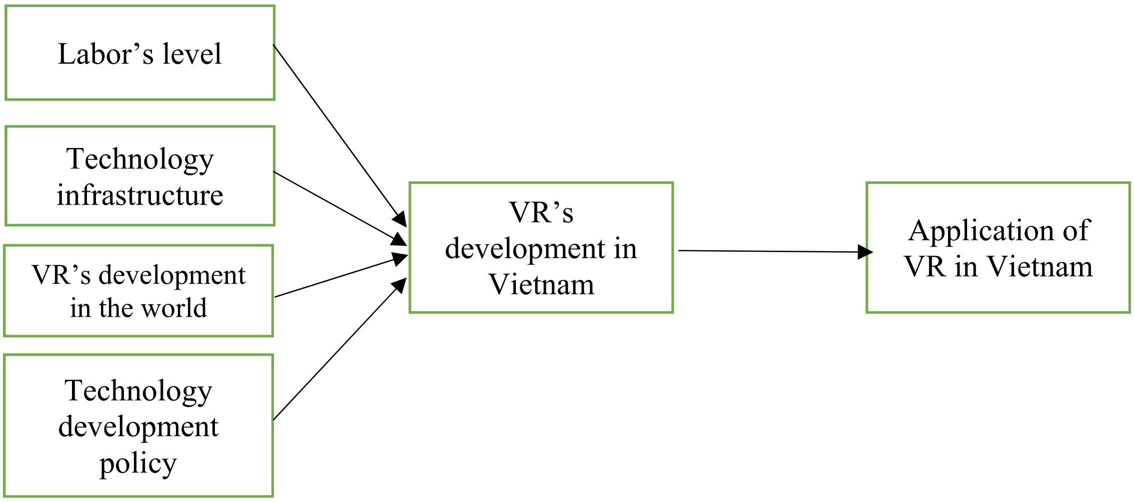

Figure 1. Key factors affecting the application of VR

The explanations of the research model include:
H1: Improving the professionalism of the workforce will facilitate the applications for VR supply chain in Vietnam
H2: Upgrading and developing the technology infrastructure will enhance the applicability of VR technology in Vietnamese supply chain.
H3: VR's development in the world will facilitate VR applications in Vietnamese supply chain.
H4: Government technology development policies will facilitate VR applications in Vietnamese supply chain.

Verification of confidence coefficients of the scale (Cronbach's Alpha index): According to the Cronbach's Alpha test, the observed variables have the Cronbach's Alpha index if the variable deleted is greater than the Cronbach's Alpha index of the scale and the small crossover correlation coefficient more than 0.4, it may be considered a recommendation to remove the observation variable from the scale. The official scale will be constructed and refactored based on observable variables that are sufficiently reliable. The Cronbach's Alpha coefficient obtained according to the results of the survey of the four scales are 0.772, 0.876, 0717 and 0.731 respectively. All observable variables of four scales have Cronbach's Alpha values if the variables deleted are smaller than the Cronbach's Alpha coefficients and the cumulative variances are greater than 0.4, so all variables in this scale are accepted. In the proposed research model, 18 observation variables are considered to influence VR applications in Vietnamese supply chain. Exploratory factor analysis (EFA) results obtained KMO = 0.89 (> 0.5), which shows the appropriate factor analysis with the research data. Applying the rotation method, the results showed that all 18 variables were significant (value> 0.43) and were categorized into 4 groups of factors with a total variance of 64.493% (more than 50%).

In the model of adaptive research, the independent variable "Application of VR in Vietnam" is influenced by the four dependent variables. Therefore, to estimate the model of factors affecting the applications for

VR technology within supply chain sector, the authors use linear multiple regression equation. The regression equation has the following form:

Application of VR in Vietnam = 0.382* Labor's level + 0.273* Technology infrastructure + 0.165* Technology development policy + 0.18* VR's development in the world

From the above analysis, it can be seen that labor's level and technology infrastructure are the two most important factors affecting the application of VR in Vietnamese supply chain. Meanwhile, VR's development in the world and technology development policy have a lower impact on the application of VR in Vietnam. Identifying the different levels of impact of each factor is an important basis for the author to come up with solutions that need to be prioritized to this is a new point and also an important contribution of the thesis.

Discussion and future research

It can be seen that, despite being a developing country, Vietnam has not slowed down the deployment of VR technology as well as its application in the fields of life including the supply chain management sector. For the application of VR in the supply chain, Vietnam is still focused on some stages, especially distribution. However, the application of this technology to the entire supply chain activities will bring about greater interconnectivity between suppliers, optimization of the flow of information and products in the supply chain as well as customer's satisfaction. The constant development of new technology trends will change the current supply chain, so not keeping up with the opposite technology trends will be a challenge in this area. To facilitate this technology development in Vietnam, solutions need to focus on improving the professional level of workers as well as improving the technological infrastructure. The acquisition and application of technological advances on VR in the world will also create a premise for the development of this technology in Vietnam. This is the work of both managers, businesses and transferors in the field.

Many opportunities exist to research the possibility of VR applications and implications for supply chain management sector. For example, research could investigate relationship between VR application and optimization of supply chain efficiency, evaluate customer satisfaction with AR and VR practical applications of some enterprises or research the models that apply VR effectively throughout the supply chain to change the structure and direction of sustainable supply chain development in Vietnam. Moreover, research could investigate the characteristics of different supply chains (e.g.: service supply chain and product supply chain) influence the potential of VR applications. Additionally, research could investigate other VR applications to solve problems of supply chain management such as risk management, quality management, cost reduction, and inventory management. These researches will contribute significantly and provide the basis for the application of VR in Vietnam in the future.

Conclusion

As this paper has demonstrated, VR's applications in the supply chain management sector is significant, so the future research can provide more practical value to supply chain sector. In the explosion of Industry 4.0, emerging technology like VR will bring opportunities as well as challenges to the innovation of Vietnamese supply chain. A complete understanding of VR and its applications will take advantage of opportunities and solve the challenges that it brings. VR offers a variety of applications in the supply chain from planning to distribution; however, its role in linking the supply chain is still limited. In the future, VR offers potential to link entire suppliers in the supply chain in a more comprehensive and effective way. As new VR technologies are developed, the potential uses for VR within the supply chain sector will continue to increase in number and importance, so both policy makers and companies should have long-term plans to apply this technology more widely and effectively. In addition, it will be the job of researchers and professionals to exploit VR for more unique opportunities.

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AN ANALYSIS OF THE COMPETITIVE POSITION OF THE EURASIAN LAND BRIDGE, CHINA TO GERMANY

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Introduction: The 'One Belt, One Road' Strategy

The 'One Belt, One Road' strategy is the major strategic decision which was developed by the Central Committee of the Communist Party of China (CPC) led by Xi Jinping in response to global trade developments. This strategy has been included in the Chinese government's 'Annual Work Report', as an important strategy (Yuan, 2014). From 2013, China established the 'One Belt, One Road' strategy, and proposed actions outlined on jointly building a Silk Road Economic Belt and 21st-Century Maritime Silk Road which was published in 2015 (Zou et al, 2015). The Silk Road Economic Belt begins in China and passes through five Central Asian countries, Russia, Western Europe and regions along the Mediterranean. The Maritime Silk Road begins in China's coastal areas, follows three routes and covers more ports and countries:

1. Pacific line: starts from the eastern coast of China to reach Japan and Korea, and 11 Southeast Asian countries including the Philippines, Indonesia and Thailand.
2. Indian Ocean line: start from the east coast of China, and reaches India, Pakistan and the east coast of Africa through the Strait of Malacca, and then goes into the Persian Gulf via the Strait of Hormuz.
3. Atlantic line: starts from the east coast of China into the Indian Ocean, and reaches European countries after entering the Mediterranean via Ba bel-Mandab and the Suez Canal.

An additional line, the South Pacific line is also being developed.

The implementation and construction of the 'One Belt, One Road' corridor is a long-term, systematic project, covering around 46 million people (Zhang, 2015). The strategy involves both domestic and foreign territories, and it is a mutually open strategy that connects domestic areas with foreign areas through modern transport and information networks. The implementation of the 'One Belt, One Road' strategy is intended to break the separation of land and sea transport, and promote integration, forming a more coherent economic whole. (Chen, 2015).

Methodology

The statistical, quantitative data was derived from two sources: directly from COSCO and China Shipping and indirectly from other published sources. COSCO and China Shipping are the two largest shipping companies in China, and the shipping and inland transport costs were extracted from the ocean freight rate tables and trailer rate tables found on the official websites of these companies. The railway freight rates were obtained from the official site of China National Railways as the 'State Council of China' has interpreted the 'One Belt, One Road' Strategy in detail. Other empirical data came from research reports and publications. The data for charges for various ports and transfer stations were obtained from forwarding companies and their cargo accounts settlement systems. Additional quantitative data was derived from two sources, primary data from interviews, a case study, and questionnaires, and unstructured field observations focused on the multimodal transport of freight between China and Germany.

The qualitative data include both categorical data and sequential data in the form of text-described data presenting both general and specific categories. This data could not be quantified but only considered and discussed.

Analysis: The export of auto parts from China
In recent years, China's auto parts industry has undergone rapid development. According to Commerce Department statistics, the sales revenue of auto part enterprises has an average annual growth of 36.8%. In the past 15 years, the export volumes of the Chinese auto parts sector have had an annual growth rate of around 30%. The United States, Japan, European Union and other car producing countries are major importers of automotive parts, e.g. chassis, bumpers, wiring looms, glass, brakes, clutches, radiators, exhausts and silencers sourced from China.

Case Study 1: Changchun Automobile Company
Changchun Automobile Company is a big customer of container shipping companies, exporting automobile parts to Volkswagen in Germany. The main multimodal transport route has been through Port of Dalian as the primaru port of export from the northeastern region of China to Europe. Northeast China has four major ports: Dalian, Jinzhou, Bayuquan and Dandong. The route from Dalian Port, the starting point, proceeds from Liaoning Province to Europe via Southeast Asian countries, the ports of the Mediterranean and on to Europe. This is a convenient, economic and efficient sea transport corridor from northeast China to Europe.

By 2015, China had established a rail transport route from northeast China to the EU, so that the goods from northeast China can reach Europe via the land-bridge which has two variants: "Northeast China - Manzhouli - Russia - Europe" and "Northeast China - Inner Mongolia - Mongolia - Europe". The route from Northeast of China to Europe through Mongolia has attracted considerable high value-added products business. Currently, the export volume of goods via Manzhouli account for more than half of the export volumes for local goods. The manager of the international cooperation department of the 'Port of Bayuquan Group Co., Ltd identified the Great Wall Motor Co., Samsung, LG, and Adidas as examples of companies who choose to use the China Railways express route from northeast China to Europe. In addition, the route from northeast China to Europe through Mongolia is an important route which transports ores and agricultural products. Routes and multimodal combinations are shown in Table 1.

All rail	All rail via Manzhouli and Moscow
Multimodal	Rail-Ferry-Sea-Road via Port of Dandong
	Rail-Ferry-Sea-Road via Port of Jinzhou
	Rail-Ferry-Sea-Road via Port of Bayuquan

Table 1 Multimodal transport modes from Changchun to Wolfsburg (Authors, 2017)

One of the automobile manufacturers is based in Chang Chun City, Jilin Province and has an enterprise's special service railway. For the China-Europe railway, therefore, containerised goods can be transported directly from the production facility to the Harbin Railway Station where the China-Europe railway begins. Beijing Changjiu International Logistics Co., Ltd., UTi Worldwide (UTIW), the Port of Dalian (PDA) and the Harbin Railway Bureau (HRB) work together to offer the Harbin-European freight train service. With advantages such as a shorter distance, faster speeds and lower costs, the Harbin-Europe railway route has attracted attention from outside China. Companies in the Hamburg area and the Bavaria and Lower Saxony state governments all want to cooperate with the Harbin Railway Company. Railway operators in countries such as France and Switzerland also have expressed their willingness to cooperate in the European part of the Harbin-Europe railway route. Transport by railway is normally less expensive than transport by road, but with extra transhipment costs caused by changing the transport mode.

Routeing Via Port of Bayuquan
The Port of Bayuquan is located at the junction of the Bohai economic circle and the Northeast Economic Zone. It is the nearest sea outlet from the three north-eastern provinces with very obvious geographical advantages. The company is also one of the most convenient sea outlets in Northeast China and one of the 20 major ports of coastal China. In 2012, the handling capacity of the Port of Bayuquan reached 301 million tons, becoming the ninth largest port in China; containers totalled 4.81 million TEU; sea and railway transport volumes ranked second in the country, only behind the volumes

through Dalian Port. Existing domestic trade container lines cover 30 major ports in China's coastal areas.

The time delays caused by changing the transport mode during the transit process of the products takes up 3% of the total transport time. Because the times for container handling in port, shipping schedules and Container Yard closing time are different, and with these time periods offering high flexibility, so the transfer time is not counted in the total transport time. The cost generated in the transfer phase accounts for 27-30% of the total transport cost. In particular, there are documentation fees, customs charges, security costs as well as costs charged by THD or shipping companies at export ports. Because the cost of railway transport for the automobile manufacturer in Changchun to the Port of Bayuquan is slightly lower than the road transport cost and the automobile manufacturer in Changchun has its own railway line, transporting products to the Port of Bayuquan by rail is the best choice.

This route begins at the automobile manufacturer in Changchun, using containers of different sizes (i.e., 20 foot TEU or 40 foot High Cube) according to the types and amounts of goods. The shipping company generally charges for moving a container through a container yard to the factory. Usually, when a factory applies for moving containers through this route, the shipping company will charge $18 per TEU as the modal change cost. Since domestic ferry transport is often used in China, the cost generated at the first transit node is not very high. Compared with neighbouring ports, the road transport costs for the Port of Bayuquan are relatively low, making this route the best of all. In the meantime, the trains from the northeast railway freight station to the Port of Bayuquan and ships to Dalian Port are the most frequent. Because hardware facilities at the Port of Bayuquan are good its handling efficiency is the highest. Therefore, the time and cost of transit shipment are the lowest. Goods from the automobile manufacturer in Changchun can be transported to Port of Bayuquan through road and railway transport. Due to the long distance of transport, the cost of freight transport of railway is obviously lower than that of road transport. And the automobile manufacturer in Changchun has its own railway lines, so customers are more willing to choose rail transport to transport the goods from the factory to the Port of Bayuquan.

Routeing Via the Port of Dandong
Dandong Port is located in the centre of the Northeast Asian economic circle and the east of Bohai economic zone, which is the northernmost international trading port on the Chinese coastline. Moreover, it is the most convenient logistics channel linking Russia, Mongolia, South Korea and Japan. Dandong port accommodates 10,000 TEU container ships, and 70,000 dwt bulk grain vessels.

The cost of road transport from Changchun to the port of Dandong is very high. The land transport cost of 20 foot containers is higher than the cost of sea transport from the port of Dalian to port of Hamburg. This route is also the most expensive of all multimodal transport routes. However, the rail transport cost to Dandong port is $220 per TEU lower than the road transport cost. Besides, because the infrastructure in Dandong port is rather poor, the transit time to Dandong port is relatively long and reaches 20 hours.

Since the handling capacity of containers in the Dandong Port is lower than other northeast ports, the price of railway and road transport is relatively higher because the port does not have return goods. However, due to the relatively low handling capacity of Dandong Port, the container transport is therefore seldom delayed. The Port of Dandong has been growing rapidly over the past few years thanks to the Port of Dalian's investment, but shippers sometimes hesitate about selecting the Port of Dandong due to disorganised operations, aging storage yards and insufficient space resulting from growing amounts and types of goods. These problems have significantly affected the Port of Dandong's loading efficiency and its distribution capacity.

Routeing Via the Port of Jinzhou
The Port of Jinzhou is the only fully open international port on the 400 km in the northwest of the Bohai coastline, and is also hub port developed by Liaoning province in the northern region. Located in the northwest of the Bohai Sea, Jinzhou Port is the most convenient access point for Northeast Asia. Although located in the north, winters there are cold but the sea is not frozen. The effective operating time is 365 days each year. With a number of container liner routes opened by shipping companies, the port of Jinzhou has become the main port linking the north and south. Domestic and foreign trade line

networks closely cover the south China coupled with Huangpu Port in Guangdong, and coastal areas of the southwest and east China with Port of Shanghai as the centre.

The transport costs on this route are between the transport costs of the other two multimodal transport routes. And the total transport time is almost the same as that of transiting via Dandong port. Because there are plenty of return loads in Jinzhou, the road transport cost at Jinzhou port is only $100 per TEU higher than the railway transport cost. Although the time of the road transport is 1-2 hours less than that by rail, the 1-2 hours can be ignored in the total transport time.

The transit time and cost of this route is basically the same as via the Port of Dandong. The main business of Port of Jinzhou is the transport of bulk goods e.g. grain and bagged fertilizer, The Port of Jinzhou is also an important coal feeder port. Container transport development at the Port of Jinzhou is slow, and at present, there are only 4 container ship berths resulting in frequent delays.

Land bridge
In 2015, the Changchun - Manchuria - Germany International Freight Train was formally launched, which on leaving Manchuria port, passes through Russia, Belarus, and Poland. At present, the import of goods mainly include auto parts, and export goods are auto parts and wood, electronic products and so on. In proximity to the freight line, there are assembly centres for Volkswagen, Audi, BMW and Tesla are planning to build an electric car battery factory nearby , to form a stable manufacturing base. During the test run of Changchun - Manchuria - Germany International Freight Train, the transport time was 18 days, saving 35 days against sea transport. After the formal operation of the Changchun - Manchuria - Germany International Freight Train, the achievable single-direction operation time is around 11 days. Thus international railway container transport between China and Europe, with the advantages of fast transit, and better environmental performance, is an important supplement to sea and air options, the price is about 1/5 of the air, and the running time is about 1/4 of the sea freight. This line has great advantages in time and cost. Although the railway transport costs reach $6000/TEU, at present, China Railway Administration has given the line a 25% tariff concession so that it makes the central line attractive for high value goods. The Harbin - Europe Railway route in north-east China is still young and remains in the stage of trial operations. Nonetheless, the data analysis shows that this route has obvious advantages in terms of time and cost. The freight cost has reached $6000/TEU due to a lack of goods from Europe to north-eastern China. But this cost will decrease significantly with the steady development of this route and an improving trade balance between Europe and China.

In Case 1, the multimodal route via the Port of Bayuquan is the preferred route. Sea transport requires 30-35 days, has the lowest freight cost and the largest volume of goods. In addition, the interest on the capital value during transport also is a consideration of both shippers and buyers. If the value of goods in a container is $US 5 million, the interest added by the one extra month required for sea transport is $US 4,000-5,000. For example, the interest on capital plus the sea transport cost plus the railway-ship multimodal or trucking cost totals $US 6,000 - 7,000. Automotive parts are high-value goods. From this perspective, therefore, selecting the Harbin-Europe Railway route rather than sea transport is more cost-efficient for such goods overall. Broadly, the shipper should select this China-Europe Railway route if the shipment value exceeds $US 2 million; air freight if the containerised goods value exceeds $US 10 million, and sea transport if the goods value is lower than $US 2 million.

Case Study 2: Nanjing City Logistics Park
In 2013, an automobile and automotive parts logistics park was opened in Nanjing City, Jiangsu Province. The parts warehouses account for one third of the entire park by storage area. The newly built automotive parts logistics park includes a container storage yard of about two hectares in area. Automotive parts are goods characterised by small dimensions, low weight and high value. For these goods, shippers want to select a transport route with a low freight cost and fast time. Sea transport tends to be selected for automotive parts transported from Nanjing to Europe. China Railway Company has been operating the Zhengzhou to Germany railway route since the Chinese government announced One Belt - One Road strategy. The freight train leaves Zhengzhou for Europe twice a week, namely, on Wednesdays and Fridays. Moreover, the return freight train service has also been launched: trains start off twice per month, namely, on the 15th and 30th days of the month. This implies up to 2 weeks of dead-time while a train

load is accumulated. In order to increase the amounts of goods from Europe, China Railway Company is setting up branches in such cities as Shenzhen, Guangzhou, Shanghai, Ningbo, Beijing, Tianjin, Qingdao and Dalian, thereby providing services such as the less-container-load (LCL) service and fast distribution for return freight trains.

All rail	All rail via Zhengzhou and Alashankou
Multimodal or Intermodal	Road-Ferry-Sea-Road via Port of Shanghai
	Road-Sea-Road via Port of Shanghai
	Road-Rail-Sea-Road via Port of Ningbo
	Road-Sea-Road via Port of Ningbo

Table 2: Multimodal transport routes from Nanjing to Wolfsburg (Authors, 2017)

From Table 2, the sea transport routes include Shanghai - Hamburg and Ningbo - Hamburg. Goods are transported by truck, train and container barge to the Port of Shanghai from Nanjing. The preferred method involves trucking goods to Nanjing Railway Station and the Port of Nanjing or trucking them directly to the port of Shanghai or Ningbo. The first ever Zhengzhou-Europe freight train began operating on July 18, 2013, indicating that China has built an international railway which connects it with other parts of the world. In other words, a New Silk Road between China and Europe has been built. Goods can be transported by rail from Nanjing to Zhengzhou where the China-Europe Railway route begins.

Via Port of Shanghai

Located at the Yangtze River Delta, the Port of Shanghai is in the centre of China's 18,000-kilometer coastline. As China's primary port, Shanghai is critical for China's opening up and participating in international economic activities. This port accounts for 99% of goods exported from and imported into Shanghai and about 20% of the total amount of foreign-trade goods handled by China's ports. From Nanjing to Shanghai, ferry transport has the lowest transport cost, but the longest transport duration. Due to narrowing of the navigation channels of the Yangtze River during the low water season in winter, ferry transport is the least reliable means. Nanjing to Shanghai port via road transport is also possible. As certain handling charges will be generated for container transport through road and railway, road transport is therefore generally cheaper and more flexible than railway transport if the transport distance is less than 500 km.

Intermodal transfer costs generated by the foregoing two transport routes account for 30% of total transport costs. Of the two transport routes, the cost of road transport is $US 300 / TEU more than that of the ferry transport. For nearly the same distance, ferry transport will be one day longer than road transport. However, in comparison with a total transport time of 28-30 days, one-day diffreence can be ignored.

Via Port of Ningbo

The port of Ningbo is the starting point of the Maritime Silk Road of ancient China. As a multi-functional and comprehensive modern deep water big port integrating inland port and seaport into one body, the port of Ningbo is open to navigation with over 600 ports of more than 100 countries and regions in the world. The cargo handling capacity of the port of Ningbo was up to 809 million tonnes in 2013, higher than that of Shanghai, ranking it first in the world. Due to its geographical location, internally, the port of Ningbo can not only be connected with various coastal ports, but it also directly covers East China and the economically developed Yangtze river basin by way of river-sea combined transport and sea-railway combined transport; externally, it directly faces East Asia and the whole Pacific Rim, thus becoming an ideal distributing centre for the coastal area of China to radiate towards port in America, Oceania and South America by sea.

The reason why ferry transport is not included in the transport modal mix of Nanjing to Ningbo is that both the transport time and distance by ferry is far beyond other transport modes. Analysis of geographical location shows that the price of both railway and road transport is relatively high, for the distance from Nanjing to Ningbo is longer than that from Nanjing to Shanghai. The sequence for most of the liner companies to berth at ports in the Yangtze river basin is to berth at Shanghai and then Ningbo. Therefore, the overall transport time for berthing at Ningbo is two days less than that of berthing at Shanghai.

The total transport cost of the two multimodal transport routes via Ningbo Port is almost the same. As the transfer cost of the first route is more than that of the second route, plus that the distance from Nanjing to Ningbo is not very long, therefore, the road freight and railway freight are almost the same. From the perspective of transport time, transport of cargoes directly from Nanjing to Shanghai port by road is the preferred route. As one transfer node is removed on this route, the transport risk is also mitigated accordingly.

Land bridge
The Zhengzhou - Europe Railway route runs for 10,214 km, starting from Zhengzhou, proceeding via the Alataw Pass in Xinjiang Uygur Autonomous Region, then going via Kazakhstan, Russia, the Republic of Belarus and Poland, and eventually arriving in Hamburg. The whole journey takes between 11 and 15 days, which is around 10-20 days shorter than by sea transport depending on the shipping service, and it can save 80% in comparison to air transport. Apart from the Zhengzhou - Europe rail route, Zhengzhou also opened two other rail routes with regular services in 2015: Zhengzhou to Almaty, the biggest city in Kazakhstan, and Zhengzhou to Moscow. The Zhengzhou - Europe Railway route also opened a southern Europe route via Central Asia and Turkey to Luxembourg in 2016.

The source of goods for the Zhengzhou - Europe block train covers the majority of provinces and municipalities directly under the central government of China. The cargo types include traditional light textiles, automotive parts, engineering machinery, medical equipment and other industrial products as well as such electronic products such as laptops, mobile hard disk drive etc. The scope of goods consolidation covered South Korea for the first time with the No. 24 train opened by the Zhengzhou - Europe Railway route in April 2015. Cargoes from South Korea are transported to the railway transfer station of Zhengzhou via the port of Lianyungang and then to Europe via the Alataw Pass. Successful testing of the transit shipment of Zhengzhou - Europe Railway route has created a solid foundation for Zhengzhou international inland port to establish the multimodal transport business channel of sea transport, railway transport, air transport and road transport. This has also provided a guarantee for the Zhengzhou - Europe Railway route to attract cargo from Japan, South Korea, Southeast Asian region and Taiwan destined for Central Asia, West Asia and Europe on a weekly basis.

The Zhengzhou-Europe Railway route has typically saved 10 days transport time in comparison with multimodal transport based on sea transport. However, the cost of this route is 3-4 times sea transport. High transport costs are the main reason restricting development of this route. To capture more cargo, however, local governments in various provinces of China have started a “price war” as a bargaining tool. For example, one of the purposes for Chongqing to open the Chongqing - Europe Railway route is to increase its attraction to HP, Acer and other laptop producers. In the second year of operating the Central-Europe block train, the gross exports of Chongqing reached $US 53.2 billion, increasing by 82.2% on year-on-year basis. To take the new Chengdu-Europe Railway route as another example: this rail route handled local products with a total value of $US 300 million and products with value of $US 200 million exported by other provinces to Europe in 2014. The Zhengzhou - Europe Railway routes had the highest operating train numbers among all China-Europe Railway routes in 2016 and its cargo weight, cargo value and overall influence also rank top amongst China - Europe Railway routes. The Government freight allowance is also a special prerequisite for Zhengzhou-Europe Railway route to implement regular operations. The government grants a subsidy of 15-25% freight rate in accordance with the cargo quantities of the shipper.

There are two types of cargoes in Nanjing automobile parts logistic park. One is the spare and accessory parts to be supplied to European automobile manufacturers for production purposes; the other one is the spare and accessory parts to be supplied to European automobile parts market for retail purposes. For the first category, total transport time is the most important to the manufacturers, for the manufacturers have to reduce the inventory cost. Hence, the transport route using the Central-

Europe block train is more suitable to European automobile manufacturers. For the second category, reduction of the transport cost is the principal factor to be considered by the retail dealer. Therefore, sea transport is more suitable as the retail dealer can gain more benefits by reducing the storage costs during transport. Furthermore, the sea transport cost is much lower than that of road and land bridge transport.

Analysis

In the first case, the northeast of China auto parts multimodal transport case was introduced. The northeast of China inland waterway transport is not developed, so the choice of road transport and rail transport become especially important. Dalian is the only major container export port in the northeast of China, and all goods need transporting by a variety of transport combinations and methods to here, including ferry transport via the ports of Jinzhou, Dandong and Bayuquan.

Although the distance from Dalian to these three ports is very similar, there are differences in loading and unloading efficiency, information transmission speed and density of departures. The optimal choice is transport through the port of Bayuquan. For land-bridge transport from north-eastern China to Europe, because the northeast China central railway trains have been running for just a year, many countries customs clearance speeds are slow, coupled with high transport costs, many cargo owners are not, therefore, willing to choose this route. But for those goods with high value, land-bridge transport has big advantages if costs and interest on capital are included. In the second case, due to the rapid development of inland water transport using the Yangtze River and its low cost, many retailers are willing to choose sea transport in order to reduce stock. For those manufacturers, reducing the storage cost is very important. And the multimodal transport model using China - Europe trains along the Yangtze River is developing quickly. Thus manufacturers are willing to choose the land-bridge option which takes significantly less time than shipping.

Transport distance

The transport distance means the total length of the route from the starting point to the terminal. The transport route is always different according to the different transport means. Usually, a longer transport distance requires longer transport time as well as more transport cost. According to the "One Belt - One Road" strategy, the construction of the land-bridge transport route on the Silk Road economic belt mainly relies on three Eurasian land bridges, which represents full utilisation of the existing infrastructures for transport.

Transport cost

The multimodal transport process will generate multiple transport costs, such as: fixed transport costs, labour costs, fuel charges, handling charges and so on. However, the most influential part is the fixed transport cost which is divided into the fixed sea transport cost, fixed railway transport cost, fixed road transport cost and fixed air transport cost. The fixed costs are inescapable under normal conditions. Although multimodal transport theoretically uses a single rate, multimodal transport operators need to think about inescapable transport costs of the various modes when deciding on the route, thus maximising their benefit. Meanwhile, there are many countries with different transport cost structures along the Silk Road. It is therefore necessary to make section-by-section calculations of the transport costs, which will thus be more consistent with actual conditions.

Customs clearance

According to the statistics of China's Ministry of Commerce, handling processes at ports accounted for around 10-20% of the total transport time through the land-bridge transport before the development of "One Belt and One Road" strategy. Document and customs inspections account for 60% of the delay while the transfer of transport mode accounts for 40%. In 2015, customs clearance integration of the regions along the Silk Road economic belt in China was launched officially. Since then customs procedures in China has followed a uniform standard, which will eliminate 20-30% of the clearance cost. This has played an important role in promoting the interconnection of the countries and regions along the “One Belt and One Road” route.

Nodes
Transfer means changing from one transport mode to another mode. Usually, the transfer process will inevitably involve unloading and reloading of the container. During this process, the transport distance and especially the operating time of the node, as well as the waiting time, will affect the working performance. The main variations here are the transport time and transport cost. Because the reloading process will be influenced by resource allocation at the transfer station, weather conditions, transfer efficiency and other factors, the reloading time has considerable uncertainty. In the multimodal transport processes, the containers can be transferred easily and rapidly, and this has a direct impact on the time and cost of the multimodal transport chain.

Port throughput
Here, panel data embraces a range of inputs including transport and cargo-handling parameters, and demand drivers such as regional GDP and GDP per head. Transport nodes include container yards, freight train stations and ports. Taking Shanghai port as an example, the throughput of the port is mainly related to the city GDP, industrial structure, transport development policy and so on. Regions with higher economic output will have greater cargo volumes and greater demand for transport through the port. Economically developed areas have greater demand for consumer goods because of the higher income levels of local residents. The changes of traffic volume of other transport nodes will also affect the throughput of ports indirectly. The five-year data shows the impact of the city GDP and supply and demand of shipping markets on the throughput of Shanghai port.

GDP has a positive correlation with the throughput of the port, the city GDP has a great impact on its foreign trade, and the foreign trade volume of a city directly reflects the throughput of the port. Besides, Shanghai import and export trade is basically realized by sea transport, therefore, the total import and export volume is positively related to the throughput of the port. In recent years, as the number of container ships keeps increasing and the size of the ships keeps expanding, the container ships cannot be fully loaded. Therefore, as wharf construction cannot catch up with the growth rate of the container ships, the supply of transport is negatively correlated to the throughput of the port. This works in favour of the development of the landbridge routes.

Conclusion
This paper takes the modern Silk Road as the study area, considers the background of the One Belt - One Road strategy, constructs container multimodal transport model and networks, studies the transport routes along One Belt and One Road strategy, and adopts two real cases in order to make analysis close to reality. The main focus of this paper includes:

- The background to the One Belt - One Road strategy. The paper analyses the Silk Road’s multimodal transport systematically; it summarises the characteristics of the route for land-bridge transport and sea transport, highlights the characteristics of the Silk Road’s multimodal transport and analyses the main factors which influence multimodal transport against the background of the One Belt - One Road strategy.
- An analysis of the transport process, taking characteristics of land-bridge transport and sea transport into consideration. The paper is structured around an established cost model based on transport cost, time and distance respectively according to real cases. The transport node change is also considered.

The One Belt and One Road strategy is not an entity or a mechanism, in fact, the development of the strategy tends to form an open system. The development of the strategy needs the common effort of the economic, trade, policy and geographical environment. On the one hand, the construction of the One Belt and One Road strategy involves a number of countries. So, the national economy, transport and international policy will play a key role in the strategic development. On the other hand, transport is only a part of the strategy, and the development of the strategy must be consistent with the overall interests of some countries. Thus, the One Belt - One Road strategy is extremely complex, having a variety of impacts on the development of trans-continental container transport. The development of the

One Belt - One Road strategy cannot do without international trade as a precondition, or the building of transport routes or transport corridors which in turn need enough cargo to justify investment. Although the Silk Road has existed for a long time, historically the goods were exported to Europe mostly by sea transport due to the slow development of land transport options and especially the low cost of sea transport compared with the land-bridge option. Sea routes have become ever more competitive with the development of larger ships. Under competitive pressure, land bridge transport needs to improve its operating speeds, its custom clearance processes, and its transport efficiency. Land bridge transport also needs active cooperation from those ports on its transport routes, co-developing the multimodal transport system.

Since the One Belt - One Road strategy covers Asia, Europe and, indirectly, Africa, long transport distances lead to significant differences between routes in terms of transport time and costs. Moreover, every transport route or mode has its advantages and disadvantages Accordingly, various transport routes and modes are highly interchangeable with each other. Shippers may transport their goods to Europe either by sea transport or via the land bridge transport or by land bridge in combination with sea transport. Road transport has obvious time advantages, while maritime shipping has freight-cost advantages. Shippers select transport routes according to the characteristics of their goods (e.g., size, weight and value) and the consignees' requirements. Multiple transport modes and routes are available to any node of the transport network; the entire transport process is finished by selecting transport modes according to the nodes. Some of these transport routes come with insignificant differences in terms of transport time and costs, leading to high levels of switching between them.

Regarding multimodal container transport, transport time and costs are the primary measures for determining whether a certain path is the best one. When it comes to the determinants of transport time and costs, road infrastructure, customs clearance efficiency at the port and the unloading/reloading efficiency at the node, in addition to transport distances and rates, will affect both of them. Sino-European land bridge transport has received more support and policy incentives from the governments, leading to lower transport costs and hence affecting transport routes selection. Since it is still in its early stage of development, the China-Europe Railway route still has problems, such as incomplete transport infrastructure and support services along the route, cumbersome customs clearance, insufficient supply-demand matching, high overall transport cost and, in China, unfettered competition. For these problems to be solved, it is urgently necessary for the governments to enhance overall planning and coordination in order to promote the healthy development of the freight train service. To this end, the National Development and Reform Commission and China Railways are working with relevant government agencies/departments and local governments to steadily promote the China-Europe Railway service in a co-ordinated manner.

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AN OPTIMIZATION APPROACH FOR SCHEDULING FRESH FRUIT EXPORTING OPERATIONS WITH QUALITY LOSS DUE TO TRANSPORTATION AND HOLDING

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ABSTRACT
Purpose: The quality loss of fruit due to the mechanical injuries and the physiological change during storage and transportation is an important cause of downgrading and wastage of fruit exportation (5% to 60%). The objective of this paper is to propose the optimization approach for scheduling fresh fruit exporting operations which consider the cost of quality loss based on the above-mentioned cause.

Design/methodology/approach: The methodology is divided into 3 phase**.** Firstly, the damage cost due to mechanical injury**(**MI**)** and holding cost due to physiological change are estimated by using linear regression**.** Secondly, mathematical modelling of exportation costs for the exporter considering the damage and holding cost is developed to formulate objective functions**.** Lastly, solution spaces of models are analysed by numerical study to determine two decision variables**:** the quantity of fruit exported in each day and on hand inventory duration**.**

Findings: In case study of mangoesteen exportation, the damage and holding cost of fruit exportation can be considered as a linear function with time**.** This can be used to determine markdown policy with steeper discount and develop the mathematical model via linear regression approach to optimize scheduling fresh fruit exporting operations**.**

Practical implications: The model provides important improvement in profit and cost of fruit exportation**.** This improvement is more significant for the logistics exporter to make decision in part of export planning, choosing the appropriate distribution scheme, and mark down policy under uncertainty of demand**.** rate**.**

Originality/value:
This paper is a combination the cost of quality loss from MI and physiological change of fruit, which has appeared in single mathematical models**.** To the best of the authors' knowledge, no mathematical model has yet been proposed**.**

Keywords: Fruit exportation, Food Quality, Holding Cost, Perishable products, Transportation

Introduction
The management of fresh fruit distribution is distinct and more enormously complicated than the distribution of other foods because most of the fruits are highly perishable nature, variable to militate against simple solutions, rarely to give the best results in terms of preserving the quality of the crop, high fluctuations in demand and prices, increasing consumer concerns for food safety and dependence on climate conditions)Van der vorst and *et.al*, 2007 .(In the supply chain of fresh fruit, large quality losses)5 %to 60 (%are incurred between farm to fork .All partners have to a shared responsibility of minimizing quality losses to deliver high-quality products to the consumer which also they must be faced with the challenge of increasing its handling efficiency and minimizing post-harvest food losses .The quality losses of fruits or fruit spoilage refer to the decrease in edible food mass which is largely based on the subjective consumer evaluation of a complex of quality attribute)such as color, firmness, and appearance (which depended on the characteristics of product properties, and the social and economic back ground and their intended usage of the product .The losses of quality can be seen resulting from concerted action or action on either side of the major contributing factors that include MI, the natural decay of the fruit, and contamination by micro-organisms .Quality losses of fruit are not constant :the quality of a food changes

over time in various pattern depend on type order reaction which are usually modeled by means of a zero-,1st-, or 2nd-order reaction)Labuza,1984 and Saguy and Karel 1980 .(In general, the losses of food quality and affecting on cost of fruits are difficult to predict correctly, due to the range and dynamics of product characteristics, transport and storage conditions, supply limitation, and market demand .Over the years, there is a significant increase in research on modeling and optimization of perishable food supply chain system focusing on operational issues causing perishable food loss or waste .Most research refers to loss which is occurs at high rate in the production, transportation and inventory activities throughout the food supply chain with different mathematical tools, as shown inliterature . However, most of literature regarding quality loss in food supply chain management focuses on assessing food quality loss by considering only one factor that does not cover all major factors caused food spoilage .In practice, they cannot be applied to some produce which quality losses resulting from concerted action of several factor . The objective of this paper is to propose a quality losses assessment of fresh fruit and the optimization approach for scheduling fresh fruit exporting operations which consider the cost of quality loss based on all major factors caused spoilage.

In this note, we give mangosteen exported from Thailand to China as a case study. The note is organized as 3 phase. In phase 1, we show how one estimate the cost of quality loss from MI and the natural decay which are two major factors caused mangosteen spoilage. In phase 2, mathematical modelling of exportation costs for the exporter considering the cost of quality loss from phase 1 is developed to formulate objective functions. Finally, we present a numerical study to determine two decision variables: the quantity of fruit exported in each day and on hand inventory duration.

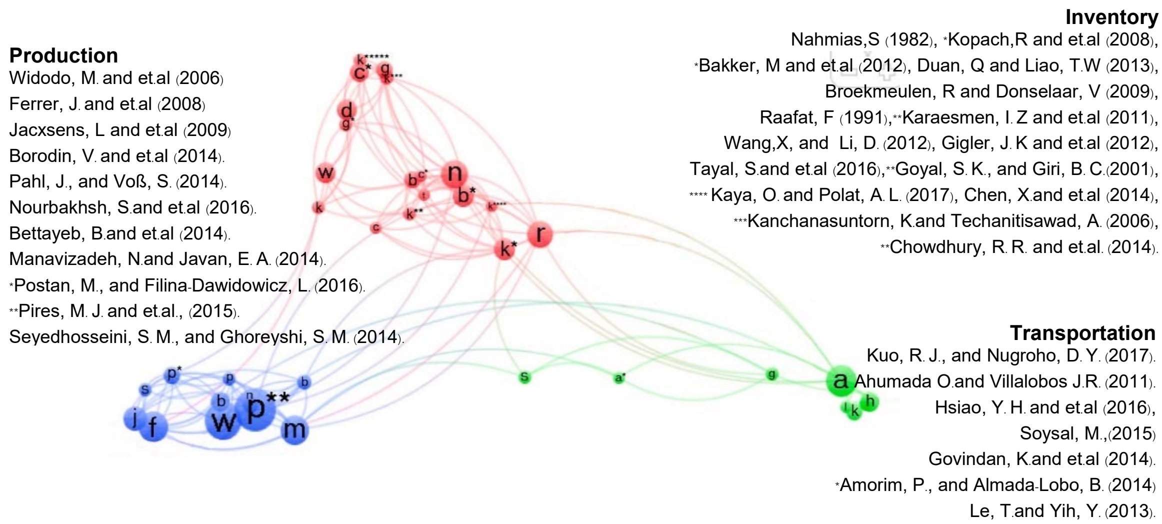

Figure 1: Research cluster of modeling and optimization for perishable food supply chain system
*Research cluster is analyzed by VOS viewer version 1.6.5

Estimating the cost of mechanical injury
The degree of fruit damage is not a static parameter but is a highly dynamic variable depending on the vibration level that fruits suffer during transport from farms to market, increasing the vibration frequency and acceleration increase the total percentage of damage to fruits. In Figure 2 [left], the mangosteens were simulated transportation condition in laboratory with various vibration level (Grm level) by the vibrator to study the relation of vibration level and the percentage of MI in fruit during handling and transportation (Damrongpol, K. 2016) Consider 10 Kg of mangosteen at maturity were packed in packaging system: non-returnable polypropylene box with internal dimension (33x44.5x16 cm) supported in both bottom and top with sponge (polyurethane), as a cushion system. The first period 0-A, the fruit is bruised by mechanical force but there are no discernible changes and the apparent quality stability. In the second period A-B (Grm level >1.0), the bruising of the fruit can be noticed and fruit quality is not acceptable by consumers. %MI of fruit per unit expresses a linear relationship with Grm level each route of transportation (*Gj*) that product have been received according to $\%FDj = a * Gj - c$, where a and c are

constant, which can be confirmed by the positive correlation coefficient value (r^2)of 0.9878. If we know the vibration level of transportation route, we can determine the percentage of fruit damage and cost of fruit damage per unit which varies according to route of transportation and material price (δ_{ij} = *PMi* %FDj*)/100, where *PMi* is material price at day of fruit exported, and also lead this cost of the fruit damage incorporated into model, as shown in Figure 2 [right].

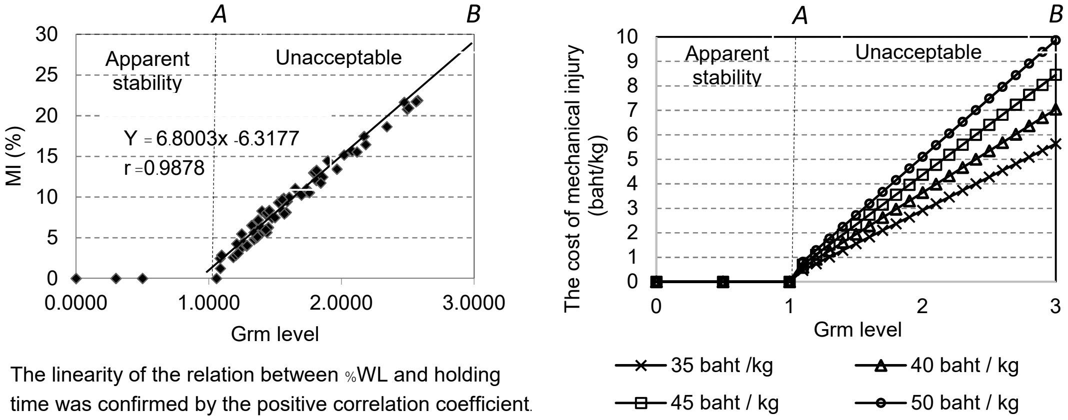

Figure 2: The relation of vibration level and % MI of mangosteen, [right] The relation of vibration level and the cost of MI in mangosteen at various material price.

Estimating the cost of natural decay

Fruit after harvest, they continue to respire, losing water through their skin .This moisture loss is most noticeable in fruits that contain large amounts of water, and over time the skin becomes flaccid and leathery .Moisture loss may also cause the fruit to shrink in size .**Error! Reference source not found.**]left [shown the example of zero-order reaction for weight loss of mangosteen)WL (at various holding time*) .Damrongpol, K .2016(

In period 0-A, the quality of fruit is stable and freshness loss of the fruit can be noticed by consumer .After that the fruit quality is not acceptable by consumers in period A-B% .WL of mangosteen can be considered as a linear function with holding time, according to %WL=1.1916t-0.1619)r^2 = 0.9872 (which can be applied by using linear least square regression to find cumulative holding cost of fruit per unit increasing with the time)ϖ_{ij}^k (and material price that fruit has been in transit and stored, according to ϖ_{ij}^k =η_i) Lj+k (– γ_i, where η_i and γ_i is constant value which they depend on material price each day) **Error! Reference source not found.**] right([

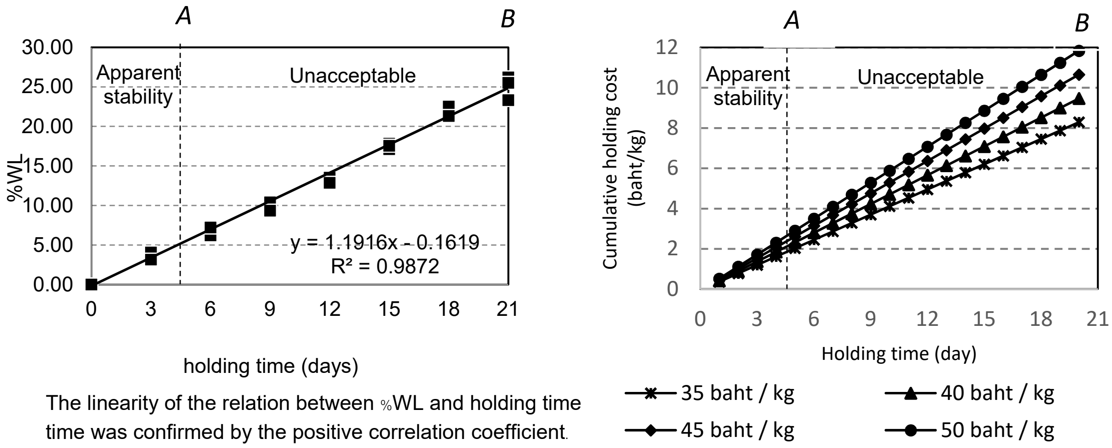

Figure 3 : [left] WL (%) mangosteen stored at 13°C/75%RH at various holding time, [right] the convex approximation for cumulative holding cost of mangosteen stored at 13°C/75%RH at various holding

Mathematical modeling

To develop the proposed model, we adopt assumptions and notation in the following Table 1, Table 2, and Table 3.

Decision variables	
r_i the revenue derived from the sale of export fruit in day *i* m_i the material handling cost of export fruit in day *i* *ci* the material cost of export fruit in day *i* *di* the transportation cost of export fruit in day *i* *bi* the communications and the others cost of fruit in day *i* h_i total storage cost of fruit in day *i* g_i the cost of MI of fruit due to handling and transportation in day *i* q_i the cost of WL of fruit in day *i* x_{ij} the quantity of fruit in day *i* that is exported by route *j*, and will be sold immediately at destination market.	y_{ij}^{k} the quantity of fruit in day *i* that is exported by route *j* and will stored for *k* days after the fruit is transported to the destination market. s_{ij} the quantity of fruit exported by route *j* that is sold immediately at destination market in day *i*. w_{ij} the quantity of fruit exported by route *j* in inventory that is sold in day *i* V_i the quantity of fruit feed in inventory *Ii* *the inventory level* in day i

Table 1 : Decision variables

Parameters	
ms_j the maximum storage of fruit each route S_i total fruit supply each day D_i total consumer demands each day CP_i the capacity of inventory SP_i selling price of fruit per unit each day MH the cost of material handling MPi the price of fruit material per unit each day TC_j transportation costs per unit for route j	CO the communications and the others cost of fruit per unit SC_k storage cost of reefer container per unit per day PP_i purchasing price of fruit material per unit at orchard each day L_j lead time of each route j

Table 2 : Parameters

Assumptions
1. Fixed product have deterministic shelf life 20 days after fruit harvested and the company has policy of holding time of fruit is not more than 10 days after fruit have been exported. 2. Shortage or backordering is allowed. 3. First – In- First- Out *(*FIFO*)* issuing policy is used 4. Product are perishable*:* they have to be produced, transported, stored and sold to retailer by 10 days in order to guarantee the final customer a product with a sufficient residual life.

Table 3: Assumptions

Based on the above assumptions a mathematical model, the design of the model is illustrated in Figure **.** 4 **.**We consider the supply chain of fruit exportation with one collector, multiple route of transportation, one inventory and one distribution center**)** whole sale market **.(**The fruit must be distributed direct from collector to distribution center by various export routes each day **.**In order to maximize total profit from sale to retailer each day, exporter need to decide to sell fruit as soon as the fruit is transported to destination market if the sell price of fruit at that time is high, and**/**or to store in reefer container to wait price increasing if the sell price of fruit at that time is low **.**

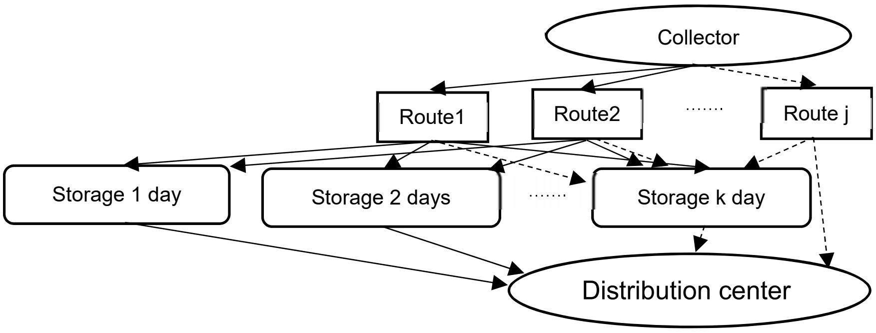

Figure 4 : Behavior of the model in a season of fruit exportation

We propose a LP model The LP model considering total revenue)r_i(, the total cost of fruit exportation, and quality loses, in which an exporter has to decide how many fruit to be exported to distribution center, which route of transportation, and transportation time **.**The objective of exporter is to optimize the scheduling fresh fruit exporting operations under maximize the net profit **)**NP **(**for fruit exporter which is expressed as the follow **:**

$$Maximize \quad NP = \sum_{i=1}^{n=1} r_i - \left[\sum_{i=1}^{n=1} m_i + \sum_{i=1}^{n=1} c_i + \sum_{i=1}^{n=1} d_i + \sum_{i=1}^{n=1} b_i + \sum_{i=1}^{n=1} h_i + \sum_{i=1}^{n=1} g_i + \sum_{i=1}^{n=1} q_i \right] \tag{1}$$

Subject to:

$$s_{i,j} = \begin{cases} 0 & : i < L_j + 1 \\ x^k{}_{(i-L_j),j} & : i \geq L_j + 1 \end{cases} \tag{2}$$

$$\sum_{i=1}^{n} \sum_{j=1}^{m} x_{i,j} = \sum_{j=1}^{n} \sum_{j=1}^{m} s_{i,j} \tag{3}$$

$$w_{i,j} = \begin{cases} 0 & : i \leq L_j + ms_j + k - 1] \\ \sum_{k=1}^{ms_j} y^k_{i-L_j-(ms-k+1),j} & : i > L_j + ms_j + k - 1 \end{cases} \tag{4}$$

$$\sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{o} y^k_{i,j} = \sum_{j=1}^{n} \sum_{j=1}^{m} w_{i,j} \tag{5}$$

$$S_i \geq \sum_{j=1}^{m} x_{i,j} + \sum_{j=1}^{n} \sum_{k=1}^{o} y^k_{ij} \tag{6}$$

$$D_i = \sum_{j=1}^{m} s_{ij} + \sum_{j=1}^{m} w_{ij} \tag{7}$$

$$CP_i \geq \sum_{j=1}^{n} \sum_{k=1}^{o} y^k_{ij} \tag{8}$$

$$r^k_{i,j} = \left[s_{i,j} + w^k_{i,k} \right] * SP_i \tag{9}$$

$$m_i = \left[\sum_{i=1}^{n} x_{i,j} + \sum_{i=1}^{n} y^k_{i,j} \right] * MH \tag{10}$$

$$c_i = \left[\sum_{j=1}^{m} x_{i,j} + \sum_{j=1}^{m} y^k_{i,j} \right] * MP_i \tag{11}$$

$$d_i = \left[\sum_{j=1}^{m} s_{i,j} * \sum_{j=1}^{m} w_{i,j} \right] * TC_j \tag{12}$$

$$b_i = \left[\sum_{i=1}^{n} x_{i,j} + \sum_{i=1}^{n} y^k_{i,j} \right] * CO \tag{13}$$

$$h_i = \sum_{j=1}^{m} \sum_{k=1}^{o} y^k_{ij} * SC_k \tag{14}$$

$$g_{i,} = \begin{cases} 0 & : L_j + k \leq 4 \\ \left(\sum_{j=1}^{m} x_{ij} + \sum_{j=1}^{m} \sum_{k=1}^{o} y^k_{ij} \right) * \delta_{ij} & : L_j + k > 4 \end{cases} \tag{15}$$

$$q_{i,} = \begin{cases} 0 & : L_j + k \le 4 \\ \sum_{j=1}^{m}\sum_{k=1}^{o} y_{ij}^{k} * \left(\eta_i * (\mathrm{L_j} + \mathrm{k}) - \gamma_{\mathrm{i}},\right) & : i > L_j + k > 4 \end{cases} \quad (16) \qquad V_{i,} = \begin{cases} 0 & : i \le L_j \\ \sum_{j=1}^{m}\sum_{k=1}^{o} y_{(i-L_j),j}^{k} & : i > L_j \end{cases} \quad (17)$$

$$I_{i,} = \begin{cases} 0 & : i = \{< Lj, 40\} \\ I_{(i-1)} + I_i - \sum_{j=1}^{m} w_{i,j} & : i \ge L_j \end{cases} \quad (18)$$

In (2), if $i \ge L_j$+1, the quantity of fruit is exported by without storage plan in day $i - L_j$ must be equal the quantity of fruit that is sold at arrival time in day i, while, if $I < L_j$+1, there are no fruit sold in market (s_{ij} = 0), due to being transportation and no fruit in stock. In (3), to make sure that the quantity of fruit exported by without storage plan in day i will have to be sold out at arrival time. In (4), if $i > L_j$+ms_j+k-1, the quantity of fruit in inventory sold at day i (w_{ij}) must be equal the quantity of fruit that is exported in day $i - L_j$ and stored for k days after the fruit is transported to the destination market, while if $i < Lj$+ms+k-1, there are no fruit in inventory sold due to being transportation. In (5), to make sure that all fruit in inventory will have to be sold out. In (6), total quantity of export fruit each day cannot be greater than the fruit supply each day. In (7), total quantity of export fruit that was sold each day cannot be greater than consumer demands each day. In (8), available total storage space is limited. In (9), the revenue of fruit exportation each day is calculated by the summation of the revenue from fruit sales immediately arrives at destination market (s_{ij}) and the revenue from sale of fruits stored in inventory (w_{jj}). To compute total logistics costs, we formulate the exporter's expected total cost based on logistics activities of fruit farmers consisting of material handling cost in eq.10, the material cost in eq.11, the transportation cost in eq.12, the communications and the others cost in eq.13, and storage cost in eq.14, respectively.

To set mark down policy that corresponds to the change of actual cumulative holding cost over time of transportation and storage (g_i+w_i), the cost of MI and WL were formulated in eq.15 – 16. In (15), if holding time (L_j+k) >4 days, the cost of MI will be considered, while if L_j+k ≤ 4 days, the quality appearance is stable, and also the cost of MI = 0. In (16), if holding time (Lj+k) > 4 days, the cost of WL per unit which is given as a function with holding time (Lj+k) and material price each day will be considered, while if Lj+k ≤ 4 days, the quality appearance is stable, and the cost of WL = 0). To be able to control the storage of fruit in inventory, we formulate eq.17 and eq. 18 which represent the quantity of fruit input in inventory (*Vi*) and the instantaneous value of fruit in inventory (*Ii*). In (17), if $i > L_j$, the quantity of fruit input in inventory each day must be equal the summation of y_{ij}^{k} which arrived at destination market, while if $i \le L_j$, there are no fruit stored in inventory due to being transportation. In (18), if $i > Lj$, the instantaneous value of fruit in inventory is equal to the initial value of the inventory on previous day (I_{i-1}) plus the quantity of fruit input in inventory that day i minus the quantity fruit in inventory that will be sold at that day i, while if $i \le L_j$, there are no fruit stored in inventory due to being transportation.

Numerical study

In this section, we present a numerical study based on historical data of mangosteen exportation from Thailand to China. We choose normal pattern of demand rate (SC1) to compare with two different patterns of demand rate (SC2-SC3), as shown in **Error! Reference source not found.** In SC1, we give the high demand rate at two periods of seasonal time. At the first period, the demand rate is high because the total quantity of mangosteen and the other seasonal fruits of China released on market at that time are low. At the second period, fruit consumption increase again due to the effect of Chinese festival which stimulate higher customer demand. In SC2 and SC3, we consider high demand rate of consumer at beginning season and at end of season respectively. To compare net profit and cost of exportation each scenario in the same situation, all simulation data patterns are settled the total quantity of fruit supply at 800ctn and fruit demand at 200ctn with three replications.We fix three parameters of exportation route in our analysis: delivery time (2 and 4 days), delivery charge (90,000 and 50,000 baht/ctn and δ_j (route1 = 0.02 and route2 = 0.04), which we justify as the follows. A completely randomized design was used with all scenarios. All decision variable and cost in each scenario were subjected to analysis of variance (ANOVA) and mean comparisons were carried out by Duncan's multiple range testing (DMRT) IBM ILOG CPLEX Optimizer 12.7.1 is used to solve the optimization models with various constraints and variables.

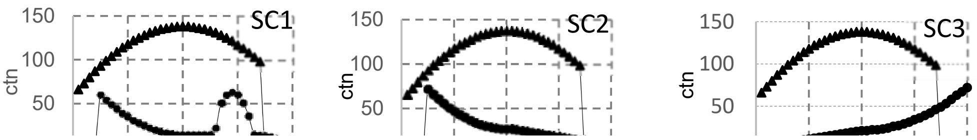

Figure 1 simulations with various levels of demand rate SC1: normal demand rate, SC2: high demand rate at early season, SC3: high demand rate at end of season

Simulation results

This section presents result from numerical analysis to develop insight into the benefit of the for scheduling fresh fruit exportation with quality loss due to transportation and holding. The primary focus of this section is two folds. Firstly, we show that the proposed model provides significant improvement in part of export planning and choosing the appropriate distribution scheme to maximize net profit of fruit exportation under various situation. Secondly, we demonstrate the effect of demand rate uncertainty on the inventory operation, holding cost and mark down policy. In considering the effect of demand rate on net profit, we found that SC2 have the highest net profit, whereas the net profit of SC3 is the least. This result can be seen that as demand rate at the end of season is getting higher and supply rate for SC3 is getting lower, the fruit needs to be stored up to meet such demand under limited supplies, as shown in Table 4 . This affect not only the increase of the cost of quality loss and storage cost, but also the decrease of total net profit, when we compare to SC1. To maximize the net profit of fruit exportation, under the demand rate change, choosing shorter transit routes in both x1 and y1 is the way to achieve the desired results. To show the relationship of the net profit and the appropriate distribution scheme, we found that SC1 and SC2 have total value of x more than total value of y ($p < 0{,}05$), while SC3 is opposite. This result can be described that the proposed model tries to find the maximum profit and the minimum cost of storage by choosing to sell the fruit as soon as it arrives at destination market, rather than to store it in reefer container, while in SC3, fruit needs to be store for sale during the off-season. Furthermore, we observe that there is a statistically significant interaction between value of x1 and net profit, while the main effect of the other decision variables on net profit was not significant. This can be indicated that choosing shorter transit routes have the effect on the increment of net profit.

SC	decision variable				Cost (bath)			Net profit**
					quality loss of fruit		Storage	
	x_1**	x_2	y_1	y_2	MI	WL		
1	124b	33a	5c	38a	7,925,217a	10,848,000b	72,000b	323,914,783b
2	171a	11c	18b	0b	7,462,633b	7,864,350c	14,400c	361,997,367a
3	60c	15b	125a	0b	5,111,972c	12,095,700a	100,000a	238,388,028d

Table 4: Summary statistics for the quantity of fruit exported, net profit, and cost in each scenario

*For all decision variable and cost of exportation, a, b different letters within a column indicate significantly different ($P < 0.05$) ** There are interaction between these factors

To study the effect of demand rate uncertainty on the inventory operation, we consider the cost of total quality loss from MI and WL, and storage cost of fruit exportation in each scenario in table 6. We found that SC3 has the highest quality loss of fruit from WL and storage cost, while SC1 is lower, and SC2 has the lowest. The results are consistent with total inventory level of fruit (y), which found that SC3 has the highest inventory level compared to other SC. The appearance of quality loss depends on holding time. In the case of sc3, the fruit must be stored to meet the demand of the consumer at the end of the season, and also the exporters need to consider mark down policy that corresponds to the change of actual cumulative holding cost over time of transportation and storage.

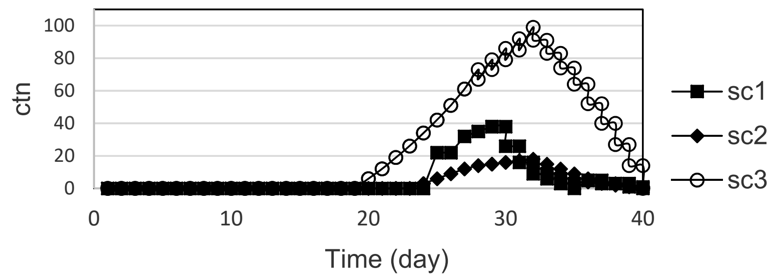

Figure 2: Inventory level of fruit in each day

Concluding remark

The vibration level that fruits suffer during handling and transport from farms to market and holding time due to delivery and storage can be considered as a linear function with the cumulative cost of quality loss due to MI and WL of fruit**.** This can be used to determine the number of markdown, **%** discount in each period of holding time, and lead it to incorporate into mathematical model via linear regression approach to optimize scheduling fresh fruit exporting operations**.** The proposed model can help exporter to prevent unnecessary quality losses of fruit and improve in profit and cost of fruit exportation throughout the supply chain. This modification is more significant not only for the logistics exporter can make decision in part of export planning, choosing the appropriate distribution scheme, and mark down policy under uncertainty of supply and demand rate but also the customers can buy fruit at reasonable price that match the actual quality of the fruit versus customer demand ratio at that time. However, this paper considered only a single product and quality loss in the distribution network**.** Future work could therefore include the regard of multiple products and interactions between the different products**.**

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ANALYSIS OF THE POTENTIAL MARKET FOR THE IMPLEMENTATION OF HYDROGEN SYSTEMS (ORH_2) IN MÉXICO

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ABSTRACT

Purpose: 27.9% of the energy produced worldwide is used in the transport sector. Consequently, the large amounts of CO_2 emitted to the atmosphere by the use of motor vehicles around the world, is one of the main causes of global warming. As a solution to this The Intergovernmental Panel on Climate Change estimates that by 2050 it may be possible for 77% of energy requirements to be replaced by renewable energy, which include the use of hydrogen. In the search to implement the development of technologies of high environmental impact, it has been selected the systems of in situ generation of hydrogen called Reactor Oxyhydrogen (ROH_2), as product in increasing demand and opportunity to develop and position this innovative technology within the next five years, so that in this research a potential market analysis is presented in order to know the feasibility for the commercialization of ROH_2 in Mexico.

Design/Methodology/Approach: As part of Phase I of the Integral Model for New Product (IMDPN), it was necessary to identify the potential market to determine the beginnings of this analysis, through a comprehensive review of scientific literature and the development of surveys as primary sources of research.

Findings: As a result of this study it was found that the demand for alternative energies, continues to increase due to the society's need to reduce the emission of pollutants to the environment. According to the results obtained from the surveys, 88% of the people answered that, they could buy the product, which means a great acceptance of the product of society. On the other hand, it is detected the need to obtain more financing in order to conclude with the stage of testing and adaptation of the product to accelerate the insertion of this technology to the market.

Originality: Research on the use of hydrogen energy is widespread, however, in Mexico, its share of the current energy system remains low relative to other similar sources of renewable energy. According to the information obtained, on the supply and demand of hydrogen, its presence is significant in some countries of the European Union, the United States and Japan. So, to detect a niche market in Mexico, is essential to create a business model and a logistics appropriate to the Society.

Keywords: Hydrogen, Marketing, Business Model, Transport Sector

Introduction

The demand for fossil fuels is increasing every day around the world, as a consequence has generated its exhaustion. This is one of the reasons why scientific research and technological development of alternative energies that can be used as complementary energy systems is important. Among a variety of resources, hydrogen is one of the most promising options to be used as an energy vector, in addition to its physical and chemical properties [1]

Despite its unique characteristics, the use of hydrogen as a fuel has not been promoted, especially in developing countries. In contrast, in some countries in Europe, in addition to the United States, a large infrastructure and projects on this technology [2]. On the other hand, in countries like Brazil, Argentina and Australia, they have published long-term projections on economic benefits, through the use of hydrogen as fuel. According to these projections, a rapid introduction of Hydrogen would accelerate the creation of a Hydrogen economy. As a result, this article highlights the strong need to implement and extend the use of H2 in Mexico, with the purpose of generating economic progress both in society as well as in the scientific community. There are different ways to promote the use of hydrogen, such as the internet and the mass media, but first, the development of an Oxyhydrogen reactor as a functional product is necessary for the generation and use of H2. This product should be affordable and long lasting. In addition, they have to be carefully tested to ensure they can work under safe conditions, be competitive and represent a real alternative to reduce gasoline use and CO2 emissions. The introduction of a quality Oxyhydrogen reactor could be the key to opening up a new and unexplored market that could generate substantial benefits [3-6]. For this reason, a multidisciplinary group made up of students of manufacturing engineering and automotive engineering in collaboration with the Escuela Superior de Ingeniería Química e Industrias Extractivas y la Escuela Superior de Ingeniería Mecánica y Eléctrica Unidad Azcapotzalco del Instituto Politécnico Nacional in Mexico are developing a system which, through alkaline electrolysis, generates a mixture of hydrogen and oxygen (namely: Oxyhydrogen Gas), which is added at the entrance of the air of an internal combustion engine, with the intention of enriching the mixture Air-gasoline up to 15%. This is not the first attempt to achieve this goal [6-8]. This indicates that it is very important to introduce this product in the Mexican market. To achieve this objective, as a first step the market, the quantity of products to be supplied and the demand for the product [9] should be investigated. In that sense the preliminary results of hydrogen demand and supply in Mexico indicate that there is a great opportunity to commercialize hydrogen energy, at low cost. Meanwhile, the scientific community involved in this topic, should promote the use of hydrogen as a source of energy.

Development of market research

This research has been developed based on the foundations Integral Model of the New Product (IMDNP) as an initial part for the development of this new technology. The IMDNP consists of four phases:

1. Phase I- Market-Retro feeding. The customer emerges as the origin
2. Phase II - Product
3. Phase III- Process
4. Phase IV – Organization

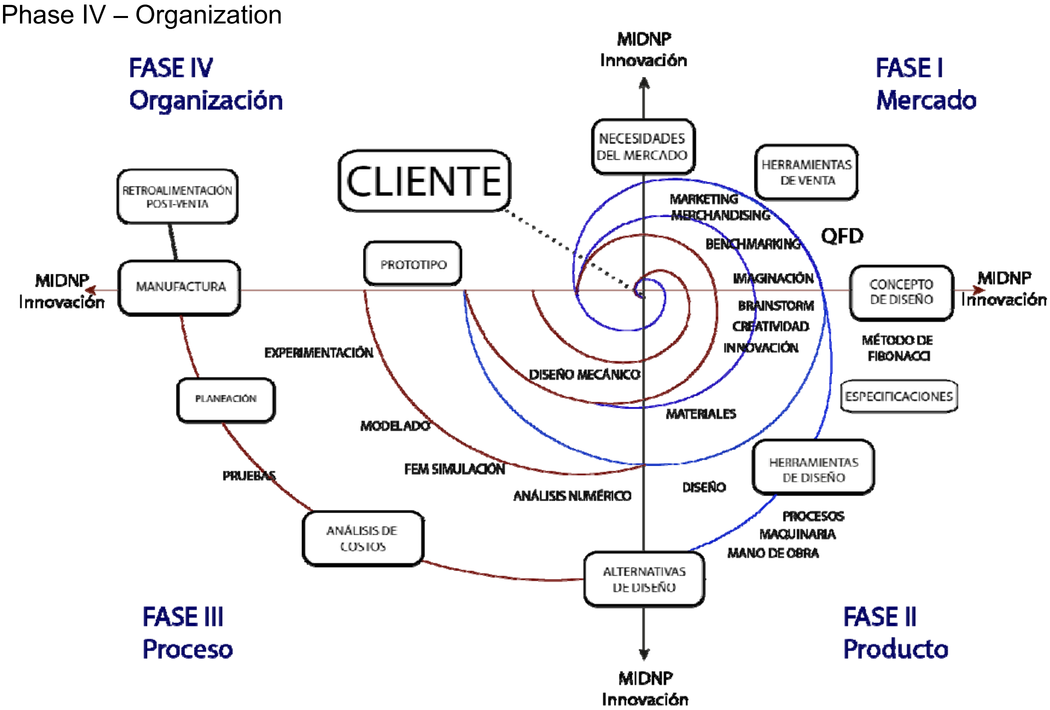

Figure. 1. Integral Model for design of the New Products (IMDNP)

These phases are cyclical and culminate in a feedback of each of them for their continuous improvement. In Figure 2, it is presented how these Phases represent the backbone of the Integral Model for the Design of New Products, where, Phase I includes the customer and the need of the market as the origin. It covers the study of the market and sales through tools such as marketing and benchmarking, with the aim of analyzing the environment of a new product.

Phase II is the conceptual development of the design, based on the results of the previous Phase, the client's requirements and specifications are analyzed, so the QFD methodology is applied, it is used because it has proven to be a very effective tool in customer analysis requirements with respect to the company's infrastructure. Once the requirements of the product are obtained, the creative part is to develop the concept of design, where imagination and creativity are extremely important. These steps involve a holistic and sustainable design as the environment requires ecological awareness in the generation of new products. Every day consumers are more demanding and more concerned about the preservation of land, so competition is stronger [35] Within Phase I, the market analysis is proposed, Figure 2 shows the steps of the methodology suggested by Baca [9], which is used to elaborate the market study.

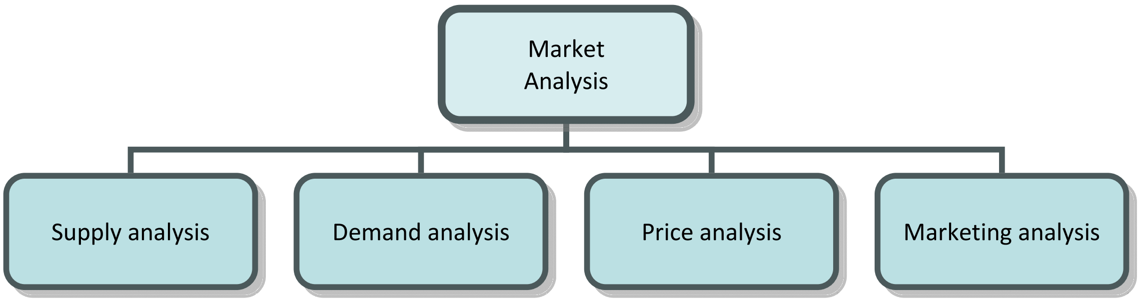

Figure. 2. Methodology for market research [9]

The present investigation begins by collecting all the information available in secondary sources related to the historical data of the supply as well as the demand in Mexico. Although there is not enough information on this topic. Consequently it was necessary to design a survey to know the opinion of potential customers.

Results

108 people were consulted, of the total sample, 62% were men and 38 were women. The question was asked about the gasoline expense that the potential customer makes weekly. Trends are depicted in Figure 2. The amount of money that 65% of respondents pay weekly for gasoline is between $ 300 and $ 500. So users can safely infer that an electrolysis system that generates more hydrogen is necessary and the return on investment happens quickly. Another question was about the number of cylinders of the car engine, to calculate the average possible size and cost of the alkaline electrolyzer. Most respondents responded that they have their own four-cylinder car.

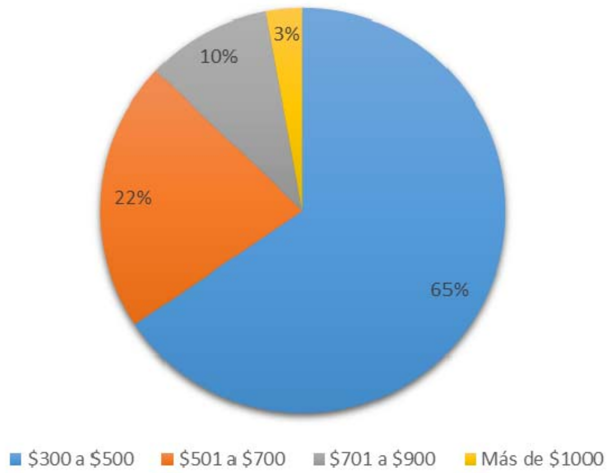

Figure. 3. Weekly Gasoline Spending

The fourth question is about the perception of hydrogen as fuel and testing fuel economy with hydrogen under safe and environmentally friendly conditions. Table 1 shows how interesting this idea seems to people.

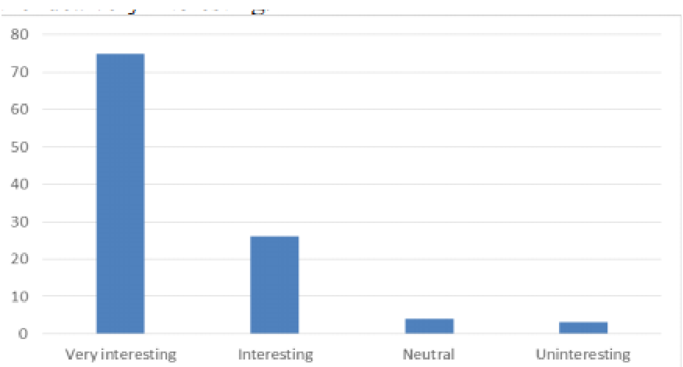

Table 1. Perception of the use of hydrogen mixed with fuel under safe and environmentally friendly conditions

The fifth question is very important, since it allows us to know about; Yes or no, people would invest in an electrolysis system. The responses were very satisfactory stating that 89% of people could probably invest in an electrolysis system, as long as they can save up to 11% gas, as shown in Figure 4.

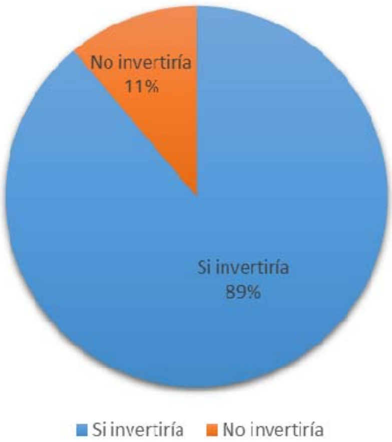

Figure. 4. Probability of investment in an electrolysis system

Question number six was designed to determine which aspects are most important when purchasing this type of product, the most important factors being the price and percentage of gasoline saved. Other factors that people consider important to acquire this device is the cost-benefit ratio.

The possibility of using hydrogen energy for economic and environmental benefits should be widely disseminated. In the seventh questionnaire question, people were asked how they would prefer to receive information about an Oxyhydrogen generator. The answers are clearly shown in Figure 5, where it is easy to see that the internet is the preferred way to receive this type of information. In this question the respondents could also choose more than one reference, with the intention of knowing the best way to know about the reactors Oxyhydrogen.

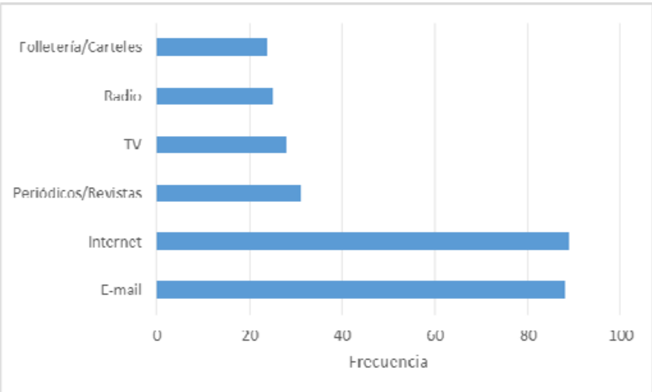

Table 2. Preferred media for receiving information on hydrogen and electrolysis systems

The eighth question showed, as shown in Figure 5, the price that people are willing to pay for the product mentioned. Most of them could pay on average $ 8000.00 for it, which shows the importance of optimizing the model to lower the price of the electrolysis system, without sacrificing quality and benefits for developers. Price ranges were calculated based on the functional prototype developed.

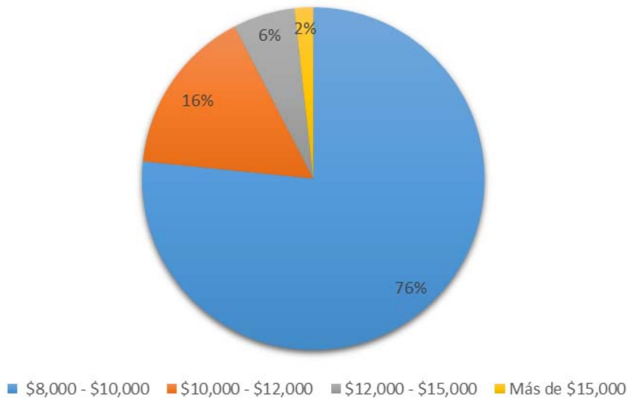

Figure 5. Price that the consumer could afford to pay for an Oxyhydrogen reactor

Finally, question 9 aims to know directly whether or not the consumer would buy the product. This question has only three options: yes, immediately, yes, after a while, and no, I might not buy it. Fortunately, 93% of people answered that they could buy the product, but 73% would expect it to be introduced to the market. As a consequence, it is essential to ensure the reliability of this technological product and as mentioned, to widely and actively disseminate the great advantage of the use of hydrogen to bring about a rapid introduction in the market.

Conclusion

Derived from the results obtained, the introduction of hydrogen in the market could be accepted by the company. This is the reason for the strong need to extend the use of hydrogen as a safe or complementary fuel. The first approach to people's preferences, allows us to know the main characteristics that a product should possess to succeed in the market: price and percentage of gasoline saved, but also, that the product is friendly to the environment and easy to use. This study also shows that the best way to advertise is online, in contrast to the preconceived idea that the best medium is television. As is well known, it is much cheaper to start with an internet advertising campaign instead of radio or television. As the surveys show, the optimization of the Oxyhydrogen system is crucial to reduce the sale price, due to all those involved in innovation processes (researchers, state and society [5]) that could have benefits of hydrogen energy. In sum, there is considerable market potential for Oxyhydrogen reactors in Mexico, and the scientific community has to develop products that are competitively priced and work under high safety standards.

Acknowledgements

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APPLICATION OF LOCATION ROUTING PROBLEM USING SPATIAL DATA ON FOOD DISTRIBUTION AND EVACUATION OF GRESIK FLOOD DISASTER

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Abstract
In recent years, humanitarian logistics has attracted much attention due have contributed a lot in helping and saving human life. In this research will be developed mathematical model of Location Routing Problem that applied using spatial data for flood disaster in Gresik, East Java, Indonesia. The purpose of the model to be developed in this research, is to minimize the time of sending aid to the victim by determining the most efficient location of aid post and the route of the food distribution. The vehicle that used, must be matched with the real condition. Determination of the location of post and route of vehicle decided by the number of victims based on the location of the house, travel time, the number of people and the amount of aid needs. The complexity of the problem will be solved using metaheuristic method. The algorithm will be developed into a user-friendly web-based application that integrated with Spatial Data on Google Maps API to obtain more accurate data on disaster location. Therefore, at the end of the research is expected to be able to answer the challenge of humanitarian logistics for flood disaster that occurred in Gresik. This will be shown in the form of application that can be used by government to facilitate the distribution of logistic aid.

Introduction

In recent years an increase in the number of natural disasters and man-made disasters has caused damage in many places and cost many human victims of injuries, starvation to death (Nathan and Gerald, 2012). A disaster can be categorized as a natural disaster when the disaster occurs in an area that has a population and leads to destruction of local infrastructure and causes the population to diminish and suffer (Costaa et al., 2012). Like the earthquake that occurred in Haiti in 2010 and the earthquake / tsunami and nuclear disaster that occurred in Japan in 2011, these disasters show the vulnerability of developed countries as well as emerging countries to disaster (Nathan and Gerald, 2012). Therefore, a good response to the possibilities of the disaster that will occur and also the response to the disaster that has occurred. A possible response to the disaster will be by undertaking plans related to the anticipation, mitigation, and management of the consequences that may be caused by the disaster. While the response to the disaster that has occurred is related to the response to the current situation that occurred in the disaster area and action related to the situation. Humanitarian operations are indispensable in situations in pre-disaster, during disaster and post-disaster. Humanitarian operations include saving the wounded, collecting corpses, allocating resources, providing and organizing the provision of food, shelter, medical care, restoring transportation access and so on. These humanitarian operations must be performed effectively and efficiently as they relate to human safety. The field that studies matters related to humanitarian operations is the humanitarian supply chain.

Humanitarian supply chain is different from commercial supply chain. In the corner of the supply chain the supply chain connects the source of the supply (supplier) to the owners of demand (end customer). The main purpose of the supply chain is to deliver the right amount of products, the right time and the right location (Chandraprakaikul, 2010). The supply chain consists of all activities and processes related to the flow and transformation of finished goods from raw materials to end users (Beamon and Bacik, 2008). Meanwhile, the humanitarian supply chain is related to the supply flow through the relief chain from donation to the consumer. The difference between commercial supply chain and humanitarian supply chain is described in Table 1.

Chandraprakaikul (2010) says that Oloruntoba and Gray (2006) in his journal explain that humanitarian supply chains tend to be unstable. Thus, coordination and management of the disaster supply chain is urgently needed and should be within the humanitarian supply chain. Goals, revenue sources and performance measures of the humanitarian and commercial supply chain have distinct differences. Humanitarians do not have specific profit targets and sources of funding come from governments and donors. The goal of a humanitarian supply chain is to respond to multiple interventions in the shortest possible time in a short-time frame.

Topic	Commercial SCM	Humanitarian SCM
Main Objective	Maximize profit	Save lives and help beneficiaries
Demand Pattern	Fairly stable and can be predicted with forecasting techniques	irregular with respect to quantty, time and place. Demand is estimated within the first hours of response
Supply Pattern	mostly predictable	Cash is donated for procurement. Unsolicited donations and in-kind donations need sorting, prioritizing to decrease bottlenecks
Flow Type	commercial products	resources like evacuation vehicles, people, shelter, food, hygiene kits, etc
Lead Time	mostly predetermined	aaproximately zero lead time, demand is needed immediately
Delivery network structure	established techniques to find the number and locations of warehouses, distribution centres	Ad hoc distribution facilities or demand nodes, dynamic netwowrk structure
Inventory control	safety stocks for certain service levels can be found easily when demand and supply patterns is given	unpredictable demand pattern makes inventory control challenging. Prepositioned inventories are usually insufficient
Technology and information systems	highly developed technology is used with commercial software packages	Less technology is used, few software packages that can record and track logistics data. Data network is non-existent
Performance measurement method	based on standard supply chain metricks	Time to respond the disaster, fill rate, percentage of demand supplied fully, meeting donor expectation
Equipments and vehicles	ordinary trucks, vehicles and forklifts	robust equipment are needed to be mounted and demounted easily
Human Resources	commercial SCM is now a respected careed path (Thomas, 2003)	High employee-turnover, based on voluntary staftt, harsh physical and psychological environment
Stakeholders	Shareholders, customers and suppliers	Donors, governments, military, NGOs, beneficiaries, United Nations, etc

Table 1: Perbandingan antara Commercial dan Humanitarian Supply Chain Management (Ertem et.al, 2010)

In this research will be made web-based application of Location Routing Problem for flood disaster case in Gresik regency. According to the official site of Gresik regency government, some areas in Gresik Regency have the potential to experience annual floods such as Benjeng, Cerme, and Balungpanggang. The relief vehicles will take aid in the form of food and medicines in the donation post and then distribute it to aid posts in several sub-districts. Assistance to be distributed to relief posts consists of many types of goods. The amount of each type of goods distributed depends on the number of victims by age and sex in the destination aid post. So did not rule out every aid vehicle distribute the type of goods with the same amount. If a victim has to be moved to a safer place or hospital then a relief vehicle will take the victim to the destination. The purpose of the model to be developed in this research is to minimize the time of delivery of assistance to the victim, so as to minimize the response time of handling the flood victims and maximize the number of victim handling in the existing relief facility with the constraints that have been determined. Determination of the location of the post and the route of the relief vehicle considers the number of casualties and assistance needed based on the travel time of the relief delivery region. Because the combination is complex, then in this research will be developed Simulated Annealing (SA) algorithm which is metaheuristic method. The algorithm will be developed into a user friendly application and integrated with Spatial Data from the Google Maps API to obtain more accurate data on disaster locations. So hopefully at the end of this research will be obtained a Multi Products Location Routing Problem application integrated with Google Maps that provide results in accordance with actual conditions and able to answer the challenges of humanitarian logistics for floods that occurred in Gresik.

Literature Review

Routing Problem in Humanitarian Logistics

Last Mile Distribution Problem (LMDP) is the final stage of the humanitarian relief chain. This is related to the delivery of relief supplies from local distribution (LDCs) to recipients or victims from affected areas (Beamon et.al, 2008). The research conducted by Beamon et al. 2008 is to allocate relief supplies to LDCs that lie between demand locations and determine delivery schedules for each vehicle through planning horizon based on supply, vehicle capacity and delivery time in order to minimize transportation costs and maximization benefits to aid recipients. However, this research still requires development for problems with more complex conditions. Ozdamar and Demir (2011) conducted research also related to this issue however, not only the problem of distribution problem but also the pick-up problem. So that not only distribute relief supplies but also take into account the ways of evacuation of victims both in terms of routes, schedules and capacity of the vehicle. Azimi et.al (2011) conducted a study which was a generalization of the covering tour problem that focused on determining the location of satellite distribution centers (SDCs) so that they could reach the optimal distance either by refugees, vehicles from the depots that supply relief supplies using vehicles and capacities which is diverse. Multi-start heuristic used in this study resulted in high quality and realistic solutions in adequate computation time. Campos et.al (2012) created a heuristic algorithm model that can generate 2 evacuation routes with minimal travel time and minimization of transport network only. Chang et.al (2007) conducted a study related to the model against flood prevention. In principle not much different from similar research. However, this study in addition to using stochastic programming but also combine with geographical information system (GIS). Rottkemper et.al (2011) makes the transshipment model for the distribution and relocation of inventory in the uncertainty state with the objective of minimizing unsatisfied demand and operational cost. This study takes account on the penalty cost resulting from unsatisfied demand. Wohlgemuth et.al (2012) examines the related activities of pick up and delivery problem (PDP). Research aims to find solutions related to PDP problems by avoiding delay and increasing utilization of equipment. However, this study only focuses on relief goods.

Furthermore, Huanga et.al (2011) conducted a study related to the formulation of efficacy and equity and showed that there is a significant difference between solutions focusing on efficiency and equity and focusing on traditional commercial concern of efficiency. Research conducted by Hamedia et. al (2012) focuses on reliable routing and scheduling of humanitarian supplies with time-dependent networks. Sugiarto et al (2015) conducted facility research for flood disaster in Gresik Regency. In this research, GIS has not been used as a support tool so that the data obtained is more accurate so that the depot specified can really meet the needs of disaster victims.

Location Routing in Humanitarian Logistics

Problems relating to the determination of the location of the supply goods so that it can optimally reach out and can distribute the aid effectively and efficiently in operations - humanitarian operations into a new field of research from the field of humanitarian supply chain which is different from the commercial supply chain. Such as research conducted OnurMete et.al (2009) that do the stochastic optimization approach to the problem warehousing and distribution of medical supplies for disaster. Stochastic programming determines the optimal warehouse location at the inventory level in the first stage. While in the second phase of the determination of transportation plans which are then converted into optimal vehicle route plan. Galindo and Batta (2012) conduct research related to the determination of the location of supply in hurricane disasters. An interesting point in the study is to include considerations regarding the locations of potential supplies that may be damaged. Thus, it is not only to determine the location but also to estimate the supply locations that will be affected by the hurricane. Spirit et.al (2013) conducts research that is still related to the determination of the location, ie warehouse. This study determines the factors that influence the selection of warehouse locations. The results of this study indicate that cooperation attribute is the most important-factor in the selection of the location of the warehouse in the humanitarian supply chain.

Simulated Annealing

Simulated Annealing (SA) is one of the metaheuristic methods often used to solve both discrete and continuous combinatorial problems (Gandreau and Potvin, 2010). Tavakkoli-Moghaddam et al. (2006) and Van Breedam (1995) used SA to complete the Capacitated Vehicle Routing Problem (CVRP) and VRP. Yu et al., (2010) uses SA to break another variant of VRP, the Capacitated Location Routing Problem (CLRP). This shows that SA provides a better solution than any other algorithm. SA has been used extensively in solving VRP problems, because SA has some interesting advantages such as the ability to handle highly nonlinear models, chaotic and noisy data and data that have many constraints. SA has been successfully applied in complex combinatorial optimization problems (Van Breedam, 1995; Yu et al., 2010). In addition, SA is one of the meta-heuristic methods that have successfully solved some VRPs (Alfa et al., 1991; Kuo, 2010; Lin et al., 2006; Van Breedam, 1995; Xiao et al., 2012).

Location Selection Requirement

Humanitarian logistics is defined as an effective and efficient planning, implementation, and control process from the relief center to the disaster site with the aim of reducing the suffering of disaster victims (Thomas & Kopczak [3]). Meanwhile, according to the Regulation of the Head of National Disaster Management Agency (BNPB) Number 14 of 2010 (BNPB, 2010), in determining the location of the most appropriate depot to cope with disasters are:

1. A large enough space that can accommodate several tents
2. Near to the main access road entering the disaster area
3. Near to the evacuation location
4. Location safe and free from disaster threats.

In this research we define the location is a place which has large yard and safe area. Therefore, we specify the location candidate or suggestion from Google API are worship place, village meeting hall, front yard of housing or esplanade.

Model Formulation

The formulation of this problem is using linear programming in model implementation the location of the postal allocation or aid depot has been used in the discussion (Kusumastuti, Wibowo, and Insanita) regarding the location of the facility aid of flood victims in Kampung Melayu, Jakarta East by using mathematical models. Model the location of this relief facility has some of the assumptions used. Besides it is stipulated in the budget of available fees, help requests, time periods, and more which will be described in the mathematical model as following.

$$\max \sum_{i=1} y_i a_i \qquad (1)$$

$$s.t \sum_{i=1} x_j \leq y_i \qquad (2)$$

$$\sum_{j \in J} x_j fv_j \leq bv \qquad (3)$$

The notations of the mathematical model are as following:
i : Request help materials on site evacuation
j : Potential location for relief facilities
t : Period of time
t_{max} : Maximum service time
x_j : 1, [if facility can be located for locationj] 0, [if not]
y_i : 1, [if request for help in location i can filled] 0, [if not]
a_i : Estimated number of casualties on site demand i
bv : Budget costs
fv : Fixed costs
vf : Maximum number of places the facility can established

Mathematical model of location determination of annual flood disaster relief post in Gresik Regency, especially in Sub-district of Benjeng and Kecamatan Cerme limited by some constraints. This has been done by Sugiarto et al (2015) The constraints are the constraints of vehicles, time, and the number of requests for assistance. This mathematical model is a development of model by Sugiarto et al (2015). This formulation has a purpose function to minimize delivery time which will be explained as follows.

$\min \sum_{i=1}^{n} t_{ij} x_{ij}$, where [j = 1, …, k] (4)

$s.t \sum_{i=1}^{n} t_{ij} x_{ij} \leq t_{\max}$ (5)

$\sum_{i=1}^{n} y_i - \sum_{j=1}^{k} = 0$ (6)

$\sum_{j=1}^{k} x_{ij} = 1$, where [$i$ = 1, …, n] (7)

Notations of the mathematical model created are as follows.
i Number of requests for assistance at the disaster site
n number of node of demand that should be filled
k number of location available that can be opened
j Potential location of help post
t Period of time
tmax Maximum service time
t_{ij} Transportation time from village of disaster location i to potential location *j*
x_{ij} 1, [if there is sending help from location *j* to i] 0, [if not]
x_j 1, [if potential location of help post open] 0, [if not]

Numerical Experiment and Discussion

Verification of the Model and Algorithm Applied in Spatial Data

The objective function and constraints of the mathematical model that have been made are then verified using LINGO 11 software. The distance that we used is the real time gotten from Google Maps API. The time that calculated in the Data assumed as the time travelled using vehicle that cannot run quickly. The tavel time setting was using formula written in https://www.quora.com/What-is-the-assumed-walking-speed-in-Google-Mapss-time-estimates. Figure 1 describe the data with two locations available and four demand nodes which represents the victims that should be served. The result using LINGO 11 is Location A – 381 – 380 – 383 – 382 – Location A and the total time is 1075s.

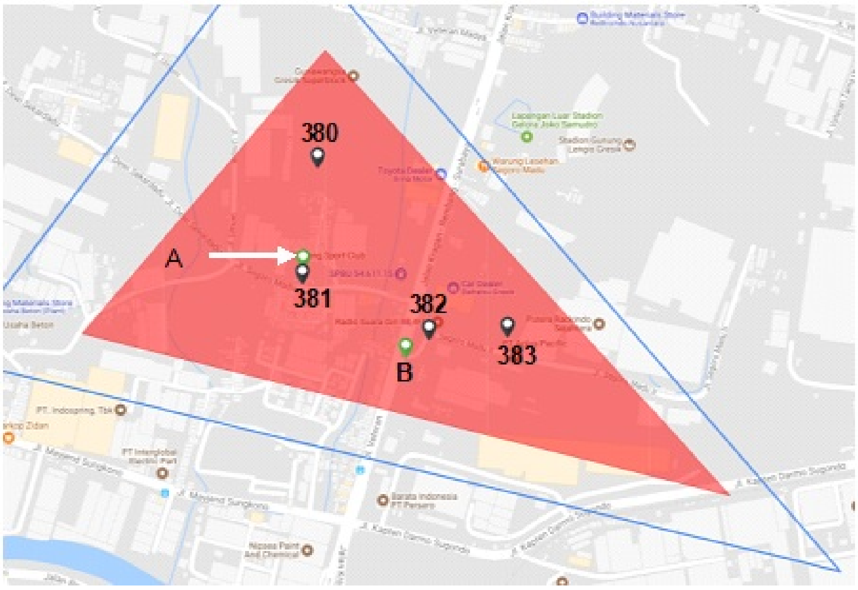

Figure 1: Display of the Test Data (2 available location, 4 demand nodes of the victim)

We use Simulated Annealing Algorithm to solve data. The algorithm is shown in Figure 2. The metaheuristic simulated annealing (SA) algorithm used is an adjustment of the algorithm found on the handbook metaheuristics by Gandreau and Potvin in 2010. The algorithm consists of two parts: the initial phase and the repair phase. Initial phase will be used Priciest Insertion to find the initial solution. After getting the initial solution, the algorithm is continued into the repair phase. In this phase, a new route selection will be made by randomly changing the neighborhood solution, such as swap, insertion, reverse move, and facility change.

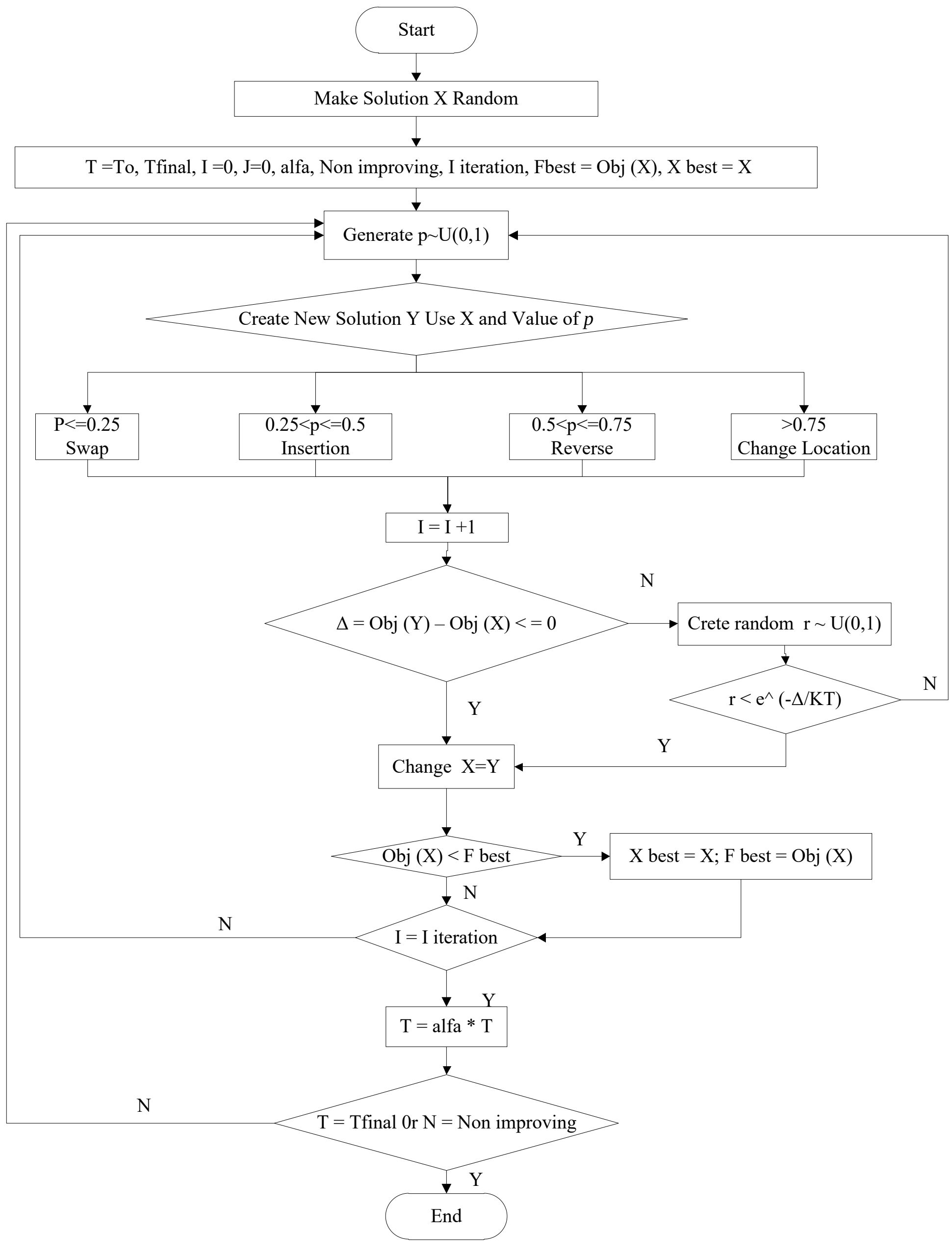

Figure 2: Simulated Annealing Algorithm

The algorithm starts with the current temperature setting, T_0 and randomly generates the initial solution *X*. The best solution is now denoted by X_{best} and the objective function of X denoted by F_{best}. The new solution denoted by *Y*, is the solution resulting from the previous solution improvement (X), each value of its objective function will be evaluated and compared. Let Δ = *obj (Y) - obj (X)*. If Δ is less than or equal to zero, then the objective value Y is better than X, therefore X is replaced by Y. Otherwise, the possibility of replacing *X* with *Y* is *exp (Δ / KT)*. X_{best} and F_{best} will record the best current solution and the best objective function value. The current temperature T0 will decrease after Iiteration using the formula $T = \alpha T$. The algorithm ends when the current T0 temperature is lower than T_{final} or the best solution currently

X_{best} is not repaired further as much as $N_{non\text{-}improving}$ in successive temperature reductions. In this research we use T_0 = 100, T_{final} = 10, α = 0.5, K = 1, and Iteration = 5.

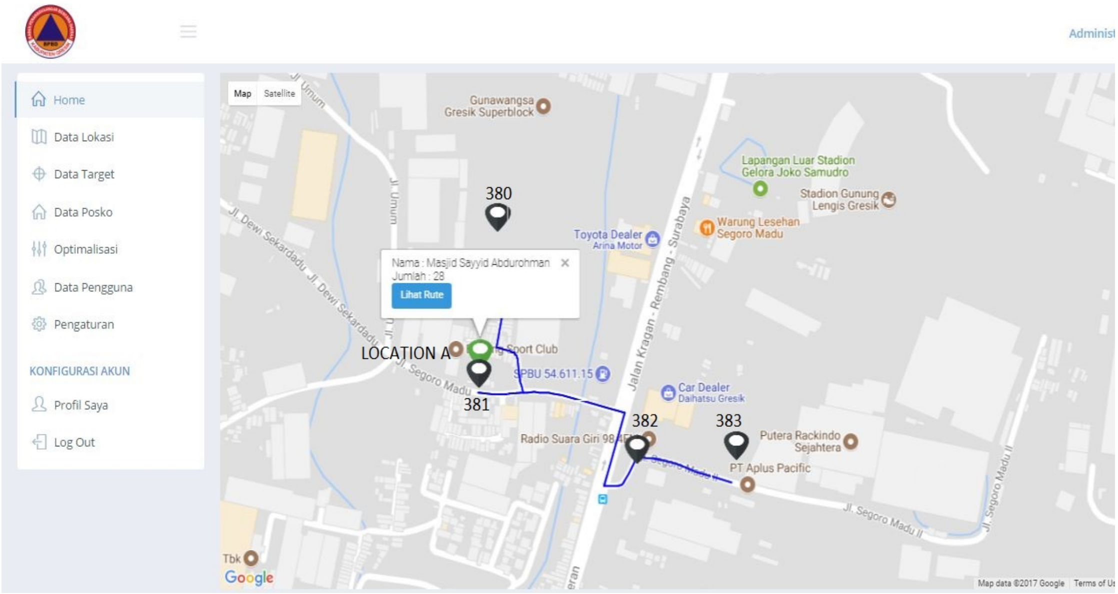

Figure 3: The choosen Location and the route

Sayyid Abdurohman Worship Place --381--380--383--382-- Sayyid Abdurohman Worship Place = 1075s and total Travel Time: 1075s.
The results of LINGO 11 and SA algorithm are the same, it can be concluded that the SA algorithm applied to web-based application using Google Maps API has been able to find the same answer with exact method for cases with small area and small node.

Web-Based Application Display of Food Distribution for Flood Disaster Victims
This research is proposed to be done in collaboration with Gresik Regency Disaster Mitigation Agency. Therefore, Government can use this application to update the information in accordance with real conditions related to be more quickly and responsive in delivery of logistics assistance. Here is the main function of the web:

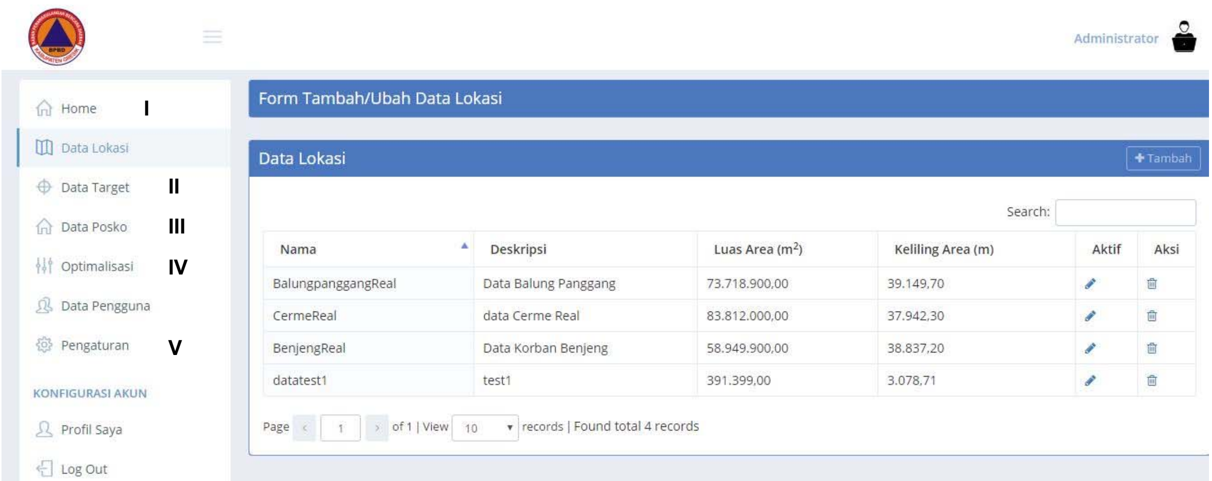

Figure 4: Main Menu of the Web

I. Home. The main menu, we could find the route including the total food distributed for each facility location in the specific area of the flood disaster.

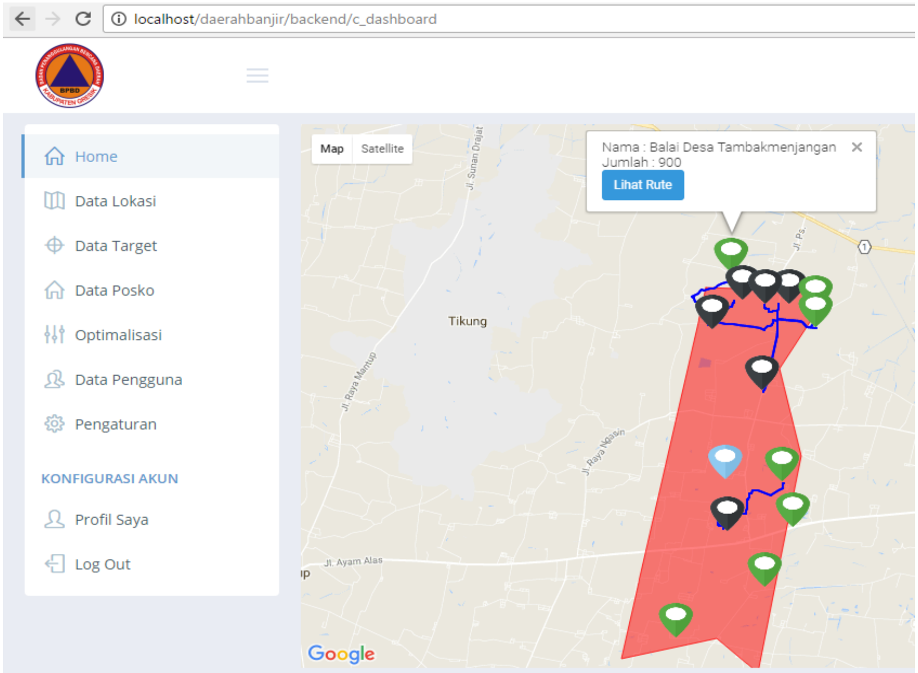

Figure 5: Home Menu

II. Data Target. In this menu, it is determined how many demand node and the location of the demand node (Black pins) respectively. It is also to determine how many aid that should be distribute. It is also a button “Hitung Jarak” for finding the time travel from and to each demand/victim node. This data is saved and then will be used in finding the route.

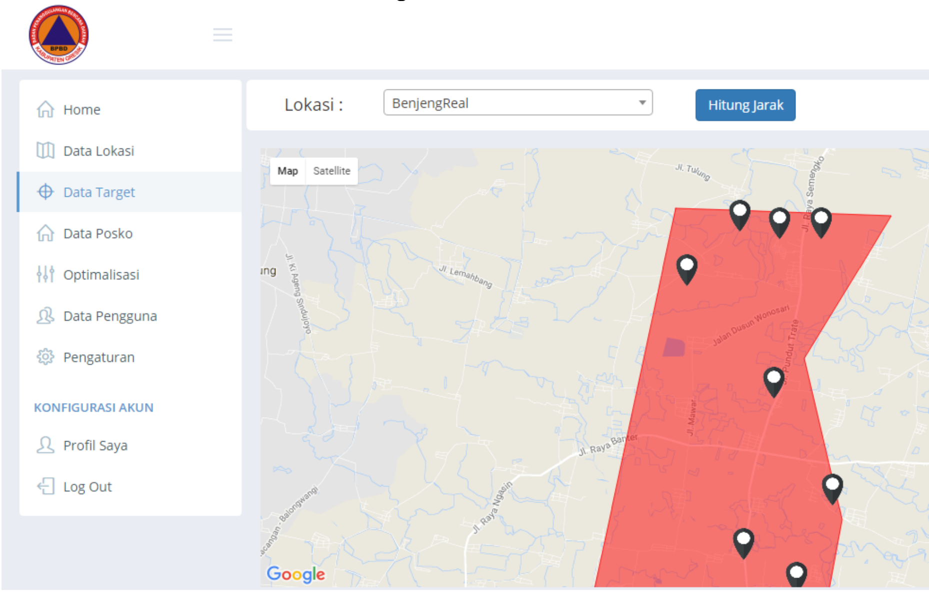

Figure 6: Data Target Menu

III. Data Posko. In this page, we could find the available locations (Yellow pins). Is is also a button “Cari Rute” to find the best location that should be open (Green pins).

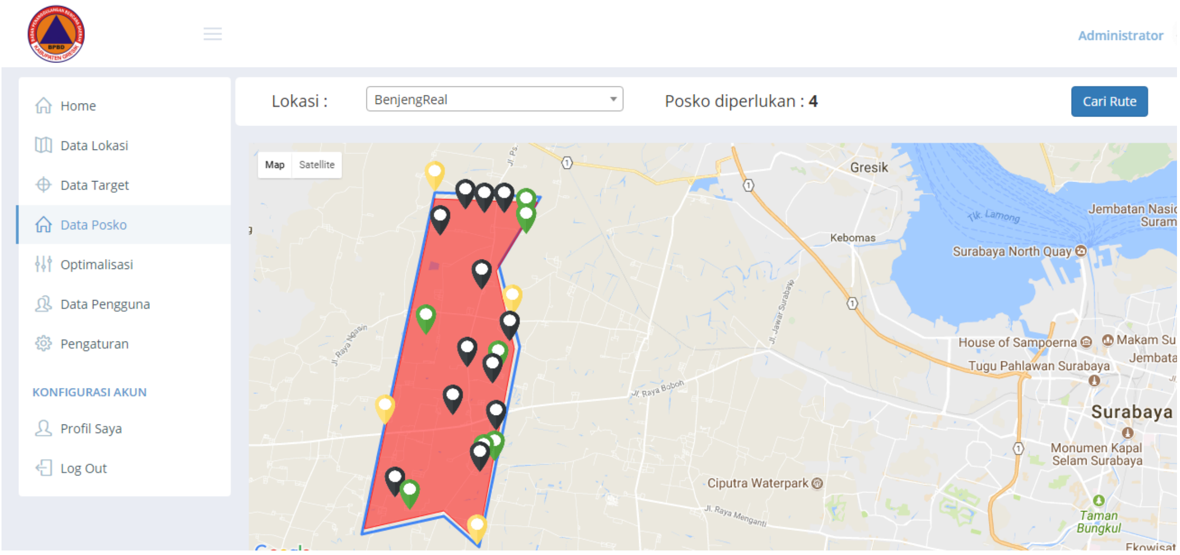

Figure 7: Data Posko Menu

IV. Optimalisasi. In this menu, Simulated Annealing algorithm is applied. It is also available button for user to change the parameter of the Simulated Annealing. We could see the initiation solution until the final solution. Then, after it is done we could see the result of the route in the Home menu.

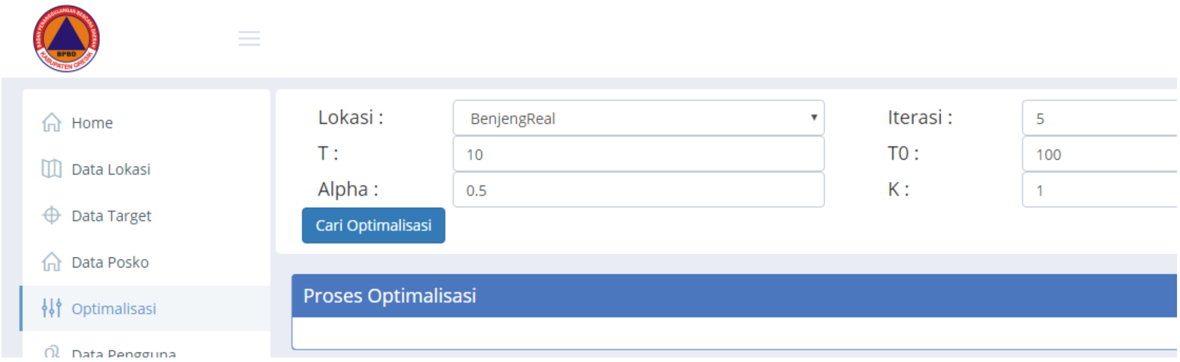

Figure 8: Optimalisasi Menu

V. Pengaturan. We can change the safe area and the t_{max} that we will use.

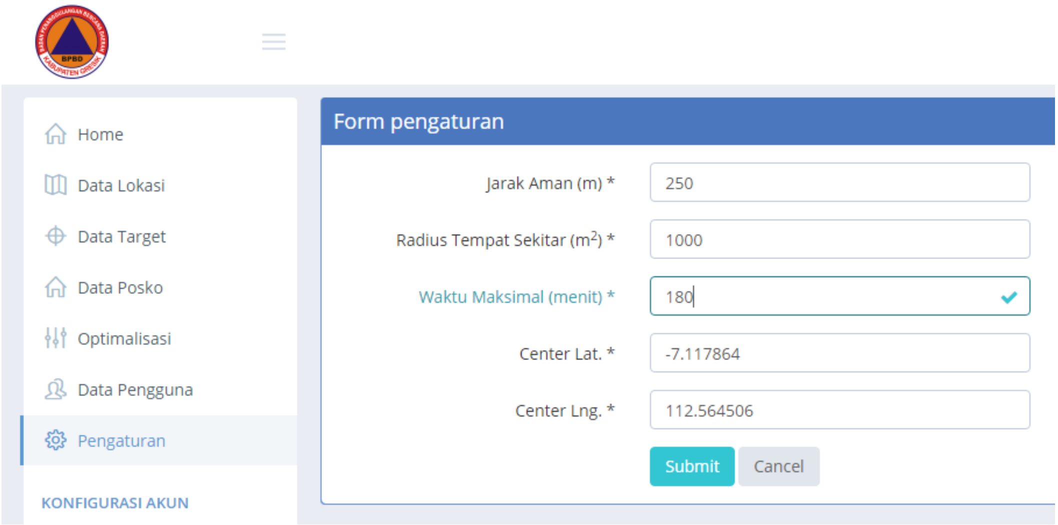

Figure 9: Pengaturan Menu

Numerical Experiment of the Locations Routing Problem using Web-Based Application for Food Distribution for Flood Disaster Victims

The data that input to the application is based on Sugiarto et al (2015) for Cerme and Benjeng Area and dummies for Balung Panggang Area. The differences between this research and the previous research is the web-based application that refers to real condition instead of linier programming which using assumed distance matrix.

Here is the available facility location that meet the requirements:

Locations Available Cerme	Locations Available Benjeng	Locations Available Balungpanggang
AL Hidayah	Baiturrohim	Jamik
Al Abror	AlMuhlisin Gredek	Al Mukaromah
Al Fajar	Roudotus Salam	At Taqwa
Baitur Rohim	Balai Desa Tambakmen	Roudhotul Jannah
Sirojul Mukminin	AL Ikhlas	Banjaragung
Hidayatullah	Sirojul Mujahidin	Babus Salam
Al Irsyad	AL Muttaqin	Al Muhajirin
Perum Menganti Permata Indah	AL Irsyad	Al A'laa
	At Taqwa	
	Al Abror	

Table 2: Available facility Locations each Area

BENJENG DATA			CERME DATA			BALUNGPANGGANG DATA		
Demand Node	Food Package Needed	Code in Application	Demand Node	Food Package Needed	Code in Application	Demand Node	Food Package Needed	Code in Application
Lundo	171	344	Morowudi	1500	356	Ngasin	250	376
Balungtunjung	132	345	Iker-iker Gejer	945	361	Ganggang	580	373
Balongmojo	164	346	Cerme Kidul	150	366	BalungPanggang	1050	371
Balungkulon	123	347	Dungus	300	362	Karangsemanding	800	374
Sedapurklagen	790	348	Pandu	150	363	Wotan Sari	350	375
Deliksumber	900	354	Ngembung	120	365	Pucung	250	376
Kedungrungkem	53	350	Guranganyar	150	357	Pacuh	500	372
Munggungianti	900	351						
Bengkelolor	150	352						
Gluranploso	325	353						
Bulurejo	900	349						
Dermo	300	355						

Table 3: Demand Node, Food Pckages, and Code in Application

As shown in Table 3 the demand nodes and food packages for each of them is different. The coded of the demand node in application is needed due to make easier in calculation process. The determination of the demand node point uses Google Maps API. The result of optimization each area are shown in Table 4, Table 5 and Table 6

Initial Solution			
Location	Route	Time Travel (minutes)	Food Distributed
Baiturrohim	345-353-354-346-347	39.703	1644
Balai Desa Tambakmenjangan	351-350	57.733	953
Al Ikhlas	352	78.120	150
Al Abror	349	97.807	900
Al Muhlisin	344	103.560	171
Al Muttaqin	355	128.327	300
Sirojul Mujahidin	348	149.400	790
TOTAL TRAVEL TIME		**654.65**	**4908**
SA Result			
Location	Route	Time Travel (s)	Food Distributed
Baiturrohim	345-353-354-346	31.610	1521
Al Muhlisin	351-350-347	29.713	1076
Roudlotus Salam	352	20.387	150
Balai Desa Tambakmenjangan	349	19.687	900
AL Ikhlas	344	5.753	171
Sirojul Mujahidin	355	24.767	300
Al Muttaqin	348	21.073	790
TOTAL TRAVEL TIME		**152.99**	**4908**

Table 4: Result in Application for Benjeng Area

Table 4 shows the solution obtained from application. It is seen that the facility location should be open is 7 locations. The SA result shows some changes from initial solution, not only the route, but also the facility that opened which make the delivery time is minimize.

Initial Solution			
Location	Route	Time Travel (minutes)	Food Distributed
Perumahan Menganti Permata Indah	365-356-366	39.360	1770
Sirojul Mukminin	357-361	71.910	1095
Hidayatullah	362	88.763	300
AL Irsyad	363	140.397	150
TOTAL TRAVEL TIME		**340.430**	**3315**
SA Result			
Location	Route	Time Travel (s)	Food Distributed
Perumahan Menganti Permata Indah	356-361-357	25.937	2595
Sirojul Mukminin	365-366	16.920	270
Hidayatullah	362	16.853	300
AL Irsyad	363	51.633	150
TOTAL TRAVEL TIME		**111.343**	**3315**

Table 5: Result in Application for Cerme Area

Initial Solution			
Location	Route	Time Travel (minutes)	Food Distributed
Al Muhajirin	371-367-375	42.757	1650
Al A'laa	373	56.157	580
Banjaragung	372-374	88.490	1300
Mukaromah	376	123.650	250
TOTAL TRAVEL TIME		**311.053**	**3780**
SA Result			
Location	Route	Time Travel (s)	Food Distributed
Al Muhajirin	372-367-371	31.723	1800
Al A'laa	373	13.400	580
Banjaragung	374-375	9.980	1150
Babus Salam	376	35.160	250
TOTAL TRAVEL TIME		**90.263**	**3780**

Table 6: Result in Application for Balungpanggang Area

Table 5 and Table 6 show that by using Simulated Annealing can obtain better solution by change the different routes. It is also shows that the food packages all should be delivered. In Humanitarian Logistics the aid have to deliver to the victims.

	Initiation (min)	SA result (min)	% Improvement
Data Benjeng	654.650	152.990	76.63%
Data Cerme	340.430	111.343	67.29%
Data Balungpanggang	311.053	90.263	70.98%

Table 7: Comparison between Initial Solution and Simulated Annealing Result in Application for all Areas

Percentage of the improvement each calculation is using formula

$$\%improvement = \frac{(initiation - SA)}{initiation} x100\% \quad (8)$$

It is seen that the improvement of the result by SA contribute for more than 60% of minimizing delivery time.

Conclusion

We develop a web-based application of Humanitarian Logistics based on Location Routing Problem in Gresik, East Java, Indonesia which is very useful for government, and so the victims of the flood disaster. This research is proposed to be done in collaboration with Gresik Regency Disaster Mitigation Agency. Therefore, Government can use this application to update the information in accordance with real conditions related to be more quickly and responsive in delivery of logistics assistance. The result of Simulated Annealing run in the application obtained faster time travel delivery. This is needed by the Government to make decision not only the located should be open as a facility location of distribution centre but also the route.

Further research could consider wider and more demand node. The decision of the vehicle type and its capacity should be takes in to account. Parameter setting for the Simulated Algorithm also should be take into account to reach better perform of the algorithm.

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ARTIFICIAL NEURAL NETWORKS-BASED TECHNIQUES IN SUPPLY CHAIN MANAGEMENT

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ABSTRACT
Purpose: This paper aims to investigate applications of Artificial Neural Networks based techniques within the field of supply chain management under key components of supply chain process.

Design/methodology/approach: The literature review of ANNs-based techniques was conducted. The key activities of SCM based on Lambert et al (1998) and Banomyong & Supatn (2011) was established as a foundation and scope of the review. This paper set out to review recent research works conducted during the past years, from 2005 – 2017. The classification of the papers was also constituted under 8 basic categories: simulation, experimental, classification, case study, analytical, conceptual, surveys, and comparative. The results were then discussed to outline the future direction of ANNs applications in SCM.

Findings: The review indicated the tendency of ANNs-based techniques for problem-solving and modelling among the field of SCM. ANNs-based techniques were found to be effective among the problematic domains of SCM regarding a pattern recognition which mostly found in the issues regarding forecasting and simulation.

Research limitations/implications: Limitation is related to the availability of research papers in some of SCM domain which ANNs is required to be established. From academic point of view, this implicates the gap which can be fulfilled by future research works.

Practical implications: The review of ANNs-based applications might provide practitioners with guidance in selecting an applicable ANNs-based technique to deal with problematic issues in supply chains.

Originality/value: This paper contributes to knowledge of ANNs-based applications which extend toward domain of SCM activities as well as identifies further research direction.

Keywords: Supply chain management; artificial neural networks; ANNs applications

Introduction
Supply Chain Management (SCM) is one of the well-known topics among the field of production and operation management. The research regarding SCM has been extended continuously throughout academicians and practitioners, and it has encountered substantial change during the past decades. The enterprises within the supply chain have been persuaded cost reduction strategy with attempting to reduce their inventories level at all supply chain tiers [35]. However, the interactions between supply chain member can cause complex situations due to dynamics of business environment which might affect the performance of supply chain [7]. According to [54], decision making in a supply chain is influenced by uncertainty which is affecting the effectiveness of supply chain configuration and coordination. In regards to the supply chain coordination and integration, the key business activities, from sourcing of raw materials to the product distribution to the end customer, must be taken into account of a supply chain planning process. The planning of supply chain is the process which the companies need to be focused in order to cope with the problems that might occur. There are several issues regarding SCM planning such as inventory management; Supplier selection; Transportation planning; and production planning.

A variety of techniques have been utilized in order to solve problematic issues in supply chain, some of them were used to solve the problems occurring in dynamic parts of the supply chain. Artificial Intelligence (AI) is one of the famous approaches for complex problem solving since AI is a science that utilizes the machines to think or do things that would require intelligence if done by humans. There are several well-known techniques such as genetics algorithm (GA), Artificial Neural Networks (ANNs), and Fuzzy Set Theory (FST), which they have expanded rapidly since the 2000s [47]. Successful applications of AI have been found in several areas such as semantic modeling, gaming, performance modeling, robotics, and machine learning [56]. However, the potential AI application within the area of SCM, which requires the comprehensive ability to deal with complex situations, associated decision-making and knowledge creation that interrelated with problem-solving, has not yet been fully explored [42].

Numerous of research regarding AI's application in SCM has emerged during the past decade. ANNs is one of the most promising approaches which a number of successful implementations have recently been reported. In the SCM field, ANNs can be used for time series forecasting, planning and decision making, modeling and simulation. As demonstrated by these examples, ANNs can be potential and useful for dealing with various aspects of SCM. With this illustration in mind, this paper aims to survey and classify the applications based on ANNs approach for solving the problematic issues in the supply chain. The rest of the paper is organized as follows, section 2 presents the fundamental of SCM activities. Section 3 presents the review results of ANNs-based applications and classification of research approaches. Section 4 contains some discussions and limitations of ANNs-based techniques in the field of SCM. Finally, a brief conclusion and future outline are presented in section 5.

Supply chain management activities

SCM comprises a set of processes and enabling the network of companies producing value in the form of products and services through a multitude of processes and activities [13]. Modern SCM is tended to rely more on the data. The data flow within the supply chain could be utilized in order to gain visibility on supply chain expenses, project cost and performance, control the processes, monitoring of inventory, and optimize the manufacturing [24]. Even in this 21st century, which a traditional mass production is transitioning to a mass customization [25], it must not be forgotten that SCM must encompass planning and management of all related processes regarding sourcing, procurement, raw materials conversion, and logistics activities [4]. Information technology (IT) might have changed a traditional way of SCM, but the core principle remains. According to [14], SCM is the relationship management from upstream to downstream among suppliers and customers in order to transfer the ultimate customer value at the least cost to the supply chain. In a sense of practicality, the term of SCM refers to a long-term strategic alliance, supplier-buyer partnership, to achieve a more profitable outcome for all parties in the chain.

Logistics management perspective has recently been employed by [22] as a more consolidated key activity for supply chain management. The nine logistics key activities were proposed based on the model that firstly proposed by [32]. The idea of model development is also corresponding to the concept of SCM given by [14] whereby the SCM is built upon logistics management framework in order to achieve linkage and coordination between the process of other entities in the chain rather than a single business. Nine key activities are as following Customer service and support; Demand forecasting and planning; Purchasing and Procurement; Inventory management; Order processing and logistics communications; Material handling and packaging; Transportation; Facilities site selection, warehousing, and storage; and Return goods handling and reverse logistics. These key activities capable of both representing operations and being key performance indicators for supply chains as illustrated by [4] who utilized the model for the development of a supply chain performance assessment tool (SCPAT) for cases of Thai SMEs. This paper, therefore, adopts nine key supply chain activities as key categories for classification of SCM problems in conjunction with ANNs-based techniques.

Applications of ANNs-Based Techniques in SCM

Customer service and support

In the era of information technology, utilization of data for customer service and support can be found in the scheme of customer relationship management (CRM). It is the process by which attempt to increase customer's loyalty and retain them via maximization of knowledge regarding customers [31]. ANNs has been a part of knowledge extraction in order to enhance customer service level. [31] utilized ANNs incorporating with online analytical processing (OLAP) in order to obtain knowledge from several sources of the operating system of the die cast manufacturing company. In this case, the customer satisfaction was predicted in order to indicate the CRM strategy of the company with the plausible course of actions. [48] also reviewed the application of data mining techniques in CRM which ANNs was included. ANNs was found to be useful in all four major areas of CRM which are identification, attraction, retention, and development of customer. According to the article, ANNs applications were focused on clustering and classification of data in order to predict the customer behaviors. ANNs was also contributed more than 24% as the most favorable data mining technique among 125 articles regarding CRM. Recently, similar applications regarding four major areas of CRM using ANNs still have been found e.g. development of decision support tool for apparel coordination CRM in hairdressing industry [62]. However, the research regarding a utilization of ANNs for supply chain redesign in order to reach a desirable service level has not yet been found.

Demand forecasting and planning

Numerous of literature have been used ANNs for the forecasting. The forecasting models from existing literature were specifically designed for particular problems. For example, supply chain demand and sales forecasting [1]; [49]; [35]; [12]; [26], throughput or productivity forecasting [37]. Based on 20 research papers regarding ANNs- based forecasting applications, there are more than 85% of works of literature that were using hybrid approaches to enhance the performance and accuracy of ANNs. The hybrid approaches are such as Adaptive Neuro-Fuzzy Inference System: ANFIS [37], Discrete Wavelet Transform- ANNs: DWT-ANNs [26] and Adaptive Differential Evolution – Back Propagation Neural Network: ADE-BPNN [61]. ANNs-based approaches were also found to be popular among demand and sales forecasting in apparel and fast fashion industry due to high uncertainty demand and short shelf-life. [35] pointed out that the ANNs forecasting technique would have an impact on forecasting accuracy when dealing with both seasonal linear demand structure and nonlinear demand structure. A number of neurons used for prediction must be carefully designed in order to obtain the most accurate result. Also, the dynamic properties of the demand data must be taken into consideration and stochastic noise eliminated.

Procurement and purchasing

Among the procurement and purchasing issues, supplier selection is one of the problems that ANNs has been frequently implemented. The characteristics of the problem required both qualitative and quantitative analysis. Thus, most of the existing proposed solution approaches are hybrid. ANNs can be coupled with other approaches such as a multi-criteria decision making (MCDM) technique (e.g. analytical Hierarchy process: AHP); data envelopment analysis (DEA); Decision Tree; Fuzzy System (FS); and intelligence approaches (e.g. GA and particle swarm optimization: PSO) [60]. Another perspective of procurement and purchasing is on the ordering policy in which ANNs – based approach was utilized on demand forecasting in order to constitute the economic production quantity (EPQ) under demand uncertainty. The supply chain cost e.g. inventory holding cost, rejection cost can be reduced by EPQ and optimal lot sizing policy [34]. However, [46] pointed out that supplier selection is still a major research topic regarding strategic procurement. So far, MCDM techniques such as AHP, are still popular among the particular topic [8], there is still a room for researchers for an improvement of hybrid ANNs techniques for procurement and purchasing solutions.

Inventory management

Within the domain of inventory management, ANNs-based techniques have been utilized in 4 area of problems, which are 1) inventory classification [27]; 2) inventory demand forecasting [11]; 3) inventory lot-sizing and order quantity [44]; [2]; 4) inventory level forecasting [52], which they have relied on learning and prediction capability of neural networks. ANNs can be incorporated with other approaches e.g. Fuzzy AHP (FAHP), GA, PSO, in order to generate fitted solutions for inventory management problems e.g. FAHP, can be used to synthesize the weight of inputs for ANNs in order to integrate the opinions of the users into the predictions [27]. In essence to hybrid approaches, [63] pointed out that multi-criteria classification approaches, especially for AI-based classification techniques such as ANN and GA, have potential to replace a traditional ABC inventory classification as they have proven to be more efficient methods for classifying inventory items.

Order processing and logistics communication

According to [32], order fulfillment requires a seamless process from suppliers to customers, which mean that it relies on an effective order processing and logistics communication. However, there are not much of the researchers that apply ANNs-based techniques in this particular area. Existing researches were focused on an allocation of the product from manufacturer to customers. For instance, [36] proposed a product allocation policy for reduction of surplus demand order from buyers using BPNN technique. The back propagation algorithm could predict an actual demand under demand fluctuation. A similar study was conducted by [50]. They improved the performance of demand prediction by incorporating ANNs with minimum descriptive length (MLD) technique to determine an optimal neural network model. However, most of the researchers have diverted their attention to demand forecasting rather than focusing on the processing of information.

Manufacturing, material handling and packaging

Based on existing research articles, ANNs-based techniques have been applied in several manufacturing applications during the past decade, ranging from material handling to advanced manufacturing process control. Existing ANNs-based techniques in manufacturing, material handling, and packaging activities can be categorized into 3 major groups of application, which are 1) Image processing applications e.g. optical inspection and classification systems [6]; [17]; [23] 2) Process planning, controlling and optimizing systems e.g. production planning system based on material requirement planning [45], process parameter optimization system [57]; [58] 3) Process modelling and simulation systems e.g. production planning model under uncertainty [45], product and process parameter prediction system [9], multi-agent system for construction of production order [39], food classification model for manufacturing quality control [15], simulation system for workload estimation in could manufacturing [10]. Hybrid approaches have also been found to be more useful for an enhancement of ANNs performance and each of them had been designing for a specific purpose and context. For instance, in process optimization applications, ANNs has to be incorporated with other intelligent approaches such as GA and expert system in order to obtain either an accuracy in prediction and optimal solutions.

Transportation

There are several transportation issues found in existing research articles. However, transportation and distribution of product are focused here. Within the context of supply chain management, ANNs-based techniques had been dealing with prediction and optimization-classification problems regard transportation activity. Issues regarding prediction are such as a forecasting of container demands for modeling of international container transport service [38], a demand prediction of temperature within a smart container [33]. ANNs can be sufficiently used solely for prediction. However, hybrid approaches are more suitable for optimization-classification problems such as route selection for multimodal transport using ANNs-Fuzzy AHP and agent-based ANNs [55]; [5], and truck scheduling and transportation planning optimization using ANNs-GA [30]. Although ANNs is capable and more flexible to model a complex dataset with nonlinearity and uncertainty tolerance of data, it still has a limitation as they lack the ability to produce a unique solution to the problem [28].

Facility location selection, warehousing and storage

Several research articles regarding the area of facility location selection have indicated that ANNs got less attention from researcher after 2000s. Based on [41], [18], [3], and [19], researchers have been mostly focusing on following approaches; MCDM (e.g. AHP, ANP, TOPSIS), heuristic (e.g. integer linear programming, mixed integer programming) and metaheuristic (e.g. ACO, GA, PSO); in order to solve both static and dynamic facility location problems. However, there are only a few showed up on 2010 in which ANNs was coupled with fuzzy AHP for location selection of an international freight logistics facility [29]. With fuzzy AHP, the weight of inputs can be determined prior the selection of location by ANNs. Regarding warehousing and storage, the issues such as layout design, order picking, order retrieving and storage space optimization have been approaching by other methods rather than ANNs-based techniques. For instance, a multi-level warehouse design method using PSO [51] and an analysis of warehouse operation using stochastic model [20]. Conclusively, ANNs-based techniques have not been found explicitly in this area.

Reverse logistics
According to [53], reverse logistics (RL) consists of 5 processes; disassembly, coordination, reverse supply chain, inventory, and repair and after sales service. Existing researches found so far seem to cover the scope of all processes. Again, ANNs-based techniques have been applying to prediction and classification tasks. Here are some examples of ANNs in prediction tasks, such as a remaining product life cycle (PLC) estimation based on time-to-failure [40], a prediction of return product quantity [59]. For classification tasks, [16] proposed a fuzzy AHP and ANNs model for a selection of the third party reverse logistics provider. In 2012, [43] had proposed an ANNs-based multi-agent architecture for RL in a green supply chain. ANNs was used for a classification of parts and components of product into reusable-recyclable and disposable based on past experiences of allocation agent (warehouse). It also has been confirmed by [21] that ANNs is applicable in forecasting and modeling problems regarding RL.

Discussion and limitations

Discussion
Survey on ANNs-based techniques is a broad category of research in the artificial intelligence field. This research narrow down the scope of the survey into applications of the ANNs-based technique in SCM which support in solving and understanding areas of the problem both in academic and practical fields. If found that some authors are having common concept and methodologies with miscellaneous problematic issues. Within the scope of a research area regarding SCM, domains of the problem can be classified based on key capabilities of ANNs which can be categorized as modeling, forecasting, and classification. Moreover, with a hybrid approach, utilizations of ANNs could be extended to a more specific context of problems or applications e.g. MCDM and optimization. Based on key SCM activities, Figure 1 illustrates contributions of ANNs-based approaches among SCM based on numbers of the article found during the past decade.

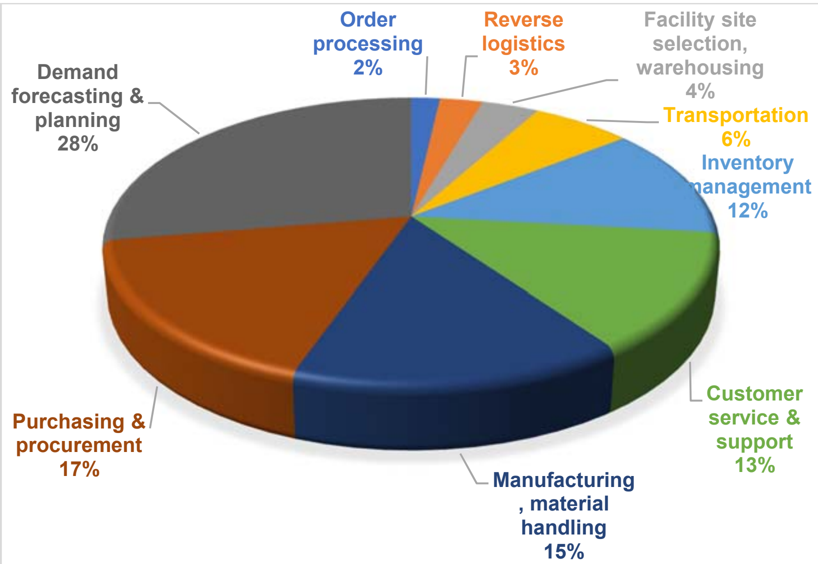

Figure 3: Contributions of ANNs-based approaches in SCM

According to the collected research articles from various online databases, journals, and conference proceedings, it is seen that applications of ANNs on demand forecasting have contributed largest proportion of almost one-third of total articles found. Other 4 mainstream activities are purchasing and procurement (17%), manufacturing, material handling, and packaging (15%), inventory management (12%), and customer service and support (13%), which contributed 57%, cumulatively. There is some interesting remark regarding ANNs based approaches in RL which has been increasing significantly since 2009. Although RL is among the smallest group of articles found at present time, it has shown a possible potential growth in both research area and practicality due to the increasing of attentions on sustainable product and supply chain issues. The following table (Table 1) illustrates a summary and classification of the research works based on SCM key activities. It's been found that more than 67.7% of reviewed research articles is a case-based article with a specific problem experiment conducted. Considering the practical complexity of

SCM, this has reflected that there is no such a single approach that fits all problem, even though the issue is the same but situate in different environment or context. Researchers or practitioners must carefully choose an appropriate technique based on the characteristics of a problem. For instance, one-third of ANNs based approaches have involved a fuzzy system which this indicates that those cases where the past experiences and feedbacks from a user are required, fuzzy system together with ANNs could provide a better result compared to a single approach.

SCM activity	Problem issue	Approach	Article type	Ref.
Customer service & support	Strategic CRM	ANNs, OLAP	EXP, CASE	[31]
	Data mining in CRM	ANNs	SUR, CLAS	[48]
	CRM in industry	SOM, K-mean	EXP, CASE	[62]
Demand forecasting & Planning	Demand forecast	ARIMA, ANNs		
	Sales forecast in fashion industry	ANNs	EXP, CASE	[49]
	Demand forecasting	ANNs, MDL	CONC, ANA	[35]
	Improvement of demand forecasting	DWT, ANNs	COMP, ANA	[26]
	Off-season longan forecast	SVR, FNN	SUR, CASE, COMP	[37]
Procurement & Purchasing	Supplier selection	ANNs, LLNF	EXP, COMP, CASE	[60]
	Supplier selection, DM technique	MCDM, MP, AI	SUR, COMP	[8]
	Ordering policy in supply chain	ANFIS, GA	EXP, COMP	[34]
Inventory management	Inventory lot-sizing, supplier selection	FNN, GA, PCA	EXP, COMP	[44]
	Prediction of critical spare parts requirement	Moving BPNN, Moving FNN	EXP, CASE, COMP	[11]
	Multi-criteria ABC analysis	AI techniques	SUR, COMP	[63]
	Multi-criteria inventory classification	FAHP, ANNs	ANA, EXP, CASE	[27]
	Inventory control	FIS, ANNs, ANFIS	EXP, COMP, CASE	[2]
	Inventory level forecasting	ANNs, ANFIS	EXP, COMP	[52]
Order processing	Product quantity allocation	ANNs (BPNN)	EXP, COMP	[36]
	Demand fulfillment	MDL, ANNs	EXP, CASE	[50]
Manufacturing, Material handling & Packaging	Automatic optical inspection system for PCB	WT, ANNs	EXP, CASE	[6]
	Production planning	ANNs & Others	SUR, COMP	[45]
	Injection mold process parameter optimization	ANNs, GA	EXP, CASE	[57]
	Prediction of process and project parameter	ANNs	EXP, CASE	[9]
	Construct of production order	MAS, ANNs	EXP, CASE	[39]
	Food classification	ANNs	EXP, CASE	[15]
	Particle size estimation on industrial conveyor	ANNs, PCA	EXP, CASE	[23]
	Workload estimation in cloud manufacturing	ANNs, K-mean	EXP, CASE, SIM	[11]
	Process parameter optimization	ANN	EXP, CASE	[58]
Transportation	Route selection in multimodal transport network	FAHP, ANNs	EXP, CONC	[55]
	DSS for International container transportation service	ANN, LP, GA, RA	EXP, CASE	[38]
	Transportation research	ANNs, statistical	SUR, COMP	[28]
	Intelligent container in cool chain	ANNs	CONC, EXP	[33]
	Intelligent truck scheduling	ANNs, TOPSIS	CONC, EXP	[30]
	Product routing in a logistics facility	ANNs, Routing heuristics	EXP, CASE, COMP	[5]
Facility location	International freight logistics center location decision	ANNs, AHP	CONC, EXP	[29]
Reverse logistics	Remaining lifecycle estimation of used components	Weibull analysis, ANNs	CONC, EXP, CASE	[40]
	Selection of 3rd party RL provider	ANNs, FAHP	EXP, CASE	[16]
	Multi-agent based RL architecture	ANNs	CONC	[43]
	Forecast of return quantity in RL network	FES	EXP, CASE	[59]
	RL & Closed loop	ANNs & Others	SUR, COMP,CLAS	[21]

SCM activity	Problem issue	Approach	Article type	Ref.

Abbreviation for approaches: **Autoregressive Moving Average** (ARIMA); **Adaptive Neuro Fuzzy Inference System** (ANFIS); **Decision Tree** (DT); **Discrete Wavelength Transform** (DWT); **Fuzzy Analytical Hierarchy Process** (FAHP); **Fuzzy Expert System** (FES); **Fuzzy Inference System** (FIS); **Fuzzy Neural Network** (FNN); **Linear Programming** (LP); **Local Linear Neuro Fuzzy** (LLNF); **Mathematical Programming** (MP); **Minimum Descriptive Length** (MDL); **Multi-Agent based System** (MAS); **Neuro Fuzzy System** (NFS); **Principle Component Analysis** (PCA); **Radius Bias Function** (RBF); **Regression Analysis** (RA); **Self-Organizing Map** (SOM); **Support Vector Regression** (SVR); **Technique for Order of Preference by Similarity to Ideal Solution** (TOPSIS); **Wavelet Transform** (WT). Abbreviation for article types: **Analytical** (ANA); **Case Study** (CASE); **Classification** (CLAS); **Comparative** (COMP); **Conceptual** (CONC); **Experimental** (EXP); **Simulation** (SIM); **Survey** (SUR).

Table 5 Summary and classification of research articles

Limitations

Considering a wide range of SCM, research works on ANNs-based techniques applied in this particular area in past years is quite much difficult to collect, study and classify. Most of them do not occupy SCM as a whole. Since ANNs-based approaches have not yet been fully deployed in the area of SCM, some articles might be missing or might not be found in an English publication.

Conclusion and future outline

ConclusionThis paper is based on literature review of ANNs-based techniques in SCM from 2005 to present using combinations of keywords search from online databases. It is seen that the ANNs-based approaches were used in most of the articles included in forecasting and classification category. Varieties of hybrid approaches also found and they have proved to be useful and practical in several areas of SCM and industry. However, it also has been found that some areas of SCM such as order processing and logistics communication, facility site selection and warehousing, and reverse logistics are still leaving some gaps for researchers to fulfill. From the academic's perspective, there is still room for an improvement of solution approaches which in this context is meant to the conjunction between ANNs-based techniques and supply chain problem issues. Although there are various types of ANNs, this review found that feed forward neural network is the most frequently found to be used by several researchers. In this case, other types of ANNs should have experimented on existing SCM problems. For practitioners, this review might be able to provide some ideas or guideline regarding applications and approaches of ANNs-based techniques in SCM problems.

Future outline

For future research, researchers might be able to proceed on applying ANNs-based techniques to SCM problems in either 1) improve a modeling method or 2) apply a new type of ANNs or a new hybrid approach to existing problems in order to improve the performance of the solution approach. In a supply chain, business entities or processes connected to each other as a sequence. This characteristic could also be used to develop an ANNs-based process modeling to represent the sequential characteristic of supply chain process as well. Multiple ANNs will be required in this case. Another extension of ANNs might use a different type of ANNs to improve the performance of the solution approach. For instance, Recurrent Neuron Networks (RNNs), which is the deepest learning approach of all ANNs, could provide a better pattern recognition and ability to deal with an arbitrary sequence of input patterns.

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ASEAN ECONOMIC COMMUNITY'S LOGISTICS PERFORMANCE INDEX BENCHMARK

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ABSTRACT

Purpose: ASEAN Economic Community, comprising of 10 ASEAN countries, has agreed to develop a single market and a single production base. Regional supply chain can be redesigned in order to optimize supply chain performance. However, the logistics performance of each country is disparate. Therefore, this paper aims at investigating and benchmarking the logistics performance of 10 ASEAN countries.

Design/methodology/approach: 6 Logistics Performance Indexes by the World Bank, i.e., Customs, Infrastructure, International shipments, Logistics quality and competence, Tracking and tracing and Timeliness, are used to benchmark logistics performance of 10 ASEAN countries. To allow benchmark the different proficiency, Gross Domestic Market (GDP) per capita is crossed over. Data from 2010, 2012, 2014 and 2016 are also taken and reflect the logistics development trends.

Findings: The paper indicates normalized gaps between 10 ASEAN countries in terms of logistics performance. Findings also indicates overall logistics performance of ASEAN as a single entity.

Originality/value: The findings help understanding logistics performance and limitation of each country.

Keywords: ASEAN Economic Community, Logistics Performance Index

INTRODUCTION

ASEAN Economic Community (AEC) is a cooperative initiative of 10 ASEAN countries, i.e., Brunei Darussalam (BRN), the Kingdom of Cambodia (KHM), the Republic of Indonesia (IDN), the Lao People's Democratic Republic (LAO), Malaysia (MYS), the Union of Myanmar (MMR), the Republic of the Philippines (PHL), the Republic of Singapore (SGP), the Kingdom of Thailand (THA) and the Socialist Republic of Viet Nam (VNM). The aims is of the initiatives is to transform 10 economies into a single market and a single production base, via 5 core elements, i.e., (i) free flow of goods; (ii) free flow of services; (iii) free flow of investment; (iv) freer flow of capital; and (v) free flow of skilled labour. This will enable ASEAN economies to compete international forces by strengthen internal/ regional supply chain. (ASEAN Secretariats, 2008)

ASEAN countries occupy more than 629 million people. ASEAN GDP at current price is at 2,432 USD billion, contributing 3.3% to the world. ASEAN trade goods to the world market at 7.6% share (2,270 USD billion). Intra-AEC trading is at 24%. Intra-AEC netflow investment is at 18.4%.

	BRN	KHM	IDN	LAO	MYS	MMR	PHL	SGP	THA	VNM
Land Area (1,000 Sqkm)	5.7	181.0	1,913.5	236.8	330.3	676.6	300.0	0.7	513.1	330.9
Population (1,000,000)	0.4	15.4	255.5	6.9	30.5	52.5	101.6	5.5	69.0	91.7
GDP at Current Market Prices (USD billion)	12.9	18.4	857.6	12.6	294.4	65.4	289.5	291.9	395.7	193.4

Export (USD billion)	6.3	8.8	150.3	3.7	199.9	11.4	58.7	366.3	214.4	162.0
Total FDI Inflows (USD billion)	0.2	1.7	16.1	1.1	11.3	2.8	5.7	61.3	8.0	11.8

Table 1: AEC Countries Basic Information Source: ASEAN Secretariats, 2016

ASEAN ECONOMY

However, ASEAN countries are disparate (see Table 1). Extremely large economies of Indonesia posses a GDP of 857.61 USD billion. While Laos and Brunei are among the small economies at less than 13 USD billion. To reflect the economies regardless of country size difference, GDP per capita is normally used to indicate economic potential of the countries. GDP per capita also ranges from 79,700-87,100 USD (Brunei and Singapore) to the low at less than 10,000 USD (Philippines, Cambodia, Vietnam, Myanmar and Laos). Only these figures can raise so many question on how the AEC can really be integrated with such differences (see Figure 1).

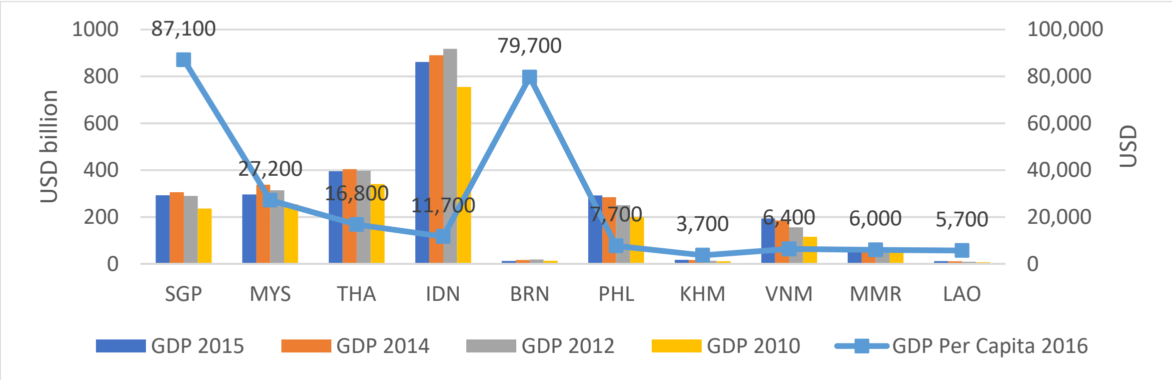

Figure 1: 2010, 2012, 2014 and 2015 GDP and 2016 GDP per Capita of AEC Countries

AEC COUNTRIES IN BREIF

Singapore is undoubtfully world's top economies. Regardless of small resources, its economics is significant to AEC and world's trade and logistics. Singapore ports are among the busiest port of the world. Trade, investment, import and export drives Singapore economies.

Brunei is also a small, but wealthy. Crude oil and natural gas production account for 90% of its GDP. Brunei is world top ten exporter of the substance in the world.

Malaysia, Thailand, Indonesia and Philippines, also known as "Tiger Cub Economies" ot "Four Asian Tigers", are developing, middle-income and newly industrialized economies. Manufacturing, trade and service industries are their top income.

Cambodia, Lao, Myanmar and Vietnam, also known as "CLMV", are the new raising economies. With GDP growth of 5-7%, these countries are enjoying massive Foreign Direct Investment by China, Japan and AEC. (ASEAN Secretariat, 2105)

LOGISTICS PERFORMANCE INDEX

Logistics Performance Index (LPI) is World Bank's logistics benchmarking tools, aiming at identifying logistics performance and benchmarking with 160 countries. LPI score is based on survey of related parties to reflect the logistics friendliness of each country. It provides qualitative assessment of a country based on 6 area, as follow:

1. Customs: the efficiency of customs and border management clearance
2. Infrastructure: the quality of trade and transport infrastructure
3. International shipments: the ease of arranging competitively priced shipments
4. Logistics quality and competence: the competence and quality of logistics services—trucking, forwarding, and customs brokerage
5. Tracking and tracing: the ability to track and trace consignments
6. Timeliness: the frequency with which shipments reach consignees within scheduled or expected delivery times

The LPI uses standard statistical techniques to aggregate the data into a single indicator that can be used for cross-country comparisons. (World Bank, 2016)

AEC LOGISTICS PERFORMANCE BENCHMARKING

Here, it can be seen that LPI scores of AEC countries are ranging from 4.14 of Singapore (5th out of 160 countries) to 2.07 of Laos (152th out of 160). While Malaysia, Thailand, Indonesia, Brunei, Philippines, Cambodia and Vietnam are more or less close. Score of these 7 are ranging from 2.80-3.43 at ranks 32 to 73. Figure 2 and 3 summarise 2016 LPI score and rank of AEC countries.

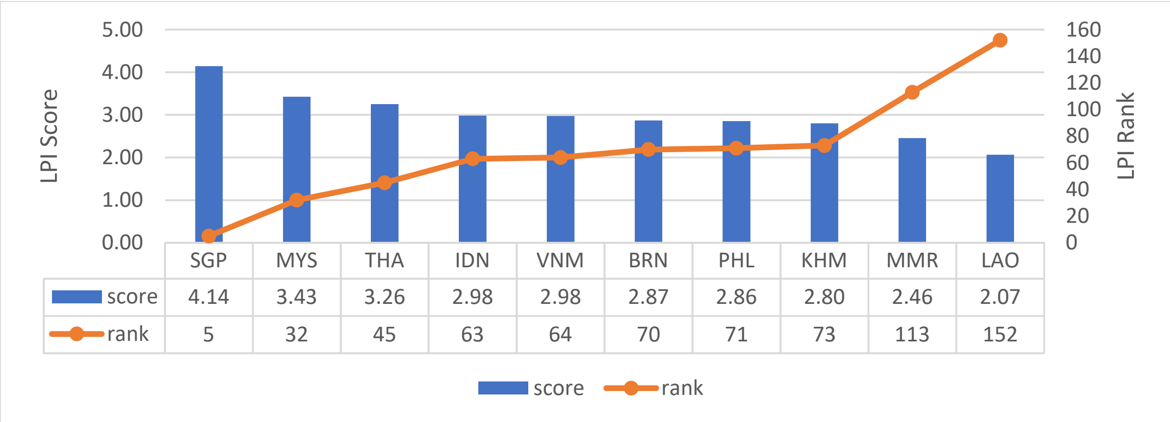

Figure 2: 2016 LPI Score and Rank of AEC Countries

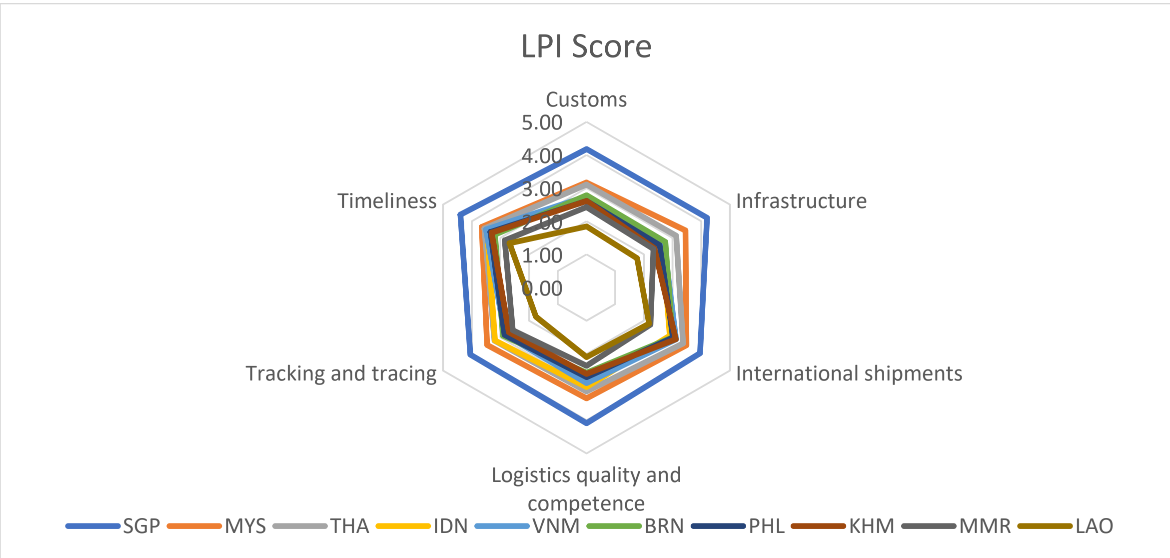

Figure 3: 2016 LPI Score by Indexes of AEC Countries

Again, it can be seen that Singapore is outstanding in every perspectives. Singapore is, in fact, ranked top 5 of the world for the past 10 years. Whereas, Laos and Myanmar are both ranked in 100-band. This indicates a big gap of integration. However, as Figure 1 showed the difference in economic potential, to allow benchmark these different proficiency, Gross Domestic Market (GDP) per capita is crossed over. Here, data from 2010, 2012, 2014 and 2016 are taken and reflect the logistics development trends.

From Figure 4, firstly, it can be seen that all AEC's GDP per capita are raising. This indicates a positive trends where AEC is growing. In fact, for the past 6 years, GDP per capita of AEC grows up to an average of 42% from 2010 to 2016. Singapore is the least among the peers at 24.3%. Thailand also grows slow at 28.1%. However, Malaysia, Indonesia and Philippines grow at the rate of 34-39%. The most growing are CLMV at the rate of 46-58%.

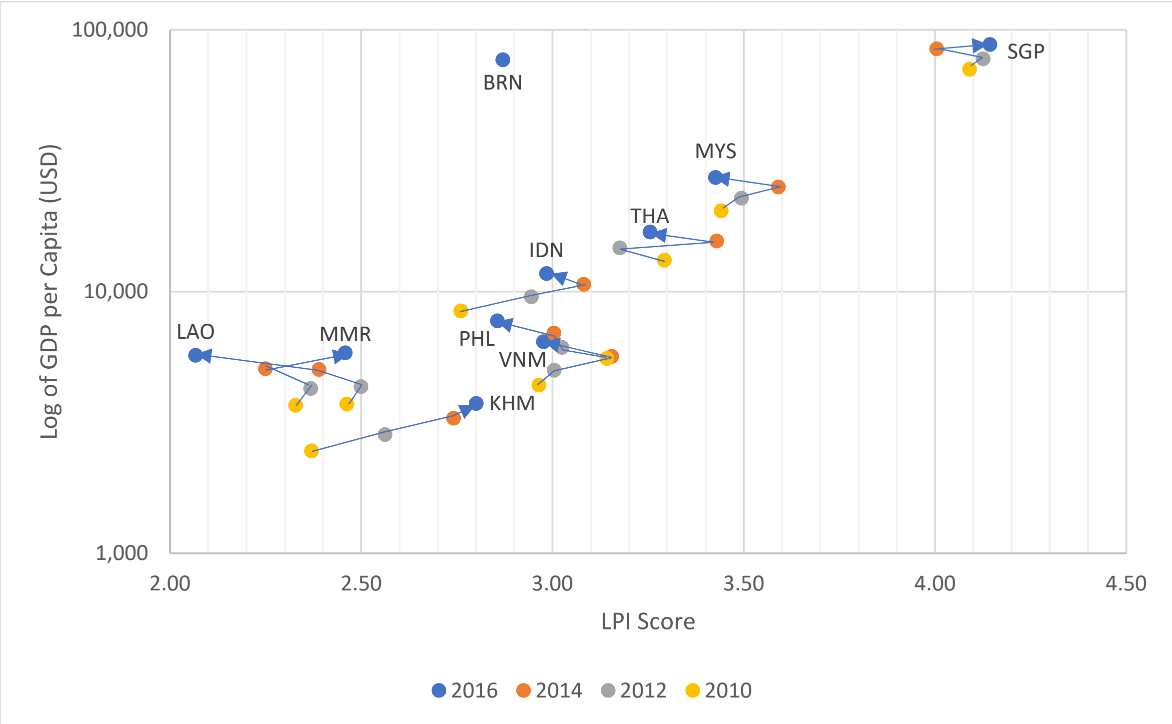

Figure 4: LPI score vs Log of GDP per Capita of AEC Countries: 2010, 2012, 2014 and 2016

Focusing on logistics performance, Cambodia is the only one that improve constantly. Cambodia logistics improves by 18% over the past 6 years of data. Indonesia and Myanmar are among the top improver at the rate of 5-8%. Singapore and Vietnam also improve but at the rate of 1%. For the rest, the score in 2016 is lower than those in 2010.

DISCUSSION

This is an alarm indicator in two perspectives. Firstly, if these countries are to be united in terms of supply chain, there are big gap to be concerned. They are in different leagues. Whilst supply chain is as strong as the weakest link, AEC group is still among the bottom of the pool. Secondly, the logistics improvement is questionable. Where the economics of AEC countries grows, logistics system does not grow accordingly. If logistics is the facilitators of the economic, this finding indicates the big room of improvement, if they need one.

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ASSESSING THE IMPORTANCE OF ASIAN PORTS BY APPLYING SOCIAL NETWORK ANALYSIS

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Abstract
The paper aims to analyze the characteristics of the containerized maritime routes between 153 ports. For this purpose, a network analysis was conducted. A particular attention has been paid to the 78 major Asian ports in the sample, 36 out of which are among the ASEAN designated container ports. We have created three networks. The first two are related to the maritime network between the ports at a port and at a country level, while the third one is an Asian trade export network at a country level. The study shows that among the 10 highest ranked ports based on degree, betweenness and closeness centralities, eight are from Asia. This indicates a high risk of congestion which is confirmed by the high bottleneck scores of the Asian ports. In the maritime network, we have identified a cluster composed of 34 countries from all regions, which means that the countries' trade interactions are no longer defined by the geographical position of their ports. The maritime network of Asian countries has a scale-free structure with a relatively high density whereas the Asian trade network is characterized by a clique structure. Finally, the regional integration was found to be stronger within the trade country network, this is especially true for ASEAN+3 states.

Keywords: Network theory, Asian ports, ASEAN states, trade network, maritime port network

Introduction
According to the International Maritime Organization, over 90% of the world's trade is carried out by sea. It is the cheapest and most efficient way to transport goods in big quantities. Considering the fact that different commodities are transported by different types of ships and given that each commodity has its own specifications in terms of weight and price, the shipping industry should be analyzed by taking into account the volume and also the value of the transported cargo (Kutin et al., 2015). Even though containerized cargo accounts for only 10% of the total volume, its value represents 52%. Since the 1960s, containerization has greatly reduced the expense of international trade and increased its speed. According to the data of Clarkson Research, since 1990, the containerized trade has increased by more than 600%. It has also dramatically changed the character of ports' infrastructure. Moreover, the role of China in the containerized industry has become very important. In 2016, more than 20% of containerized seaborne trade was passing through the Chinese ports.

However, the industry is still facing high level of vulnerability. Following the Subprime crisis, in 2009 container prices fell by 14% (UNCTAD, 2009). Since then, the industry has been in an unstable state. UNCTAD highlighted the mismatch between supply and demand in the containerized trade. The growing imbalance of the trade South-Nord forced liner shipping companies to work together in order to reduce their operating costs. These strategies have an effect on the container terminals development. Confronted by the growing size of the ships and the continuous increase in the containerized goods, the ports have to find the most suitable solution to adapt to these trends. The immediate challenge for ports is to adapt to these increased volumes of containers throughput and the size of the ships. (Notteboom, 2010) stated that "*the success of the port is strongly affected by the ability of the port community to fully exploit synergies with other transport nodes*." Therefore, a suitable method to measure the connectivity of container ports is Social Network analysis. Such an analysis is a good complement to traditional measures of individual throughput Ducruet et al. (2010).

ASEAN member states have become more integrated in the world economy, but also, they have increased the trade between them by launching the ASEAN Economic Community in 2015. According to (Tongzon and Lee, 2015) this integration will result in lower shipping cost and improved quality of shipping throughout the region, and thus contribute to an improvement in the ASEAN members' trade performance and international competiveness. Therefore, the position of the ASEAN community in the maritime and global trade networks needs to be analyzed.

Our research aims to determine the characteristics of the maritime and the trade networks at a port and country levels by using graph theory. We analyze the characteristics of the maritime routes between 153 major container ports in the world. A particular attention is paid to a subset of 78 Asian ports. The study aims to respond to the following questions:

- ***What are the characteristics of the maritime port network and the trade network?***
- ***What is the effect of the container throughput on the country's main centrality indicators?***
- ***What are the main differences between the maritime and the trade networks in the Asian and ASEAN regions?***

The remainders of this paper are as follows. Section 2 discusses the literature related to Network Analysis in maritime economics. Section 3 explains the methodology and the data used. All the results are depicted in Section 4. Finally, a discussion on the outcomes of the study and possible future research are provided in section 5.

Review of the literature

In the last decade the network theory has gained a considerable importance in the maritime logistics. The cost effectiveness and production efficiency of ports are closely linked to the optimization of their networks. (John et al., 2016) applied Bayesian belief networks to model various influencing variables related to different risk' factors in a seaport system. They have provided useful recommendation to policy makers to optimize the operations of their systems for resiliency. (Peng et al., 2016) used a mixed-integer nonlinear stochastic programming model and showed that the deployment of the containers handled at each seaport is not directly related to its throughput capacity.

Notteboom (2010) conducted a detailed container traffic analysis for the period 1985–2008 for 78 ports. His study shows that European ports function not as individual places that handle ships but within supply chains and networks. There is also a gradual deconcentration process and the container handling market remains more concentrated than other cargo handling segments. The author also suggests that the container port hierarchy and competition in Europe have become highly complex and dynamic due to structural changes in logistical, economic, institutional and regulatory settings.

Ducruet (2013) applied network simplification techniques based on the linkage analysis, which consist in removing from each port all its links except the largest one. Their study revealed that the most diversified ports have a high level of centrality and dominance in the network. They also connect with more ports situated on a greater physical distance. On the other hand, the more specialized ports concentrate the majority of global traffics, but their average connection distance is lower due to their distribution role at the intra-regional level.

Network analysis on international trade flows has been widely done in the economic literature (Snyder and Kick, 1979), (Smith-White and Preiss, 1992), (Kim and Shin, 2002), (De Benedictis and Tajoli, 2011)). The trade flow of goods and services between countries can be presented by directed graphs where all edges are potentially bidirected, as long as exports and imports between two countries are nonzero values. We can perform the same analysis on the Maritime Routes Network. By looking at the trade flows as a network, allows analyzing either the relationship between the countries in the network or the overall network structure. A recent analysis to both trade and FDI flows within ASEAN+3 has been conducted by (Nguyen et al., 2017). They conclude that, first, the degree of trade and FDI integration varies among ASEAN+3 member states over the 1990-2012 period. Second, ASEAN+3's intra-regional trade network seems to be more densely connected than its intra-regional FDI network. Third, large and/or advanced countries tend to be better linked and form a sub-regional bloc of tightly connected economies. Regarding the efficiency of ASEAN ports, (Kutin et al., 2017) found that most of the ASEAN container ports operate under increasing returns of scale, which means that they are able to handle even more containers. (Banomyong, 2015) applied Geographical Simulation Model (GSM) to analyze the effects of the implementation of The Master Plan on ASEAN Connectivity (MPAC) by the members' states. The study shows that the development is mostly concentrated in specific locations and countries with better trade facilitation. The positive effect could spread to non-ASEAN member states such as Japan, China and India, countries with better trade facilitation environment.

A major gap in the literature review is the lack of any research about the maritime trade routes at a country and at a port level using Social Network Analysis. Moreover we were not able to find many studies related to the effect of the maritime connectivity on the overall trade performance of a country. Hence, our study aims at fulfilling these gaps and providing useful recommendation to policy makers to optimize their network and to implement their mid and long run trade policies based on trade connectivity.

Methodology and data

Social network analysis (SNA) is the process of investigating social structures through the use of networks and graph theory (Otte and Rousseau, 2002). A network, as in Figure 1, is a collection of nodes, and links (or edges) between nodes. In our case, the nodes are either a port or a country, and the link can be the flow of exports from one country to another country, or any maritime/ports indicators, as the average containerships size between the two ports. The importance of the flow depends on the link weight. Since, there is always one source of the flows, and one target, e.g. a ship that moves from one port to another port, our network is directed.

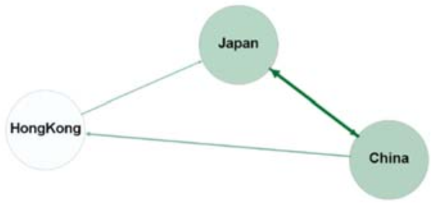

Figure 1: Example of a simple directed network between 3 countries.

Social Network Analysis in the context of maritime trade

To gain a better understanding of the connectivity in the Maritime network, and with respect to the network literature ((Freeman, 1978), (Newman, 2001), (Borgatti, 2005)), a broad set of well-known centrality measures was used. The centrality approach, which is based on the number of maritime links of a given port and their strength (number of ships or TEUS), assesses how well connected a port is to the rest of the network and how influential a port is, for example within a specific region (see Figure 2). According to (Jackson, 2010), centrality measures can be classified into four main groups: i) degree centrality - assessing how a node is connected to others, ii) closeness centrality - showing how easily a node can be reached by other nodes, iii) betweenness centrality - describing how important a node is in terms of connecting other nodes, and iv) eigenvector centrality measure (or the Bonacich centrality) - referring to how important, central, influential, and tightly clustered a node's neighbours are.

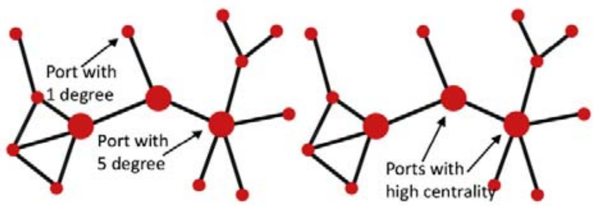

Figure 2: Degree and centrality.
Source: (Freire Seoane et al., 2013)

A related question of interest is to know if one port belongs to a particular community of ports, and, if yes, how is this community defined? As suggested in (Pons, 2005) and (Pons and Latapy, 2006), the concept of community within graph theory is not clearly defined. However, it is possible to define a community as a set of vertices (links) whose density of internal connections is greater than the density of connections to the outside (Pons, 2005). Accordingly, to calculate the potential communities within a given network, one should split the network into a given number of groups. Among others, agglomerative algorithms are the most well-known ones.

One of the aims of this article is to detect the structure/configuration of the network. Among the different types of network, the two more frequently used ones in maritime and trade literature are the Hub and Spoke networks (Figure 3). The first one is a system of connections, where all traffic moves along spokes connected to the hub at the center. In the maritime network a typical example of a hub-port is the Port of Singapore. We could also have multi-port calling configuration where the vessel is delivering goods to many ports. Such a system is used by smaller containerships.

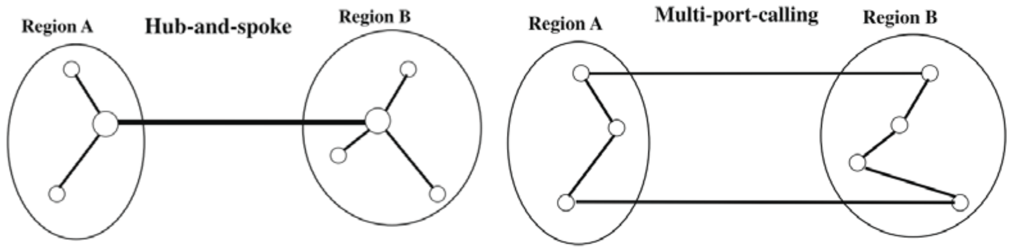

Figure 3: Hub and Spoke versus Multi-Port Calling configuration.
Source: (Imai et al., 2009)

Imai et al. (2009) found that in most scenarios the multi-port calling is superior in terms of total cost, while the hub-and-spoke structure is more advantageous in the European trade for a costly shipping company.

Data

Our maritime database was obtained from Lloyd's Marine Intelligence Unit (LMIU) and contains information about port to port transport in 2014. It consists of 153 ports from 51 countries with 79 located in Asia, 27 in North America, 20 in Europe, 19 in Africa and 8 in the Latin America and the Caribbean. The following variables are in the dataset:

- Container port of departure (A)
- Container port of arrival (B)
- Average size of the ships in dead weight tonnage (DWT) going from port A to port B
- Average size of the ships in Twenty-Foot Equivalent Unit going from port A to port B
- Number of ships going from port A to port B
- Number of operators transporting goods from port A to port B
- Number of trips between from port A to port B

The export database was collected from UN ComTrade [1] commodity databases in the Standard International Trade Classification (SITC) Revision 3.

We have built three types of network. The first one is the trade network which takes into account all exported goods between the countries in the sample and gives the value of exports in thousands of dollars. The second one is "maritime network" which includes the ports in the sample. We also have a third network which is the maritime network at country level. It should be emphasized that the dataset neither includes all the operational ports in each country nor has data for all countries in the world.

Results

The network analysis was conducted by using the following softwares: Gephi and Cytoscape (version 3.5.0.). The first sub-section presents the results at port level while in the second one depicts the outcomes of the research at country level. The last two parts show the effect of the container throughput on the ports main centrality measures and the trade and maritime networks of Asian and ASEAN states.

[1] https://comtrade.un.org/

Container Ports' network

At the port level, weights have been attributed to the nodes and links according to the average size or the dead weight tonnage[2] of the containerships that operate on a given route or that dock at a particular port as well as the average number of operators or trips between any directly connected ports/countries (Appendix 1, Table A1). The descriptive statistics of the nodes and link attributes shown in Appendix 1, Figure A1 depict a significant dispersion around the mean as the studied sample consists of highly heterogeneous ports and maritime routes. Table 1 shows that the network has a high degree of connectivity. On average, the distance between any two connected nodes is 1.809 edges and each of them interacts with approximately 48 other ports in the sample.

Clustering Coefficient	0.690409154
Connected Components	1
Diameter	4
Radius	2
Connected Pairs/Shortest Paths	23256
Average Short Path Length	1.808565531
Average Neighbors	47.81699346
Node Count	153
Number of edges (without self-loops)	6410
Density	0.2756

Table 1: Network Statistics – Port level data

The clustering coefficient of the global network reflects the average neighbourhood connectivity. It is relatively significant (0.69) as it should be expected considering the average number of neighbours of each node. Therefore, there is a possibility that many cliques[3] and communities exist within the maritime network. It is observed that the network density is small. These results indicate that the network has a scale-free configuration. Such networks, introduced by (Barabási and Albert, 1999) are mainly characterized by a degree distribution that follows a power law with a few highly connected nodes and a majority of low-degree nodes.

The port ranking based on centrality measures (Appendix 2, Table A2) indicates that Asian ports have become major focal points in the maritime sector. Among the 10 highest ranked ports based on degree, betweenness and closeness centralities, eight are from Asia. The absence of North American ports in that ranking surely contrasts with the port hierarchy that existed around two decades ago. This can be explained by the on-going industrial relocation process of North American firms to Asia (particularly in China and ASEAN member states).

Port rankings according to different centrality measures are very similar due to the positive correlation between degree, betweenness and closeness centralities (Appendix 2, Figure A2). This indicates a high risk of congestion which is common in scale-free networks and can affect the network resiliency. Therefore, the coefficient of bottleneck score for each node was computed. Not surprisingly, ports that capture a large portion of containerized traffic also have high bottleneck scores, i.e. Shanghai, Antwerp or Ningbo-Zhoushan (Appendix 3, Figure A3). This topological measure is also an indicator of the lack of "redundancy" in any given network as any dysfunction or removal of one of those hubs can lead to the separation of different clusters or communities. This can lead to the destabilization of the logistics chain (Xu et al., 2015)

Maritime network at country level

Given that dataset include main ports from different countries, the data has been aggregated to a country level in order to analyze the countries' interactions. This section focuses on two aspects of the containerized trade between countries. Firstly, we consider the vessel movements between each pair of countries similarly to the port network analysis. Secondly, we analyze the trade patterns between them. The objective is to identify the differences between the two maritime networks at port and country level.

[2] Ship sizes and dead weight tonnage are expressed in twenty-foot equivalent unit (***TEU*).**
[3] A small close-knit group of people who do not readily allow others to join them.

The maritime Network at country level

At country level, the maritime network is a polarized or scale-free structure with a high level of connectivity. It is a core-periphery structure where the most important countries are the world's main importers and exporters. Countries such as China and USA are the most connected nodes while most countries have a relatively low connectivity according to degree centrality (Appendix 4, Figure A4.1). Thus, it is the level of economic activities in each region that defines the spatial disparities within the maritime network. The hubs identification confirms that the regions that host the most important ports are located in North America, Western Europe and East Asia (Appendix 4, Figure A4.2).

When detecting highly dense sub-networks, two clusters have been identified (Appendix 4, Table A4.1). However, the focus has been put on the first cluster which is composed of 34 countries from all regions. This is a proof that within the considered cluster and to a lesser extent, the entire global network, the countries' trade interactions are no longer defined by the geographical position of the ports as mentioned by (Ducruet et al., 2010). Although trade network and the maritime network are structurally different, the international trade patterns can still be observed in the whole maritime network and they are even more visible when studying its main cluster of countries.

Comparison of the Maritime Routes' and Country level Trade's Networks

Table 2 shows that the trade network has a higher level of connectivity than its maritime counterpart. Its clustering coefficient is close to 1 and it has smaller characteristic path lengths, which is very close to the characteristics of a clique.

Maritime Network - Country level			**Trade Network - Country level**	
Clustering Coefficient	***0.79418764***		***Clustering Coefficient***	***0.978***
Connected Components	***1***		***Connected Components***	***1***
Diameter	***3***		***Diameter***	***2***
Radius	***2***		***Radius***	***1***
Connected Pairs/Shortest Paths	***2550***		***Connected Pairs/Shortest Paths***	***2550***
Average Short Path Length	***1.40470588***		***Average Short Path Length***	***1.024***
Average Neighbors	***32.4313725***		***Average Neighbors***	***49.608***
Node Count	***51***		***Node Count***	***51***
Number of edges (without self-loops)	***5650***		***Number of edges (without self-loops)***	***2490***

Table 2 – Regression results, maritime network at country level

As stated in the previous section, countries are strongly connected in terms of trade of goods. On the other hand, they are less clustered when analysing the containership traffic between their main ports. In the last two decades, the international trade has had on average an annual growth rate doubling the world's production, particularly due to the integration of the emerging countries in international trade (BRICS and most of the ASEAN member states).

There are some fundamental differences between maritime and trade networks. For instance, the likelihood of two countries becoming trade partners is mainly based on *incentive*-based market *mechanisms and potential comparative advantag*es. On the other hand, the maritime sector is mainly guided by the carriers' incentives to optimize their costs and profits. However, both networks have a fair share of drawbacks. While the trade network is not optimal for ship operators in terms of efficiency, the maritime network is confronted by the risk of empty cores which are issues that arise when there is a lack of competitive equilibrium and an inefficient use of resources due to high sunk costs, inelastic demand and excess capacity etc., (Button and Nijkamp, 1998).

How does container throughput affect ports main centrality measurements?

In order to analyze the correlation between the degree centrality of country in the maritime network and its container port throughput as well as the level of its neighbourhood connectivity, an estimation using the OLS method was performed in the following form:

$$Log\ (Degree) = \beta_0 + \beta_1 * Neighborhood\_Connectivity + \beta_2 * Container\ Port\ Throughput + \varepsilon$$

As displayed in the results in Table A5 (Appendix 5), when a country has highly connected neighbours, it decreases its number of interactions whereas its container port throughput per country increases its degree centrality. Collecting cargo from their point of origin and transporting them to the hub so that the shipment can be distributed to its destination ensure the optimization of the capacity use of containerships.

Moreover, these past decades have seen a rise in public-private partnerships to invest in port infrastructures. Major operators have been taking an important part in making sure that they do not only position their terminals in strategically placed ports but they also ensure that such hubs are fully equipped because they are the main areas for transhipments. Their closeness centrality implies that they can manage the operations with the peripheral ports, while betweenness centrality entails that they are the swivel plates that connect different regions which are tightly connected in the trade network. This confirms that the maritime and the trade network have different topological structures whilst the maritime flows are in fact a reflection of trade relations between countries.

Asian countries, comparison between Trade and Maritime Networks at a country level

Since the dataset includes all major ports in Asia, we focus our analysis to the particular case of the maritime and trade sub-networks defined only by either all the Asian Countries, or by the ASEAN member states. At first glance, it is observed that major economies which serve as bridges toward Europe and North America play a substantial part in the interactions at a regional level, in both networks.

Obviously, the global statistics for both networks show a different configuration for each of them (appendix 6, Table A6). The maritime networks for both Asia (ASEAN included) and the ASEAN community show a scale-free structure with a relatively high density where most countries are clustered except for Brunei, Cambodia and Turkey as such countries either play a small role in the network or do not maintain interactions that go beyond their geographical surrounding.

On the other hand, both the trade networks for Asia and ASEAN are characterized by a clique structure. They have shorter distances and the density as well as the clustering coefficient are equal to 1, which means that all the possible interactions between countries are achieved.

Moreover, it was deemed necessary to compare the level of integration between the maritime and the trade network (Figure 3).The links in the Asian maritime network are weighted by the number of operators whereas in the trade network, they are weighted by the value of exports in thousands of USD.

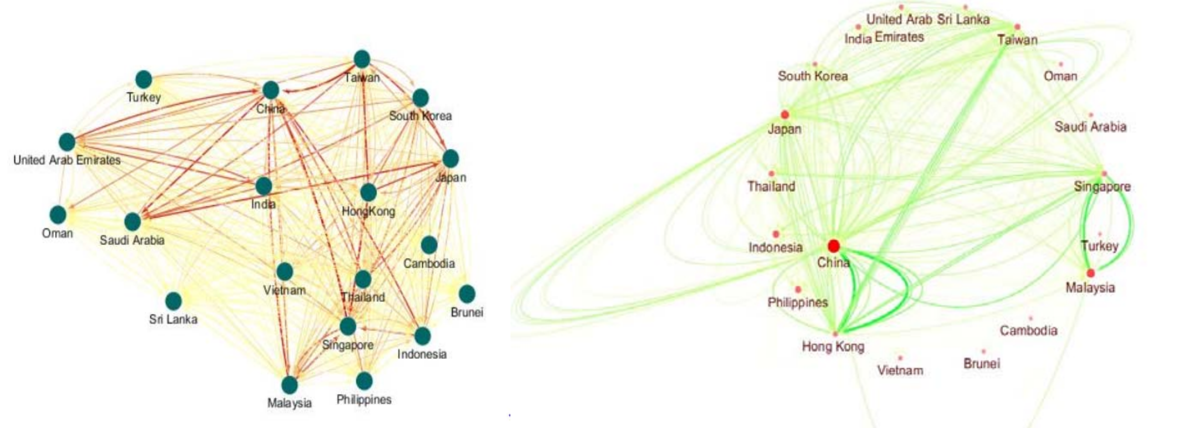

Figure 3: ASIAN Cluster in the Trade network (left) and the Maritime network (right)

The trade network shows a higher level of integration though similar linkage patterns can be observed in both the trade and the maritime networks. Countries such as China, Singapore and Japan have stronger trade linkages and also a high level of competition among them. These countries have a high level of GDP, which indicates the positive relationship between maritime connectivity and economic growth.

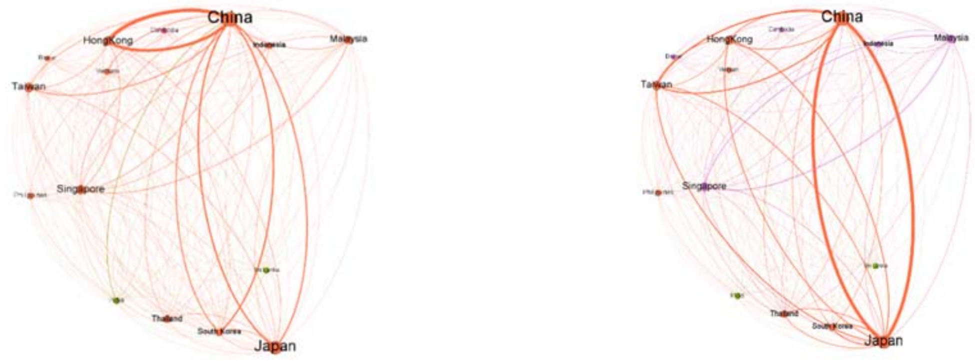

Figure 4 - ASIAN Communities in the Trade network (left) and the Maritime network (right)

We also analyze how the regional integration is reflected within the network of Asian countries. As shown in Figure 3 and 4, the regional integration is stronger within the trade network. When we consider the communities of all the countries belonging to ASEAN+3, except Cambodia belong to the same community. On the other hand, the Maritime network (right hand side, Figure 4) is defined by the link between China and Japan. There is also another community which includes Singapore, Malaysia, Indonesia, Cambodia and Brunei.

Conclusion

This study aims at understanding the characteristics of the maritime and the trade networks using graph theory and analysing the differences between them, either from a global perspective or within the Asian and ASEAN regions. It also studied the factors influencing a country's degree centrality. Our findings show that the maritime network is characterized by a core-periphery structure associated with scale-free networks and is guided by shipping carriers cost minimization incentives whereas the trade network which is a small-world structure reflects the ongoing globalization process and regional integration. This explains why the linkages have been found to be stronger within the trade network than in the maritime network.

Regarding port classification based on degree, betweenness and closeness centralities, it is observed that Asian ports are the most connected, while North American ones have significantly lower scores. It suggests that some trends in the maritime sector such as trade liberalization, outsourcing and technological progress have had a major impact on the countries' connectivity. However, high bottleneck score of Asian ports indicates a high level of congestions and potential negative effects on the global supply chain, in case of removal or dysfunction of one of the Asian hub ports. The ports with high level of container throughput also have a high degree centrality. This confirms that the maritime network is a hub and spoke. Such structure can be characterised by a low level of resilience. This characteristic can be explained by the rise of in public-private partnerships to invest in port infrastructures and the increase of the size of containerships and the strategies of liner shipping companies to realize economies of scale.
When analysing the maritime network at a country level, we found that main exporting countries such as China and USA are the most connected nodes while the majority of states have low degree centralities. It suggests that it is the level of economic activities in each region that defines the spatial disparities within the maritime network. The identification of a cluster of 34 states from different continents show that trade interactions between the states are no longer defined by their geographical positions. In the case of trade network, we found that the countries' centralities measures are higher than their scores in the maritime network. Another important finding is the fact that states with very well connected neighbours have less interactions (number of containerships operating between the two countries).

The analysis on the trade network of Asian and ASEAN states show that countries such as China, Singapore and Japan have stronger trade linkage. All ASEAN +3 states except Cambodia have very strong trade relations. On the other hand, the maritime network at a port level reveals a strong link between China and Japan. Another cluster of mutually connected countries is composed by Singapore, Malaysia, Indonesia, Cambodia and Brunei. This suggest that additional efforts should be undertaken to integrate Cambodia in the ASEAN Economic Community. In order to improve the implementation of the ASEAN Single Shipping Market we should further analyze why in the maritime network, the cluster of countries does not include Thailand, Vietnam and Philippines.

On the basis of our results, further research to link empirical facts (links in the network) with the optimal possible routes given by an operational research optimization would allow to deepen the analysis of the shipping carriers' strategies on maritime routes while testing the efficiency of the global port network.

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<u>Appendices:</u>

Appendix 1: Container Port' network

Nodes attributes						
Attribute	***Min.***	***1st Qu.***	***Median***	***Mean***	***3rd Qu***	***Max.***
Total TEU of arrived vessels at each port	0	581824	1351088	2633576	2969636	16303330
Total TEU of departed vessels at each port	0	474527	1219443	3194332	3653856	25770455
Links attributes						
Attribute	***Min.***	***1st Qu.***	***Median***	***Mean***	***3rd Qu***	***Max.***
Avg.TEU	80	1712	4082	4300	5867	18270
Avg.Dwt	2351	24278	51542	54885	73905	194335
No.of.Ships	1	2	9	25.2	27	1237
No.of.Trips	1	2	21	99.7	90	5510
Estimated TEU between ports	80	8412	57890	391681	361053	14386449
No.of.Operators	0	2	5	11.13	13	264

Table A1- Descriptive Statistics

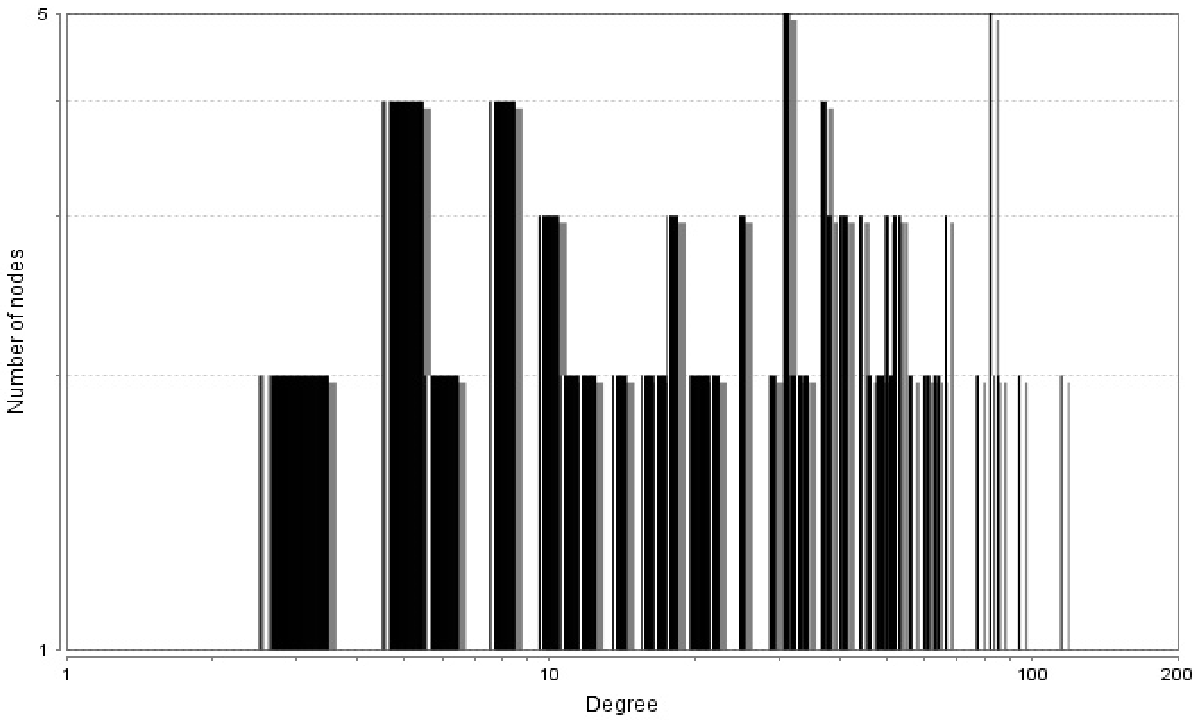
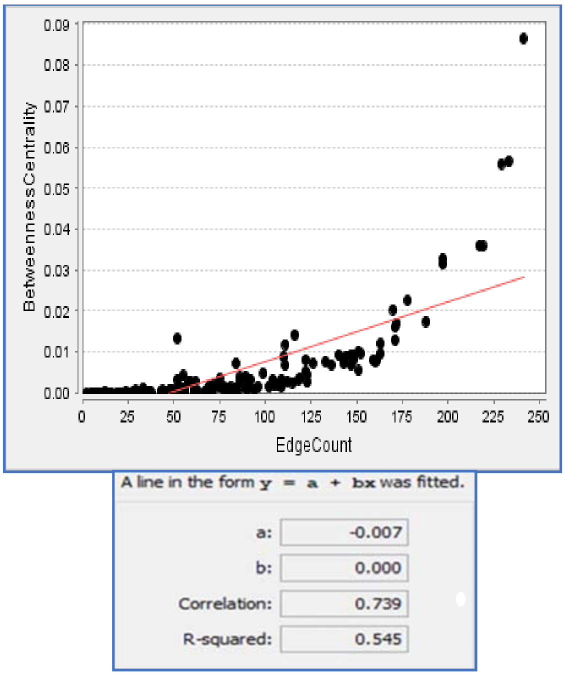


Figure A1- Degree distribution of maritime network - Port level data

Appendix 2: Port ranking based on centrality measures

	Top 20 in port network file ranked by the Degree method		**Top 20 in port network file ranked by the Closeness method**		**Top 20 in port network file ranked by the Betweenness method**	
Rank	Container Port	Score	Container Port	Score	Container Port	Score
1	Singapore	241	Singapore	138.50	Singapore	1873.04
2	Hong Kong	233	Shanghai	136.50	Shanghai	1257.84
3	Shanghai	229	Hong Kong	136	Hong Kong	1234.02
4	Ningbo-Zhoushan	219	Shenzhen	133.50	Ningbo-Zhoushan	790.04
5	Shenzhen	217	Ningbo-Zhoushan	133.50	Shenzhen	769.07
6	Port Klang	197	Port Klang	129	Port Klang	706.83
7	Kaohsiung	197	Kaohsiung	127.50	Kaohsiung	665.08
8	Rotterdam	188	Rotterdam	126.67	Antwerp	479.87
9	Antwerp	178	Port Said	126.50	Algeciras	477.63
10	Tanjung Pelepas	172	Antwerp	124.33	Rotterdam	404.35

Table A2 - Port ranking by degree, closeness and betweenness centralities – Port level data



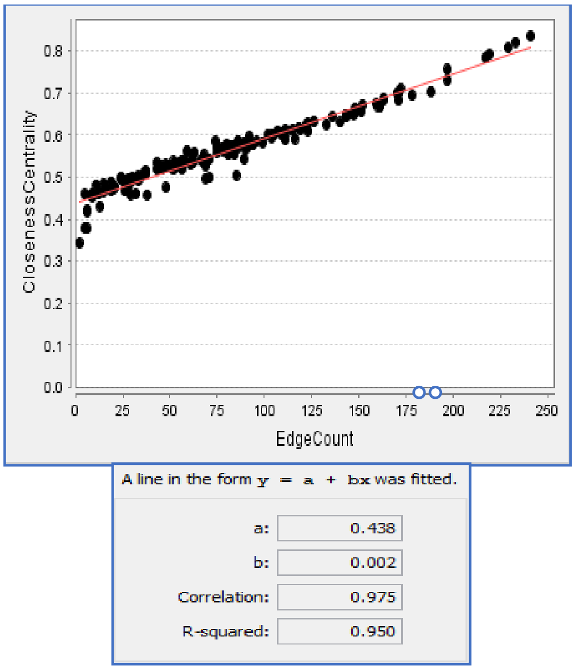
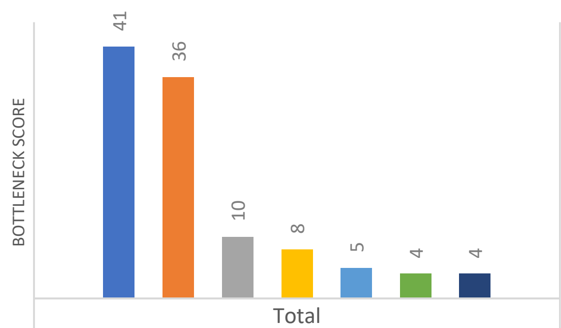


Figure A2- Correlation between degree centrality and closeness and betweenness centralities

Appendix 3: Bottleneck scores



	Total
Antwerp	41
Ningbo-Zhoushan	36
Shanghai	10
Hong Kong	8
Algiers	5
Singapore	4
Port Said	4

Figure A3: Ranking of the ports with the highest scores for bottleneck

Appendix 4 Maritime network at a country level

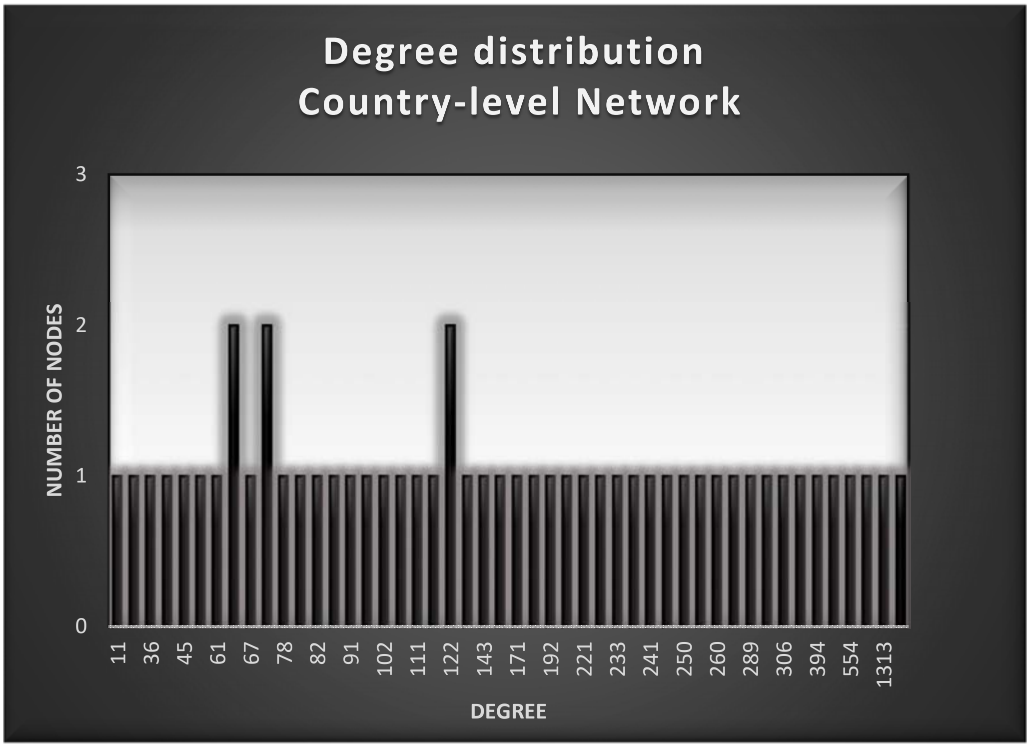


Figure A4.1: Degree distribution of maritime network – Country level data

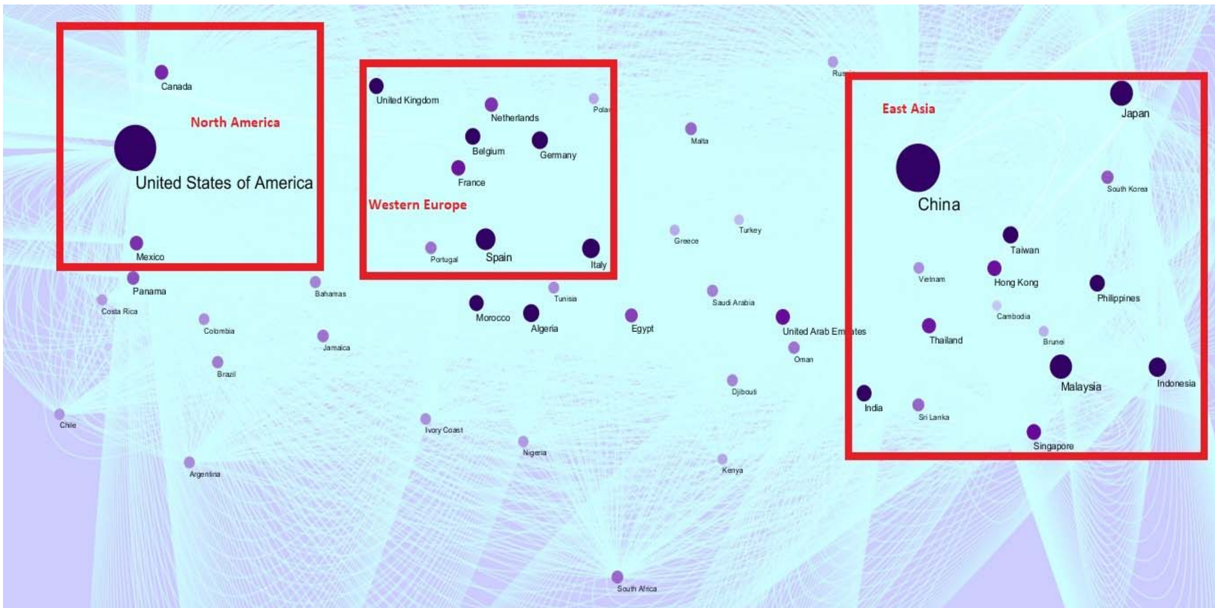


Figure A4.2: Maritime network visualisation – Country level data

Cluster	Score (Density*#Nodes)	Nodes	Edges	Node IDs
1	31.515	34	520	Brazil, Germany, Saudi Arabia, Malaysia, Argentina, Portugal, France, India, Egypt, China, Belgium, Djibouti, Algeria, United States of America, United Kingdom, United Arab Emirates, Taiwan, Sri Lanka , Spain, Singapore , South Korea , Panama, Oman, Netherlands, Morocco, Jamaica, Mexico, Malta, Bahamas, Thailand, Japan, Italy, Hong Kong , South Africa
2	3	7	9	Nigeria, Ivory Coast, Philippines, Indonesia, Russia, Costa Rica, Poland

Table A4.1 – Maritime network cluster – Country level data

Appendix 5: Container throughput and centrality measurements

```
lm(formula = log(Degree) ~ Neighborhood_Connectivity + CPT, data = DEGREE)
Residuals:
   Min      1Q      Median     3Q      Max
-1.9870 -0.1830  0.0232  0.2323  1.1741
Coefficients:
                             Estimate   Std. Error   t value  Pr(>|t|)
(Intercept)                  1.214e+01  1.424e+00   8.523   1.05e-10 ***
Neighborhood_Connectivity   -2.027e-01  3.681e-02  -5.507   2.03e-06 ***
CPT                          2.864e-08  1.402e-08   2.042     0.0475 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.4964 on 42 degrees of freedom

Multiple R-squared:  0.5949,           Adjusted R-squared:  0.5756
F-statistic: 30.84 on 2 and 42 DF, p-value: 5.745e-09
```

Table A5: Country level data –Maritime network global stats versus Trade network global stats (ASIAN & ASEAN regions)

Appendix 6: Asian Countries and maritime network

MARITIME NETWORK				
Network Stats - ASIA			**Network Stats - ASEAN**	
Clustering Coefficient	**0.847987049**		***Clustering Coefficient***	**0.896428571**
Connected Components	**1**		***Connected Components***	**1**
Diameter	**3**		***Diameter***	**2**
Radius	**2**		***Radius***	**1**
Connected Pairs/Shortest Paths	**342**		***Connected Pairs/Shortest Paths***	**56**
Average Short Path Length	**1.257309942**		***Average Short Path Length***	**1.142857143**
Average Neighbors	**13.47368421**		***Average Neighbors***	**6**
Node Count	**19**		***Node Count***	**8**
Network density	**0.748538012**		***Network density***	**0.857142857**
Number of edges (without self-loops)	**1595**		***Number of edges (without self-loops)***	**272**
TRADE NETWORK				
Network Stats - ASIA			**Network Stats - ASEAN**	
Clustering Coefficient	**1**		***Clustering Coefficient***	**1**

Connected Components	**1**		***Connected Components***	**1**
Diameter	**1**		***Diameter***	**1**
Radius	**1**		***Radius***	**1**
Connected Pairs/Shortest Paths	**342**		***Connected Pairs/Shortest Paths***	**56**
Average Short Path Length	**1**		***Average Short Path Length***	**1**
Average Neighbors	**18**		***Average Neighbors***	**8**
Node Count	**19**		***Node Count***	**8**
Network density	**1**		***Network density***	**1**
Number of edges (without self-loops)	**341**		***Number of edges (without self-loops)***	**56**

Table A6 – Country level data – Maritime network global stats versus Trade network global

BIBLIOMETRIC MAPPING OF HUMANITARIAN LOGISTICS RESEARCH

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Introduction

Recently, an increasing number of natural and man-made disasters have occurred in many regions in the world, killing thousands of people and causing millions of indirect beneficiaries. Logistics has always been an important factor in humanitarian aid operations. Humanitarian logistics focuses on efficient management of flows of goods, information and services, to meet the urgent needs of affected people under emergency conditions (Kovács and Spens, 2007). Temporary Shelters provide immediate accommodation, medical care and food to affected people (Bayram et al., 2015). Its contribution towards overall relief operations is 80% (Trunick, 2005), which makes it a critical element for a successful relief operation (Sheu, 2007). Thus, a failure of the humanitarian and relief supply chain can result in catastrophic consequences for the affected populations.

The field of humanitarian logistics has been extensively studied so far, especially during the last 10 years. Many literature reviews have been published so far on this topic (Altay and Green, 2006; Kovács and Spens, 2007; Pettit and Beresford, 2009; Natarajarathinam et al., 2009; Overstreet et al., 2011; Kunz and Reiner, 2012). However, they all take a different perspective and approach for analysing the literature. In opposition to earlier work, this study use a bibliometric mapping approach which is data driven and relies heavily on computer algorithms and visualization techniques. The approach can be seen as complementary to the earlier studies. In this study, we present the results of the bibliometric analysis the humanitarian logistics field, and in particular the presentation of maps of the relationship between keywords, maps of clusters of research areas, as well as the maps of the density of keyword citations.

The term map is based on identifying pair of keywords, which occur together in large number of documents (Callon et al., 1991). The term map is used to visualize the structure of a scientific field by showing the relations between important terms in the field. The framework assumes that when two words appear together in titles or abstracts or in full text for a same document it indicates possible link between two distinct centres of interest designated by these words. Links like this when repeated in large number of documents can delineate are search sub-topic or intellectual sub-domain that may not have entered the mainstream of research delineation of that field. Recently, various studies have applied the bibliometric mapping approach for studying the structure and the dynamics of fields such as (Lee et al., 2014; Madani and Weber, 2016; Campos et al., 2017; Boudry et al., 2017; Hajduk, 2017; Mishra et al., 2017; Oraee et al., 2017; van Nunen et al., 2017; Zeng and Chini, 2017).

We analyse the broadest set of papers ever covered in previous literature reviews on humanitarian logistics. This paper is also the first in humanitarian logistics to use bibliometric mapping analysis as the main methodology to analyse literature in a structured way, which is of particular value to the academic community as well as practitioners.

The rest of this paper is organized as follows. The next section presents the process for constructing data set use in our analysis. Then explain how we performed our bibliometric mapping analysis. The last part of the study contains results and conclusions.

Methodology

Material collection

The first step in this study is the construction of a representative data set of humanitarian logistics literature. We conducted a search in June 2017 in following databases: Business Source Complete, Science Direct, ABI/INFORM Global and Web of Science, and included all papers published or made available online until the end of 2016. The following keywords and Boolean operators were searched for in the fields “Title”, “Abstract” or “Keywords”: (Logistic* OR Supply Chain*) AND (Humanitarian OR Relief). These keywords were inspired by the keywords used in previous literature reviews (Kovács and Spens, 2007; Kunz and Reiner, 2012). The search was limited to peer-reviewed publications only, and book sections, conference proceedings, reports and practitioner journals were excluded from our selection. In total, 309 articles were collected from the search above. Titles abstracts and keywords are supposed to represent the full contents, including key concepts, of an article, and supposedly they are more focused than full texts and therefore more suitable for automated analysis.

The second step is data cleansing process. A sequence of strings is broken into pieces called tokens. This process is called tokenization. The aim of tokenization is to explore the words in a sentence and identify meaningful keywords. Punctuation was removed in the process of tokenization. Tokens can be made up of characters, numeric or alphanumeric. Following this, stop-words are removed from the data set. Stop-words are words from non-linguistic view that do not carry information. Prepositions (such as “from”, “to”, “after”, etc.), articles (such as “a”, “an” and “the”) and pronouns (such as “I”, “you”, “she”, “he”, etc.) can be treated as stop-words. Eliminating stop-words helps to improve text processing performance. Next, word stemming is executed. Word stemming is a process of transforming words into their roots. Many words in English have different forms of the same words, for example “stemming”, “stemmed” and “stems” have the same root word of “stem”. Lastly, capital letters are converted into lower case.

Bibliometric mapping

We analysed the data set using a bibliometric mapping approach. Bibliometrics is the scientific field that is concerned with the *data-driven* quantitative analysis of books, articles, and other types of written communication.In the field of bibliometrics, a significant amount of attention is paid to bibliometric mapping.

Bibliometric mapping is a powerful tool for studying the structure and the dynamics of scientific fields. Researchers can utilize bibliometric maps to obtain a better understanding of the field in which they are working (van Eck et al., 2010). Bibliometric mapping aims to produce visual representations of the relations between certain units of interest. Various types of bibliometric maps can be distinguished, which each visualize the structure of a scientific field from a different point of view. Some maps, for example, show relations between authors or journals based on co-citation data. Other maps show relations between words or keywords based on co-occurrence data (van Eck et al., 2010). In this paper, we focused on maps that show relations between terms. We refer to these maps as term maps. By a term we mean a word or a phrase that refers to a domain-specific concept.

We identified noun phrases in the titles abstracts and keywords of the 309 articles in our data set by using a computer program called “visualization of similarities” or VOS; freely available at http://www.vosviewer.com) (van Eck et al., 2010; van Eck and Waltman, 2010). The VOS uses two techniques which are mapping technique and clustering technique which can refer to (Waltman et al., 2010) for more detail.

Only noun phrases occurring at least 10 times in the titles abstracts and keywords were taken into consideration. The irrelevant noun phrases were excluded from further analysis such as Author, Abstract, Year or Published are not particularly informative about humanitarian logistics. This resulted in a set of 158 terms.

For each pair of terms, we counted the number of times the terms occur together in the same article. Co-occurrence frequencies of terms are a commonly used measure of the relatedness of terms. We used the co-occurrence frequencies of our terms as input for the VOSviewer software which provides a graphical representation of the bibliometric networks, and in particular, enables the mapping of the relationship between keywords, indication of the most common terms in the defined description of a bibliographic record, highlighting the cluster groups of the analysed concepts, mapping the intensity of the citations of the highlighted concepts (Moed, 2010; Zhu et al., 2009).

<u>Results</u>

The term map constructed using the methodology discussed in the previous section is shown in Figure 1 and 2. These figures display the so-called network visualization and density visualization of the map. The network visualization focuses on the details of the map, while the density visualization provides a general overview of the map by indicating the relative importance of the various areas in the map.

Network visualization

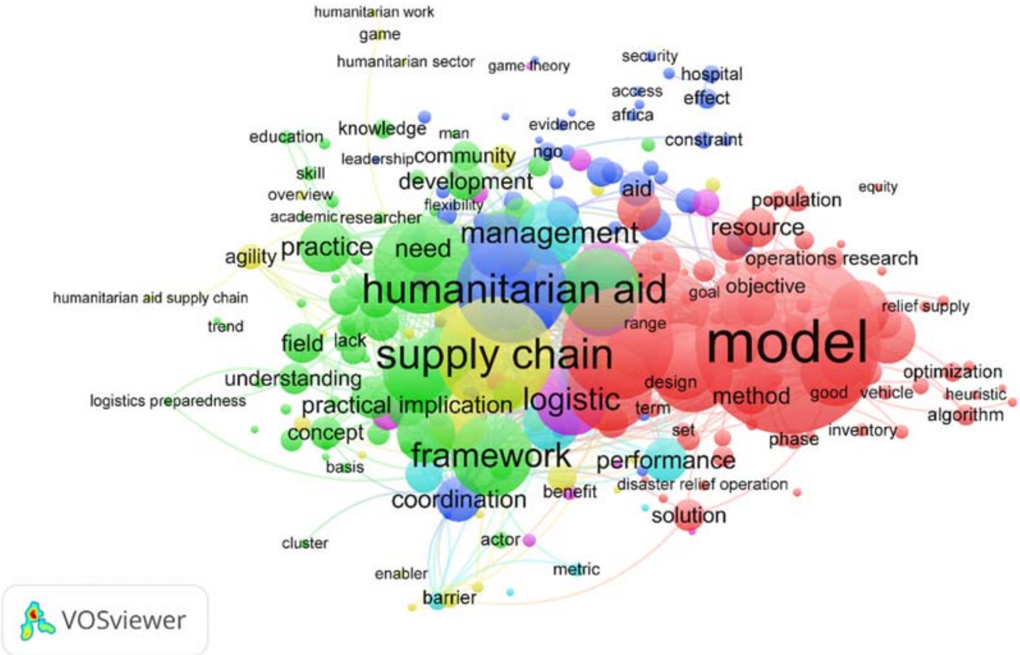

Figure 1: Network visualization. Colours indicate the clusters of research areas.

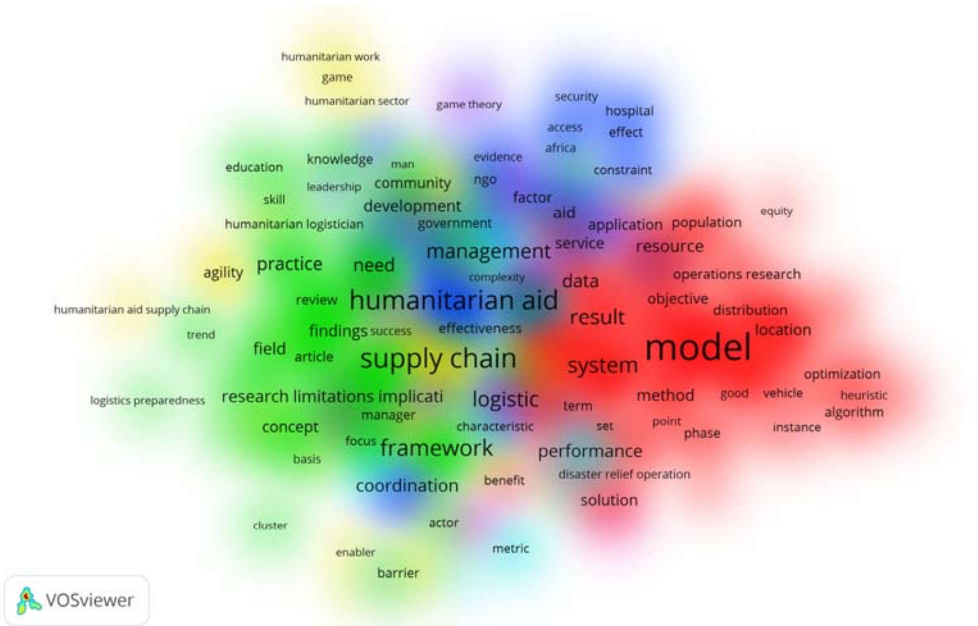

Figure 2: Network visualization. Colours indicate the clusters of research areas.

This is a map in which the 158 terms are located in such a way that the distance between any two terms reflects the relatedness of the terms as closely as possible. In general, the stronger the relation between two terms, the smaller the distance between the terms in the map. Each term in the term map also has a colour. Colours are used to indicate the grouping or clustering of the terms. Terms with the same colour belong to the same cluster and tend to be more closely related than terms with different colours. In other words, terms with the same colour tend to co-occur with each other more frequently than terms with different colours.

Figure 1 shows that each of the 6 clusters (research areas) has a more or less central term around which the other terms are positioned. The 6 central terms are model, humanitarian logistic, humanitarian aid, supply chain, logistic and management. The font size used to display a term and the size of a term's circle indicate the number of articles in which the term occurs. For each cluster, the 10 most occurring terms are listed in Table 1.

The first cluster combines studies relating to analytical models concerning logistics issues in disaster relief operations. The observation in the second cluster that humanitarian logistic is the most occurring terms in the field should not come as a surprise and needs no further explanation. The third cluster combines studies relating to humanitarian aid operations. The fourth and the fifth clusters combines studies relating to logistics and supply chain in context of humanitarian aid operations respectively. The final cluster represents the study of performance measurement in humanitarian logistics management.

Cluster 1 : Model	**Occurrences**	**Cluster 2 : Humanitarian logistic**	**Occurrences**
model	330	humanitarian logistic	176
disaster	199	framework	146
logistics	152	analysis	146
approach	144	design methodology approach	116
system	136	originality value	114
problem	127	finding	105
result	125	challenge	103
disaster relief	119	practice	93
time	107	need	88
demand	100	case study	77
Cluster 3 : Humanitarian aid	**Occurrences**	**Cluster 4 : Supply chain**	**Occurrences**
humanitarian aid	196	supply chain	206
operation	130	supply chain management	100
organization	117	issue	87
coordination	81	context	82
environment	64	impact	77
aid	63	activity	52
role	62	tool	47
service	60	agility	47
country	59	technology	43
relationship	54	state	37
Cluster 5 : Logistic	**Occurrences**	**Cluster 6 : Management**	**Occurrences**
logistic	128	management	117
area	104	process	101
humanitarian organization	58	performance	79
application	49	humanitarian supply chain	67
humanitarian operation	41	work	49
opportunity	37	performance measurement	34
partnership	34	metric	26

mechanism	34	studies	25
benefit	28	applicability	15
cooperation	24	performance evaluation	13

Table 1: The 10 most occurring terms in clusters

Density Visualization

In the density view (Figure 3), the colour of an area reflects the number of times the terms located in the area occur in the titles abstracts and keywords of the articles in our data set. The red areas in the density view can be regarded as the most important ones. The terms located in these areas together occur many times in the data set. The most occurring terms in density visualization is shown in Table 2.

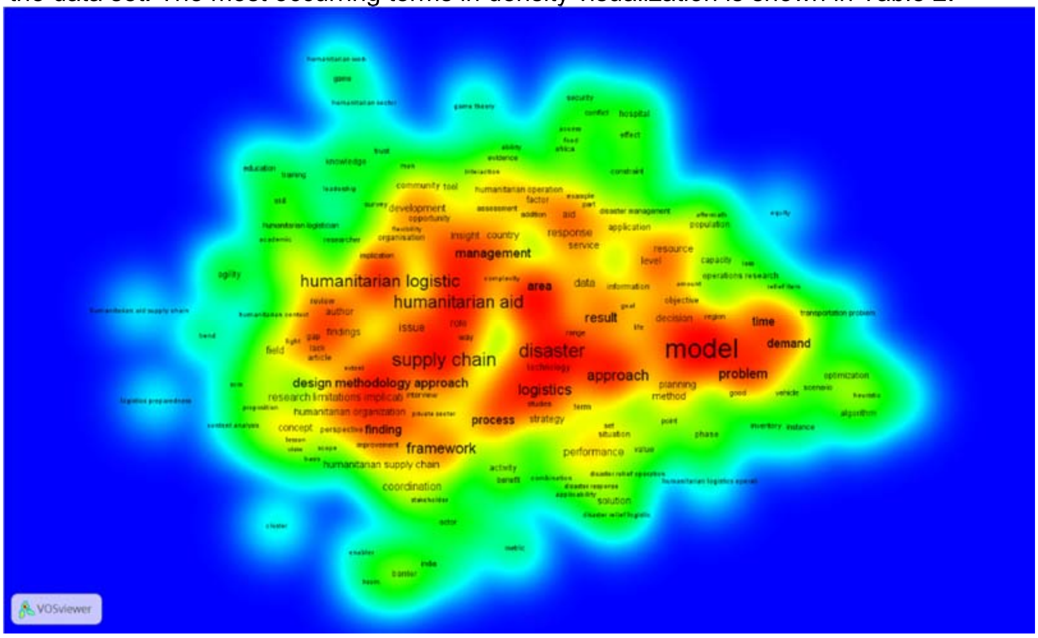

Figure 3: Density Visualization.

Term map of the field of humanitarian logistics field. Colors indicate the density of terms. The red areas in the density view can be regarded as the most important ones.

Terms	Occurrences	Terms	Occurrences
model	330	result	125
supply chain	206	disaster relief	119
disaster	199	organization	117
humanitarian aid	196	management	117
humanitarian logistic	176	design methodology approach	116
logistics	152	originality value	114
framework	146	time	107
analysis	146	finding	105
approach	144	area	104
system	136	challenge	103
operation	130	process	101
logistic	128	demand	100
problem	127	supply chain management	100

Table 2: The most occurring terms in Density Visualization

Conclusions

This paper is the first in humanitarian logistics to use bibliometric mapping analysis as the main methodology to analyse literature in a structured way, which is of particular value to the academic community as well as practitioners. A representative data set of titles abstracts and keyword of over 309 peer-reviewed articles published in leading journals in the humanitarian logistics field was constructed. With the help of various computer algorithms, key terms were identified and co-occurrence frequencies of these key terms were calculated. Based on the co-occurrence frequencies, the term map was constructed by using computer program called VOSviewer. The term map provides a visual representation of the humanitarian logistics field by showing the relations between 158 key terms in the field. The term map that was produced contains 6 clusters, namely model, humanitarian logistic, humanitarian aid, supply chain, logistic and management. The density visualization reveals the most important terms in the field of humanitarian logistics.

Furthermore, instead of term maps based on term co-occurrences, other types of bibliometric maps may be used. One may for example use maps of documents, authors, or journals. Instead of term co-occurrences, one may use co-citations or co-authorships to measure relations between items.

However, Interpretation of a bibliometric map is not entirely straightforward. Because bibliometric mapping has a number of limitations, the interpretation of a map should always be done in a very careful manner. Essentially, there are two types of limitations of bibliometric mapping, namely limitations imposed by the data and limitations imposed by the map. The availability of data will always be limited, and the data that is available will always contain a certain amount of noise. In our case, noise in the data may arise from the somewhat arbitrary decisions researchers make when choosing the terminology they use in the titles abstracts and keywords of their articles. Researchers may also use synonyms and homonyms. Our techniques do not recognize synonyms and homonyms, and this may also make the interpretation of our results somewhat ambiguous. A map provides a simplified representation of reality, and simplification generally implies some loss of information. In our case, there is a loss of information because terms are put in an Euclidean space and because this space has only 2-D. Given the limitations of both bibliometric maps and expert knowledge, a bibliometric map can best be seen as a tool that supports experts to improve their knowledge of a certain domain.

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BUSINESS PERFORMANCE AND PROCESSED FRUIT EXPORT SUPPLY CHAIN IMPROVEMENT OF THAI SMES TO INDIA MARKET

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Introduction

Terms of SMEs or small to medium-sized enterprises has become noticeable in Thailand since 1997 after an occurring of economy crisis. The government launched many economic measures to protect the economy. One of the measures was promoting small to medium-sized business in many aspects. Motivating SMEs in proper way leads to income distribution as SMEs consist of three main sectors; manufacturing, trading, and service. Hence, such sectors can support unemployment condition and create value-added comparing to Large-sized business which rely on high technology and imported resources.

An exact meaning of small to medium-sized enterprises or SMEs relies on the country. As for Thailand, when an enterprise has less than two hundred employees and/or its fixed capital is less than around US$5.7 million, it will be categorized as SMEs. There are nearly three million SMEs existing in Thailand, which equal to ninety-nine percent of entire Thai enterprises.

Thai Processed food industry is a high capability industry in export competition since Thailand is in the world top-ten rank of processed food export measuring by value. In 2015, the total export value of Thai processed food was 17,322.36 million USD which around 43.2 percent of such value came from an exporting of SMEs sector (Kasikorn Research Center, 2016). One of the noticeable processed food products of Thailand is processed fruits which have been also export globally in high proportion with a figure of 57 percent of total fruit exporting.

Moving to a destination market, imported quantity figure of processed fruits has rose eminently over the last ten years from 22.7 thousand tons (US$27.3 million) in 2006, then doubled to 50.1 thousand tons (US$81.8 million) in 2016 (Global Trade Atlas, 2017). This reflects an interest of processed fruit and potential purchasing among India market. The data conforms to a study of Kumar (2011) which indicates that Indian consumers tend to spend higher amount of money buying processed food due to their increased income. Furthermore, EXIM Bank Thailand (2012) also reveals that Indian middle-class consumers open their mind to new types of food such as instant food and ready-to-eat food more than those in the past.

To take a closer look into specific products, although India has been importing various processed fruits from Thailand, it imported just tiny amount of processed longan, tamarind, and coconut even though the products are the noticeable exporting processed fruit for Thailand. This situation is curioused by the researcher, are exporting risk(s) and SMEs' business performance play an important role in this situation or not?

This paper will investigate three dimensions on key success factors and one dimension of exporting risk, along with an interest in exporting to India market to explore the business performance and readiness of processed fruit SMEs, especially processed longan, tamarind, and coconut SMEs toward India market.

Research Objectives

This research is a study of business performance to improve processed fruit export supply chain of Thai small to medium-sized enterprises (SMEs) to India Market. The research aims to find business performance and exporting risk in SMEs' perception which can specify objective as follows;

1. To study the business key success factors of processed fruit SMEs in Thailand toward India market, what factors should be promoted or enhanced by SMEs themselves?

2. To find significant exporting risk(s) among SMEs' perception, what exporting risk(s) should be concerned to bring SMEs to get to India market in terms of governmental supporting?

Conceptual Framework

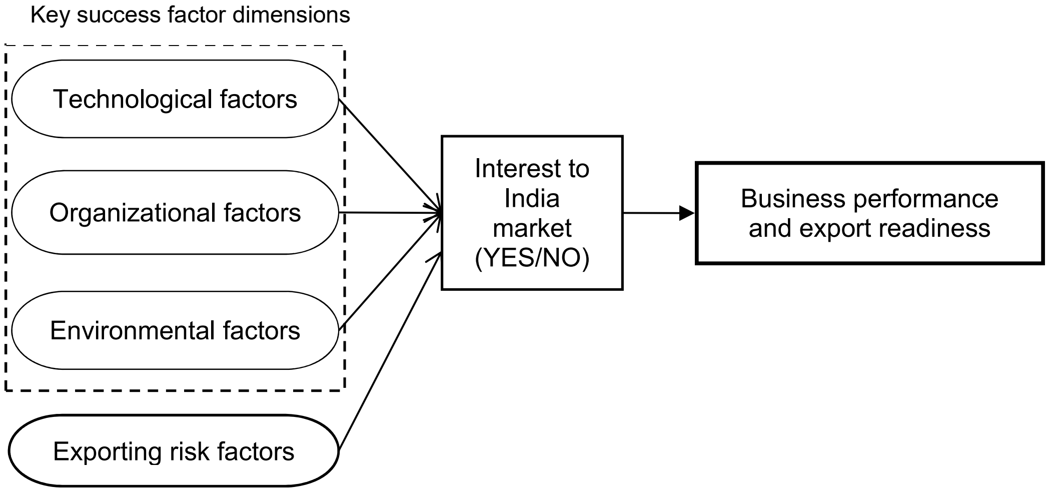

Figure 1: Conceptual Framework

Figure 1 illustrates a conceptual framework of this research. As the conceptual framework applying from TOE Framework of Tornatzky *et al.* (1990), the research aims to study three dimensions of key success factors; technology, organization, and environment, and one dimension of an exporting risk perception which were assumed to be a function of the interest in exporting to India market (Interested or not interested). Then the research can get the results of business performance and export readiness of Thai processed fruit SMEs toward India market.

Literature Review

This topic provides reviews of literature which relate to business performance and processed fruit export supply chain improvement of Thai SMEs to India market in terms of both theoretical idea and related research. The chapter was divided into two parts beginning with research's theoretical idea, the TOE framework, following by related research.

TOE Framework

The concept of TOE Framework was developed by Tornatzky *et al.* (1990) which consists three contexts; technological, organizational, and external task environmental. These three factors are linking each other and the three contexts lead to technological innovation decision making. To take a closer look among three factors, Mingmalairaks (2011) had been adjusted the TOE Framework to be suite with Thai context and business performance evaluation. First, organizational context was defined in terms of such as business size, firm culture, organizational structure, management style, innovation capability, and quality of human resource. Technological dimension concerns about both internal and external technology contexts such as machine efficiency, capacity of machine, information quality, and compatibility, while the last factor, environmental context, is a field in which an organization conducts its business with external tasks such as competitors, suppliers, customer requirement, accessing to resource, stakeholders, and government influence.

Related Research

Business performance can be measured in several ways. In traditionally, the measurement of business or company performance will focus on financial terms. However, many scholars have suggested that to comprehensively analyze business performance, the use of both financial and non-financial dimensions can measure business performance in terms of both operational and marketing performance (Hu *et al.*, 2017). To start a business, of course, business or company will face some obstacles in running a business due to financial problem or technology in production. Irjayanti and Azis (2012) studied about business performance of SMEs in Indonesia by identifying obstacle factors faced by SMEs which are competition barriers, financial access, price of energy; technology, inefficient production cost, economic factors, management skill, process, limitation of sales, and raw material.

Building identity and reputation are also noteworthy for starters like SMEs. As for small-sized business, three themes that business owners have to concern to create identity are consistency, internal training, and human capital and three themes to build reputation are credibility, transparency, and legitimacy (Huang, 2015). Other than that, the findings of Appiah and Singh (1998) present that environmental variables may influence the degree of customer orientation and then the customer orientation is significantly and positively related to business performance across a range of small and medium-sized companies.

As for small-sized business, Yusuf (1995) classified critical success factors for small business and test them with South Pacific entrepreneurs. The nine factors classified are 1) good management; 2) satisfactory government support; 3) Marketing factors; 4) overseas exposure; 5) level of education and training; 6) access to finance and level of initial investment; 7) personal qualities; 8) prior experience in business; and 9) political affiliation. The result of Yusuf indicates that good management is the most significant factor of small business success, follows by accessing to financial and level of initial investment and personal qualities, while marketing factors has the least effect on small-sized business success. The study conforms to a study of Ghosh *et al*. (2001) which strong management team and leadership and an ability to identify and focus on market are key success factors of top SMEs in Singapore.

Research Methodology

The research was designed as a quantitative research using five-point Likert-scale questionnaire to collect the data from entire 111 SMEs producing processed longan, tamarind, and coconut in Thailand (Department of Business Development, 2017). The questionnaire was designed in both paper-based format and online format.

As for questionnaire design, each questionnaire consists of four main parts. The first part is general information such as business-running age, number of employee, and type of production as questions will be asked with choice-answer type. Next part is an export experience information and interest in exporting to India market. The third part is key success factor questions which ask how respondent agree with each factor that firm has been applied in doing business (5 means strongly agree until 1 means strongly disagree). The last part is risks of exporting goods to India market in perception of a respondent.

The research aims to test a degree of relationship of key success factors and exporting risk factors if each factor relates to the interest in exporting goods to India market or not by applying Paired-Samples t-test approach and using SPSS statistical program to analyze a quantitative data.

Results and Discussion

After the questionnaires were sent to 111 SMEs, there is 76.6 percent of questionnaire's return rate (or 85 questionnaires). In general, most of respondents are small-sized enterprises. 38 percent of respondents have been running business for more than 10 years, following by 6-10 years of running business with a figure of 29 percent. Most of respondents have their own product's brand with a figure of 41 percent, while brand with OEM (Original Equipment Manufacturer) production took place at 35 percent.

As for interest of India market, there are 76 enterprises (or 89 percent) who are interested in export their products to India market by both their brand and OEM. The rest 11 percent of respondents who are not interested explains that they have faced with insufficient production and presently desire to focus just only in domestic market.

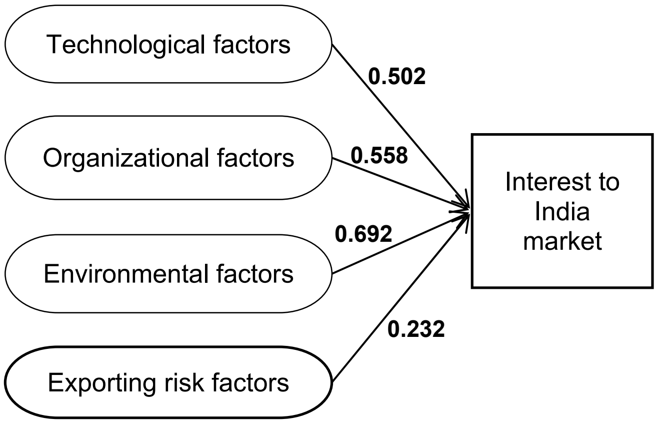

Figure 2: Interest to India market and factors' correlation

Figure 2 refers to an Interest to India market with factors' correlation; technology, organization, environment, and exporting risk factors. In overall, environmental dimension has the highest correlation with interest to India market, following by organizational factors, and technological factors, respectively. As for exporting risk factors, the correlation between such factors and interest to India market shows small figure, which means an interest to India market has low relationship with exporting risk factors. However, specific factors in each group will be discussed next.

The finding reveals that governmental assistance factor has the strongest relation among environmental factors with a correlation of 0.317, means that government support is a significant key success factor exporting products to India market in a perception of respondents. As for organizational dimension, exclusive or CEO's experience is a significant key success factor of business among organizational factors with the correlation figure of 0.205. Meanwhile, quality of products is a significant key success factor among technological factors with the correlation figure of 0.246. Lastly, even exporting risk factors have low relationship with an interest to India market, Indian consumer behavior is a remarkable exporting risk in SMEs' perspective with a figure of correlation -0.112. This correlation means that the SMEs will give low interest to India market so long as there is no information about Indian consumer behavior.

Conclusions

This paper presents important key success factors and exporting risk of processed fruit SMEs in Thailand to indicate a business performance and readiness toward an exporting processed fruit to India market. The data was analyzed through technological, organizational, and environmental contexts. All in all, from the contexts of technological, organizational, and environmental, the SMEs have business performance and readiness for exporting processed fruit (longan, tamarind, and coconut) to India market, especially a government-supporting factor which can push the SMEs toward an interest of new market. Business matching between Thai producers and Indian trader should considerably be arranged by the government to fulfill a business accomplishment.

This research is a study on only supply side, however, a demand-side study should be focused as well. A study of Indian consumer behavior towards processed fruit should be researched to comprehend the consumer behavior, such as what taste they like, which market segments should be focused, or their purchasing decisions.

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CHALLENGES AND OPPORTUNITIES OF INDUSTRY 4.0 FOR LOGISTICS & SUPPLY CHAIN MANAGMENT

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ABSTRACT
Purpose: Around the world, traditional manufacutring industry is in the midst of a digital transformation that is accelerated by exponential growing technologies, commonly encapsulated by the term - "Industry 4.0". It encompasses a promise of a new industrial revolution—one that marries advanced manufacturing techniques with the Internet of Things (IoT) to create a digital manufacturing enterprise that is not only interconnected, but communicates, analyzes, and uses information to drive further intelligent action back in the physical world (Deloitte University Press, 2017). The ubiquitous connection of people, things and machines through networking across the "internet of things", services, data and people. Logistics and supply chain processes will have to transform and shaped in order to work seamlessly with these disruptive technologies that will create a seamless link between the virtual world and physical object in the real world (Hofmann & Rüsch, 2017). This study fills this gap through a conceptual research approach (Meredith, 1993) to provide a better understanding of this rather undiscovered topic. To this end, this study raises three key research questions: - (1) What are the potential benefits in adopting disruptive technologies in logistics and supply chain management (LSCM)? (2) How can organisations manage challenges in process transformations based on a lean perspective and (3) What are the relevant skillsets that the future of work will entails in LSCM?

Design/methodology/approach: Although Industry 4.0 and the relevant disruptive technologies have received a lot of attention recently in practitioner oriented articles, research in this area remains scarce. An exploratory research approach is employed as we aim to provide a holistic overview of the implications of Industry 4.0 in LSCM by addressing the prior research questions. The exploratory study involves an initial phase of narrowing down the relevant literature in Industry 4.0 and the context of LSCM. This was accomplished through an extensive desk research on extant literature and accompanied with multiple unstructured discussions within the research team of the authors and practitioners whose organisations and operations are involved in implementing change and transformations in their work processes.

Findings: In addressing the three research questions, this study first sets out the key challenges that logistics and supply chain companies face in digital transformation and the potential benefits from a successful adoption of exponential technologies. To aid companies in successfully manoeuvre the transformation processes brought about Industry 4.0, the paper focused on how companies can transform work processes using a systematic approach that is guided by the lean philosophy to enable real time integration of networking systems, supply chain transparency and optimisation. In particular, we make use of lean methodology to examine how basic principles and tools in lean can be integrated with the next generation of logistics and supply chains to bring about simplification in processes and operational complexity. In addition, this paper provides insights on the core skill sets that the manpower has to be equipped with in order for people to work seamlessly with technologies, automations and robotics in the same organisation.

Originality/Value: The findings from this study is expected to provide a deepened understanding on the impact of transformations that can be brought about by disruptive technologies.

Practical implications: Logistics practitioners and supply chain managers can make use of the findings to (1) make informed decisions in streamlining LSCM processes by adopting lean as an established management approach, and (2) equip the existing workforce with the necessary skill sets so as to support the organisation in reaping the potential of disruptive technologies.

Keywords: Disruptive Technologies, Logistics and Supply Chains, Skills sets, Lean, Conceptual Paper

Introduction

In this unprecedented globalised era, where humans, objects, data are more interconnected than ever, the 4th Industrial revolution is set to bring it to another level. Companies are leveraging on disruptive technologies to achieve competitive advantages. (Angappa et al., 2017).

The first two industrial revolutions had bought on the modern life necessities such as steam water power mill and electricity. The 3rd industrial revolution formed the roots for modern day landscape such as emails for daily work communication, invention of printed circuit boards that are present in almost all electronic appliances, all of which are incorporated in today's revenue generating activities. (Nicholas, 2017)

In pursuit of progresses, the 4th industrial revolution has sprung up in recent years. It seeks to 'disrupt' the existing logistics and supply chain management landscape through disruptive technologies and corporations are incrementally adopting disruptive technologies such as Amazon's kiwi robots in their warehouses (Amazon robotics., n.d.) and Foxconn's Foxbots (Kristin 2017)

Moving forward, many corporations are under pressure to follow suit or risk been made obsolete by market forces. Work processes are expected to transform with the adoption of disruptive technologies and workers will have to learn, unlearn and relearn knowledge, skills in order to bridge gaps in manpower's competencies and abilities. Therefore, lifelong learning and upskilling through work-based training will be pertinent so as to meet the demands in the work transformation processes.

This paper examines three key areas in relation to the impact of disruptive technologies. They are: (1) what are the potential benefits in adopting disruptive technologies in logistics and supply chain management (LSCM)? (2) how can organisations manage challenges in process transformations based on a lean perspective and (3) what are the relevant skillsets that the future of work will entails in LSCM?

In similar vein, the objective of the lean methodology has traditionally been in cutting waste and improving the efficiency of operations through the eliminations of bottlenecks in the processes. We posit that LSS complements the rationale for the adoption of disruptive technologies in operations and process in optimising the output of logistics and supply chain processes. Both seeks to improve operational visibility and process performance

The rest of the paper is structured as follows. Section 2 explains the method of this study and provides background for the conceptual paper. Section 3 first presents a general overview of the relevant literature that are systematics reviewed and analysed to address our subsequent address to the three research questions. Section 4 presents the findings in response to the three research questions. Section 5 summarises the chief findings of this study, and section 6 discusses potential implications of the study to practice and research in the adoption of disruptive technologies in LSCM.

Research Method

Although Industry 4.0 and the relevant disruptive technologies have received a lot of attention recently in practitioner oriented articles, research in this area remains scarce. An exploratory research approach is employed as we aim to provide a holistic overview of the implications of Industry 4.0 in LSCM by addressing the prior research questions. The exploratory study involves an initial phase of narrowing down the relevant literature in Industry 4.0 and the context of LSCM. This was accomplished through an extensive desk research on extant literature and accompanied with multiple unstructured discussions within the research team of the authors and practitioners whose organisations and operations are involved in implementing change and transformations in their work processes.

Literature – A Systematic Review

Logistics operations has evolved from military context in the 18th Century of troops management (Michael et al., 2005) to today volume of 85 million packages and documents delivered around the world at any single day. These massive delivery volumes reflect the huge number of jobs generated from the sector. Traditionally, the logistics and supply chain management function had been viewed as a cost centre, associated with laborious and heavily dependent on human resources.

Streamlining LSCM operations have been an incessant issue as output variability is high in work processes that are infused with tasks that are performed by operators that are proficient at work to different degrees. Variance in the knowledge, skills and abilities of workers further add onto the pyramid of spatial factors, making it a challenge to achieve an optimal output in logistics operations.

Research has shown that logistics and supply chain companies are adapting disruptive technologies to collaborate with manufacturers for real time data exchange for supply chain visibility. Manufacturers are introducing robots to assist workers on repetitive strenuous tasks ("BMW Group Harneness"., 2017) robots are used in warehouses to enable automated picking and packing processes (Sam, 2017) and cyber physical systems are used to allow synchronised decision marking through a real time view, discussion and analysis of critical information on a dash board (Hofmann & Rusch, 2017). These disruptive technologies will shape a new way of working and an updated need on skill profile and manpower competencies. Insights on the benefits promised by the adoption of disruptive technologies is presented in the findings section.

Findings

The findings section is structured in three sections in accordance to the three guiding research questions that this study has raised.

Research question (1): What are the potential benefits in adopting disruptive technologies in logistics and supply chain management (LSCM)?

These technologies are likely to bring about changes to existing job processes, information visibility and accuracy and manpower allocations. What is more pertinent is that disruptive technologies seek to eradicate the bottleneck issues the industry have been facing. These technologies and its potential benefits are summarised in Table 1.

Potential benefits	Technologies
Maximise operational output by 24/7 utilisation	Self-driving vehicles (Logistics Trend Rader, 2016)
Real time data visibility (Hofmann & Rusch, 2017)	Cyber physical systems
Predictive modelling and advanced decision making	Big data and data analytics
Increases the company's agility to market fluctuations thereby achieving a lean deployment.	Autonomous robots (Logistics Trend Rader, 2016)
Shortening of logistical turnaround time effectively	Internet of things (Witkowski, K. 2016)
An alternative to last mile delivery transport with a potential of shorter turnaround time	Drones (Logistics Trend Rader, 2016)

Table 1. Summary of Technologies and Potential Benefits

Research question (2): How can organisations manage challenges in process transformations based on a lean perspective?

Lean management in an era of disruptive technologies

Invented by Henry Ford (Lean History, 2017) and successfully implemented by Toyota (Lean Origin, 2017), lean aims to create value with minimal resources, the lean principle prescribes an operational system that places emphasis on results and effectiveness rather than process and not a system that proposes standardized management logic (Fullerton and McWatters, 2001). The central idea in the "lean principle" is the removal of unnecessary waste during the production process. If resources are consumed without creating value, they become waste. Ohno (1998) defined seven types of waste that create no value: Over-production, defects, inventory, transportation, waiting, motion and over-processing. Liker (2004) proposed an eighth type of waste: inappropriate design. If these categories of wastes can be removed and the manufacturing process continually improved, a perfect lean production enterprise should be an achievable goal.

This underlying motivation that endeavour to improve the efficiency of effectiveness of operations and work process resonates with the adoption of disruptive technologies. Organisations can attempt to adopt lean methodologies to make systematic process transformations. Table 2 provides an overview of the eight forms of waste that are commonly abbreviated as "TIMWOOD" (lean, 2107)and examples of waste under each category in the lean literature.

Abbreviations	Waste Category	Example of waste
T	Transportation	Excessive transportation of inter-plant cargoes due to lack of appropriate vehicles
I	Inventory	Holding more inventory than what is required to service their stakeholders
M	Motion	Extra time and steps spent searching for correct cargo location, tools and equipment
W	Waiting	Time spent waiting for upper stream stakeholders such as order generation
O	Over processing	Prepare more than what their stakeholders require with a mindset of being able to complete the work in advance
O	Over production	
D	Defects	Mishandling of equipment, tools and cargoes

Table 2. Categorization of the eight types of wastes under lean management

High quality by adopting lean in disruptive technologies

Certain skills such as physical labour and manual dexterity are expected to be displaced by disruptive technologies. This signifies a need for transformations in logistics operations and supply chain processes. Lean is an established management philosophy, which has been widely applied in process streamlining and operations improvements. By adopting lean tools, organisations can expect to produce high quality work by improving TIMWOOD. This has to be done from ground up perspective where the stakeholders' voices are heard:

Objectives	**Tools**
To understand internal and external stakeholders' requirements bought on by disruptive technologies	Voice of customers
1) Holistic view of existing department and inter-department processes 2) To analysis for signs of ineffectiveness and/or inefficiencies along the work processes	Value stream map/swim lane diagram
Takes into account all major and its sub problem causes systematically. This allows for an informed and critical analysis of the problems	Ishikawa diagram
A mistake proofing tool that attempts to acts as a 'gate keeper' by informing the executor when the variables of the tasks being performed are not met. Related technologies can be programmed to assist the worker in this aspect.	Poka Yoke
Provides real time data for synchronised analysis and decision making on a strategic, tactical and functional level.	Dashboard

Table 3. Categorization of the eight types of wastes under lean management

Lean tools can be introduced at different stages of process streamlining to ensure a careful and sequential transformation. (Martin J.W., 2017) If implemented correctly are expected to bring about the improvements of various (non-exhaustive) performance metrics. As depicted in table 4, various sets of lean tools can be applied to address issues in relations to the performance metrics that are tracked by many organisations such as the customer satisfaction level and order accuracy. The list in table 4 is not exhaustive.

Tools	Performance metrics
Voice of customer	Customer satisfaction level
Swim lane diagram	Work process throughput
Ishikawa diagram	Order accuracy level
Poka Yoke	Improved order accuracy

Table 4. Categorization of the eight types of wastes under lean management

Besides addressing the process changes in an organization, people in the organization needs to be trained and equipped with the necessary skill sets and knowledge in order to work in synergy with technologies. In the following section, we address the third research question and shed light on the core skill sets that would be relevant and beneficial with the transformed operations so that people can be competent to work seamlessly with advanced technologies in the future of work.

Research question (3): What are the relevant skillsets that the future of work will entails in LSCM?

All in all, as the industry is expecting major changes to its work processes, it does not seek to eliminate humans from its processes. Rather, it attempts to bridge the gap between existing performance and desired performance.

We are also at an intersection era where non-digital natives and digital natives are going through different form of transformation to eventually live and work with the 4th industry revolution. However, there have been fears of disruptive technologies replacing their existing jobs. (Joerres et al., 2016)
Demand for existing skill sets may be significantly reduced, either across the industries or aggregately whereby workers' skill is still required but in new industries bought on by 4th industry revolution effects. New domain knowledge and skills may emerge too. (Joerres et al., 2016)

The logistics and supply chain industry is expecting significant growth due to increasing globalisation and supply chains being more connected/intertwined than ever. To fill up the knowledge and skills gap and manage the growth, it is pertinent the government, industry leaders, educational institutions collaborate to manage the change effectively across all levels (strategic, tactical and operational). Domain and quantitative knowledge are expected to be the key drivers in training an effective supply chain data scientist (Waller M.A., Fawcett S.E., 2016) who will exploit the technologies to maximise its benefits for businesses.

Research has shown, practical skills have equal importance with formal qualifications. Certain skills that involves physical labour and manual dexterity might be close obsolescence whilst technological familiarization and cognition skills that facilitates the connections of machines and human will be of core importance across various technologies (Joerres et al., 2016). Table 2 provides an overview of the relevant skills family and technologies that will be of importance in this age of disruption. These skills are expected to be high in demand or at least stay at current demand by 2020 in the logistics and supply chain industry (Joerres et al., 2016).

Along with retraining, workers will be expected to have increased ownership in their work pertaining to utilisation of the technologies. Managing the change barriers and risk effectively (Joerres et al., 2016) envisages a relationship where digitalisation and automation complement organisations to bring about competitive advantages and better quality of work and life. To manoeuvre the intricacies of process transformations, human resource management and manpower competency in relations to the skill sets are highlighted in Table 5.

Technologies	Skills family	Skills
Self-driving vehicles	Content skills Social skills	ICT literacy and active learning Coordination
Cyber physical systems	Social skills	Emotional intelligence Coaching Negotiation Coordination Communication
Autonomous robots	Content skills Social skills	ICT literacy and active learning Coordination
Internet of things	Cognitive abilities Social skills	Logical processing Coordination
Drones	Resource management skills Social skills	Managing of Financial, Materials, People and Time resources. Coordination
Big data and Data analytics	Complex problem solving Social skills Process skills	Complex problem solving Emotional intelligence Coaching Negotiation Coordination Communication Active listening and critical thinking

Table 5. Summary of Technologies and Potential Benefits

Industry 4.0 - Manpower training and Skillsets

The research methodology had proposed a change in workers' skills with the introduction of disruptive technologies, as such, human resource management is critical is to ensure smooth process transformation. It is recommended to incorporate human elements in readjusting manpower deployment.

Along with adapting disruptive technologies, the organisations have to consider human resource management in their business transformation strategy to achieve high receptivity by internal stakeholders. It is recommended to take an incremental approach with constant communication and education as changes are often met with resistance.

Managers at different level should demonstrate skills listed in table 2 which are instrumental in change management. It is recommended to introduce incremental changes through pilot tests and identify receptive workers to be involved in the tests and leverage on their sphere of influence to educate and transform the mindset of less-receptive workers.

While human redundancies are expected in Industry 4.0 with the introduction of various technologies throughout the decades, communicating the idea of human-technologies collaboration and predecessor cases is expected to assist the workers in accepting these changes.

Conclusions and Implications

The paper explored and discussed the potential benefits and changes brought on by disruptive technologies and how it can be managed by lean six sigma and human resource management.

While there has been extensive research on disruptive technologies, little has been said on managing these technologies on an operational level and the changes that comes along with it. To ensure the success of disruptive technologies implementation, it is critical to manage change effectively. Effective management would mean a transformed organisational strategy and better quality of work.

The paper attempts to provide a better understanding on the implications of Industry 4.0 on LSCM by first setting out the key challenges that logistics and supply chain companies face in digital transformation and the potential benefits from the successful adoption of exponential technologies. To aid companies in successfully manoeuvre the transformation brought about Industry 4.0, the paper focused on how companies can transform work processes in the digitalised age by using a systematic approach that is guided by the lean philosophy to bring about simplification in processes and operational complexity. In addition, this paper provides insights on the core skill sets that workers have be equipped with in order for them to work seamlessly with disruptive technologies. Overall, this paper serves as a source of reference for organisations that seek to adopt these technologies on its selection and management- Planning, Organising, Leading and Controlling (Robbins and Coulter, 2014). For consultancies and learning institutions, this work may serve as a new school of thought in pushing for mass adaptation of disruptive technologies and operational transformations in logistics and supply chain management.

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CONSISTENCY OF THREE SELECTED BANKRUPTCY PREDICTION MODELS

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Abstract
Purpose: This paper aims to analyze the bankruptcy models developed by several authors, elaborating the consistency of the models in predicting the performance of the representative transportation companies. By analyzing the stated issue, suggestions are the focus of what should be noticeable if one is to conduct a similar research on bankruptcy prediction, improving the quality of the research.

Methodology: The paper chose to use three models with nearly similar set of indicators to create a basic analysis of them on how they predict the bankruptcy rate in transportation sector. Using samples of 30 transportation companies as database for the models, the paper summarized 11 indicators used among the three models and construct the database then proceed to apply the collected data into the models. Then the paper conducted simple comparison and analysis with the aggregate score compiled into tables. The secondary data collected from the firms has proven to be valuable for future research.

Findings: Altman Z-score utilizes more indicators and the prediction scores tends to follow a very broad sense, whereas the the Springate model and Zemijewski model presented a form of collective score largely based on the firms' selective financial results. Other authors or readers should pay attention to each model in their predicting capability in order to avoid confusion when considering a research in the similar field. As the statistical method is the single conduct with simple key indicators, more complex or hybrid methods should be in consideration for future research in order to better utilize the source of data available for research.

Originality/value: the paper was in conduct with the most recent data sample utilizing the range of data used for the comparison with the latest 5-year period. The paper in a sense illustrates the most basic concept on the development of bankruptcy prediction.

Keywords: bankruptcy prediction models, transportation companies, Altman Z-score model, Springate model, Zemijewski model, sample, review

Introduction

The World Economic Crisis in 2008 has affected several key industrial sectors in developing the business, heavily affected the transportation at a substantial level, halting the speed of production in major fields. Specifically, the stated Economic Crisis began with the financial sector, following by international trade, production, directly influencing the structure of transportation industry clearly seen in countries with high foreign trade volume (Rothengatter, 2011). Ending in the 2010s, the recovery of the world's economy is showing some expectations despite several obvious obstacles remaining; in transport sector, more specifically in maritime industry, trade and transport volume has not been stable and has several low-points worth noting, such as volumes of transportation passengers and gross weight of goods handled in port staying near the minimum level (Collet, 2013). Therefore, the need for financial failure prediction is becoming more obvious as the results of business bankruptcy likely lead to heavy losses, with its effects directing at the national economy and the employment level (Sulub, 2014)

Regarding the definition of bankruptcy, several trustful sources mentioned different ways to define the phenomenon over the last few decades. Sun et al. (2014) summarized from their findings on classical materials that bankruptcy happens when a firm is overwhelmed with debts or existing dividends, leading to deposit overdraft, serious liquidity for creditors' interests and therefore filing bankruptcy proceedings. In a related research, Camichael (1972) concluded that bankruptcy was the result of a firm' inability in maintaining the balance between its liquidity, equity, debt and capital.

Forecasted by economists and accountants for several years, bankruptcy is considered to be one of the extremely important factors that decide the future of the world's economy. Bankruptcy forecasting therefore has become a trend for several research topics since 1968, with the effective use of predicting models. The first bankruptcy prediction model ever publicized created by Professor Edward Altman was considered to be a monument for the prosperity of the research branch. After Altman's pioneering establishment, several other attempts appeared over the decades, using the methods that are very similar to that of Altman's. The few notable prediction models among those brave attempts were of Grigaravičius (2003) followed by Stoškus et al. (2007), whose research conducted in Lithuana, with a subsequent work concluded that the above-mentioned bankruptcy prediction models were equal in term of accuracy comparing to the international models, such as the Altman Z-score model (Šlefendorfas, 2016). Even more recent ones in measuring with the Altman z-score model were the Bex Index[4] and Baltic Dry Index[5], which can evaluate the performance excellence of an industry or a company (Jurun et al., 2015). Each of these models has been tested and applied in various contemporary situations, including the performance of shipping and transportation companies. Each of those models also requires a different set of indicators, with the similarity happened in one or a few indicators of the sets. The models, therefore, have their own advantages and drawbacks, which this paper will not provide the details of them due to its main focus. The information elaborating above is for the purpose of introducing the history of the bankruptcy predicting models that has become very important in analyzing companies' performance, however rare they might be comparing to other research topics within the finance major.

The purpose of the paper, as previously stated in abstract, will be a focus of a few notable bankruptcy prediction models, namely the Altman Z-score, and the Springate and Zmejiwski models, and their effectiveness when applying to the current situation of the shipping market. By evaluating them with their financial indicators, the paper seeks to provide a comprehensive comparison of accuracy in bankruptcy prediction techniques. Furthermore, this paper will provide the updated financial data with high accuracy and the detailed values of major international stock-listed shipping companies reported primarily in Data Stream, namely NYSE and NASDAQ, for future research's reference.

The organization of this paper's structure is as follow. After the introduction, the second part will present a background of history of bankruptcy prediction models and their structures, as well as basic methodology that previous authors used to apply them under their research purposes. Third section will delve into the case study incorporating the modes into a selective database of companies in the industry of general transportation. This analysis process will be nonetheless comprehensive using the database of chosen companies within the time range 2011-2016. The final section will be a dedication for conclusion and possible future research avenues for all stakeholders.

A review of research on bankruptcy prediction models

Researchers constructed the prediction models by applying statistical methods. Based on their close similarity in the choice of indicators, the paper selected three following models for comparison:

Altman Z-score

In 1968, E. Altman, by analyzing multiple audits among 22 ratios, selected 5 financial ratios he considered as the best predictor of bankruptcy. During the following decades, he made multiples attempts to revise and improve the accuracy of his own model. The newest Z-score model's structure is as follow:

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[1] The Business Excellence Model, otherwise known as the Bex index, represents models based on balance indicators developed for the capital market including (1) Earnings before Interest and Taxes/Total Assets, (2) Net Profit /Equity Capital x capital price. (3) Net Working Capital /Total Assets, (4) 5 x (Net Profit +Depreciation + Amortization) /Total Debt. The model enables a fast and simple evaluation of a company's solvency.

[5] The Baltic Dry Index refers to the economic indicator issued daily and London-based Baltic Exchange, which contains route assessments based only on time-charter hire rates "USD hire paid per day", formulated by ((CapesizeTCavg + PanamaxTCavg+ SupramaxTCavg + HandysizeTCavg)/ 4) * 0.110345333 TCavg = Time charter average. The index measures the demand for shipping capacity versus the supply of dry bulk carriers.

$Z = 1.2x_1 + 1.4x_2 + 3.3x_3 + 0.6x_4 + 1.1x_5$
X1 = Working capital/ total assets
X2 = Retained earnings/total assets
X3 = Earnings before interest and taxes / total assets
X4 = market value of equity / value of debt
X5 = Sales / Total Assets
This model considered the value Z < 1.8 for bankrupt company,
1.8 < Z < 2.675 for likely-bankrupt company
Z > 2.675 for "safe" or non-bankrupt company

Springate Model

In 1978, Gordon Springate developed his bankruptcy predicting model by selecting out four common ratios to test the likelihood that a firm's health is in distress. The model utilized discriminant analysis to conduct scores for each company in sample. Majority of data is collected from the balance sheet, the income statement and cash flow statement.

Z = 1.03A + 3.07B + 0.66C + 0.4D
A= Working capital / total assets
B=Net profit before interest and taxes / total assets
C=Net profit before tax / current liabilities
D=Sales / Total Assets
In this model: if z <0.862, the possibility of bankruptcy is dangerously high and the company's health is considered to be in distressed signal. Springate's test with a sample of 40 companies on this model resulted in an accuracy of 92.5%.

Zemijewski model

The Zemijewski model, invented by Zemijewski in 1984, used analysis based onprobability to predict a firm's bankruptcy within two years.

$Z = -4.336 - 4.513X_1 + 5.679X_2 - 0.004X_3$
X1= Net income/ total assets
X2= Total liabilities / total assets
X3= Current assets / current liabilities
In this model, when Z<0.5, the company's bankrupt probability is highly alerted.

<u>Results of research</u>

As the research's aim is to evaluate the consistency of the three chosen models in predicting the rate of bankruptcy, the structure of the results followed will have a design that helps reflect the comparison clearly. Evaluation for samples is a conduct with analysis and comparison in order to check for inconsistency within the same type of value.

First, we conduct the set of indicators for using in the models. The process began with selecting a sample of 30 firms' data in transportation industry, with a total of 11 indicators. After selection is a review of data and filtering to choose the most completed set of indicators for presenting and subsequent application into models, as shown in the table 1.

With the available data input, the next step was to promptly apply them into each model for outputting results. The process required selecting the appropriate data and applying them into the respective model. The methods used were simple classification and analysis to determine values. After compiling the results into one single table, the comparison is as in the table 2.

	WC	TA	RE	Core EBIT	MC	TL	Sales	EBT	NI	CA	CL
SFL											

2011	18615000	2896128000	254683000	162705000	1318077701	2039037000	295114000	131175000	131175000	192763000	174148000
2012	45114000	2973089000	288510000	207620000	1239474901	1978321000	319692000	185836000	185836000	242632000	197518000
2013	-140236000	3045983000	268602000	117366000	1529437887	1854050000	270860000	89206000	89206000	292204000	432440000
2014	126470000	3041554000	239275000	145146000	1630997297	1888062000	327487000	122815000	122815000	340225000	213755000
2015	136952000	3064825000	277513000	166046000	1495380512	1823015000	406740000	200832000	200832000	375917000	238965000
2016	39457000	2937377000	255630000	168089000	1455886209	1803282000	412951000	146406000	146406000	278427000	238970000
TK											
2011	81826000	11131396000	792682000	98112000	2064626735	7799595000	1953782000	-382431000	-386721000	1212756000	1130930000
2012	32524000	11002025000	648224000	-150393000	2117836285	7781736000	1956235000	-325522000	-311116000	1555425000	1522901000
2013	-270924000	11555701000	435217000	62746000	2756571525	8336087000	1830085000	38352000	35480000	1674590000	1945514000
2014	-30724000	11864212000	355867000	427159000	4083803927	8462737000	1993920000	134175000	124002000	1335252000	1365976000

2015	-567144000	130612480 0	15889800 0	62513200 0	2789709900	9104503000	2450382000	38869300 0	40546000 0	1319644000	1886788000
2016	-365026000	128147520 0	22893000	38429000 0	680513039.6	8476357000	2328569000	11113200 0	86664000	1281434000	1646460000

Table 1. Summary of data collection

Year	Companies / Models	SFL	TK	CMRE	DAC	DHT	DCIX
2011	Altman Z-score	0.816	0.490	0.741	0.374	4.881	1166.250
	Springate score	0.262	0.072	0.331	0.172	-0.182	1.013
	Zemijewski score	-4.545	-4.184	-4.538	-4.353	-3.982	-4.470
2012	Altman Z-score	0.879	0.400	0.759	0.237	-0.772	70.106
	Springate score	0.335	0.005	0.325	0.084	-0.685	0.283
	Zemijewski score	-4.623	-4.212	-4.499	-4.224	-3.296	-4.440
2013	Altman Z-score	0.788	0.415	0.669	0.350	0.441	36.849
	Springate score	0.138	0.059	0.228	0.209	0.392	-0.630
	Zemijewski score	-4.471	-4.353	-4.511	-4.379	-4.395	-3.543
2014	Altman Z-score	0.954	0.632	0.894	0.356	0.663	47.405
	Springate score	0.275	0.186	0.304	0.150	0.225	0.307
	Zemijewski score	-4.525	-4.387	-4.529	-4.333	-4.391	-4.409
2015	Altman Z-score	0.997	0.513	0.885	0.470	1.220	23.692
	Springate score	0.338	0.205	0.335	0.208	0.616	-0.051
	Zemijewski score	-4.638	-4.479	-4.584	-4.480	-4.686	-4.160
2016	Altman Z-score	0.966	0.315	0.701	-1.001	0.650	0.310
	Springate score	0.299	0.144	0.281	-1.037	0.275	-2.560
	Zemijewski score	-4.566	-4.370	-4.483	-3.808	-4.375	-1.814

Table 2. Summary of the results

Note: Green shaded cells implied that the company is highly likely to become bankruptcy forecasted by the prediction models, while the blue shaded cells implied that the company is not likely to become bankruptcy in the near future.

Based on the results, we can see that all three models' consistency is significant when comparing them in scores prediction. As the selected constant numbers and indicators set in each model varies, results also differ by each model. In order to know if a firm's health is in distress or not, as stated previously, their scores will be lower than 1.8 (Altlman Z-score), lower than 0.862 (Springate model) or lower than 0.5 (Zemijewski model). There are overall consistency in all three models; however, as Springate used earnings before taxes (EBT) as an indicator, whereas a number of firms do not have tax responsibilities (due to the laws of the countries or regions they operate in), a slight inconsistency occurred at which the score went down below zero, in contrast to Altman Z-score that has the value much higher than zero at that point. Another reason for this is due to Altman score requires more complete data, which also include the market capitalization (a volatile indicator that depends on a firm's daily stock price) and this is likely to fluctuate strongly for the results, whereas the other two models favor internal data of a firm, thus resulting in a different perspective of a firm's financial health which clearly shown in predicting the odds of bankruptcy for Diana Containerships Inc. between 2011~2015. Note that the data with a negligible inconsistency is normal as the predictors' accuracy varies for each firm with different operating methods. Generally speaking, three selected models have an established status in bankruptcy prediction.

Conclusions

This paper aimed to assess the consistency of similar bankruptcy prediction models, specifically in three popular models called Altman Z-score, Springate and Zemijewski with a sample of six among thirty shipping firms reported in the Data Stream database around the world. Results indicate that more indicators will produce more conclusive results, notably the Altman Z-score; however, selecting indicators with internal perspectives and using more complex constant yield more consistent results, which Springate and Zemijewski models illustrated.

The paper recognizes its limitation on the availability of the data and literature sources that the researchers can access. Due to the limitation of database, the paper was not able to apply the predicting models on already bankrupted large shipping firms such as Hanjin Shipping Corp (Korea), Daiichi Chuo Kisen (Japan), Copenship (Danish), or China's Winland Ocean Shipping Corp. This might have the chance resulting to biased results at some minor points. The use of only three most popular bankruptcy prediction models as without reviewing the other bankruptcy prediction models with more complex structures that might be helpful in increasing prediction accuracy.

The paper suggests that future research could include the following areas. First, expanding the size of the useful database can allow researchers to employ a wider, more complex method to compare the predicting models, reinforcing the transparency of the results. Depending on the amount of data available, researchers can use cross-sectional and panel data to construct and specify the new bankruptcy prediction models. Future research avenues can include the improving the accuracy of bankruptcy prediction by incorporating statistic and intelligent methods, improving the quality of predicting the bankruptcy scores, improving both the accuracy and efficiency of forecasting financial distress companies in the other service industry around the world.

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COORDINATION MECHANISMS IN SUPPLY CHAIN WITH THIRD PARTY LOGISTICS OUTSOURCING

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ABSTRACT

Purpose: By making logistics outsourcing decision, companies have been able to improve the logistics performance, maintain focus on core business, and minimize distribution cost. However in decentralized condition, there is only limited control of the third party logistics service provider (TPLSP), whose logistics service performance affect the products availability, quality, price, and market share. The paper aim to develop the model of coordination mechanisms in supply chain with third party logistics outsourcing.

Design/methodology/approach: Revenue sharing contracts are developed in the proposed model to coordinate the supply chain consisting of a manufacturer, a TPLSP, and multiple retailers. Moreover the incentive and penalty scheme are implemented in accordance to the supply chain logistics service performance, so the risks and the necessary costs could be allocated to all players.

Findings: To increase the desirability level of the contracts for all players, we should determine the contracts parameter so that all entities could obtain higher profit than in decentralized conditions chain and win-win condition can be achieved.

Originality/value: The paper provides new model of coordination mechanism in supply chain with logistics outsourcing and offers the incentive and penalty scheme into the basic model of revenue sharing contracts.

Keywords: Coordination mechanism, Logistics outsourcing, Revenue sharing contracts, Supply chain

Introduction

This study addresses the problem in the supply chain where the distributor supplies the product through third party logistics service provider (TPLSP) to the market with a relatively long distance. Products brought by TPLSP are then accepted by retailers for sale to consumers in the market. Problems arising from the distance that must be taken and the wide area of market penetration that must be met in the process of distribution of products.

As many problem arisen in decentralized supply chains, company control over the interests of TPLSP can not be done completely. This usually poses a problem if at the time of the product distribution practices carried out by drivers of carrier that are not in accordance with the planning that has been done by the company. To be able to maintain market share in market regions, the company must plan carefully how many products must be sent, whenever the product must be accepted by the distributor, and how the delivery process can maintain the quality of the products received by the distributor.

Incentive alignment needs to be done to improve mutual relationships that are mutually beneficial for all players in the supply chain. This study developed a mechanism. Contracts among players in the supply chain of products with the involvement of logistics outsourcing. Supply contract according to Cachon and Lariviere (2005) is a mechanism that can assist in the supply process with the purpose of parameters. This research develop a mechanism model by using supply contract at supply chain with TPLSP being responsible for distribution process and transportation of product to distributor. The existence of supply contract is able to apply incentive and punishment scheme in accordance with the performance of TPLSP. The values of the parameters on the model determined to increase each player profit in the supply chain and the win-win conditions can be achieved.

Model

We consider supply chain system that include three participants: distributor, TPLSP, and retailer. Products will be delivered from distributor by TPLSP to be ready for selling season in retailer. In the model, we considered that there will be three possible conditions. Two condition of supply chain without revenue sharing contract are whether the supply chain is centralized or decentralized. The third condition is supply chain under revenue sharing contracts. The retailer's demand distribution that will be taken into account for its stocking decision is N(μ;σ). Then we denote F as the normal cumulative density function of N(μ;σ), and F-1 as the inverse normal cumulative density function. It assumed that all of players know the information of the demand distribution.

Notation	Description
r	Unit selling price
$D_{(r)}$	Demand level of end customer
$\prod_h$	Total supply chain profit in centralized condition
Q^c	Optimal order quantity in centralized condition
Q^d	Optimal order quantity in decentralized condition
Q^{RS}	Order quantity under revenue sharing contract
c_u	Understocking cost
c_o	Overstocking cost
ω	Wholesale price set by distributor
c_D	The marginal cost of distributor
c_R	The marginal cost of retailer
c_T	The marginal cost of TPLSP
P	Quoted logistics services price provided by TPLSP
p_T	Negotiated penalty cost under-ordered quantity received on time
α	Ratio of under-ordered quantity received on time ($0 \leq \alpha \leq 1$)
φ_R	Contract parameter (1-φ_R) determine the proportion of retailer revenue to be shared to distributor
φ_D	Contract parameter (1-φ_D) determine the proportion of distributor revenue to be shared to TPLSP
$N(\mu;\sigma)$	Normal distribution function

Table 1: Notation.

Formulation Model under Centralized Supply Chain

The condition of centralized supply chain defines the ideal condition, which all the parties throughout the supply chain are under the same firm/ company and not across to other firms, so that the decision making as a whole will have the same direction: to get the optimal solution for the firm itself. In the centralized supply chain, the supply chain expected profit is given by:

$$\prod_h = r \min\left[Q^c, D_{(r)}\right] - (c_R + c_D + c_T)Q^c \quad (1)$$

The optimal order quantity is characterized by a balance between understock cost and overstock cost. The understock and overstock cost is given as follows:

$$c_u = r - (c_R + c_D + c_T + ((1-\alpha)(P - pt)) \quad (2)$$

$$c_o = (c_R + c_D + c_T + ((1-\alpha)(P - pt)) \quad (3)$$

So that the optimal order quantity is as shown below:

$$Q^c = F^{-1}\frac{c_u}{c_u+c_o} = F^{-1}\frac{r-(c_R+c_D+c_T+((1-\alpha)(P-pt))}{r} \quad (4)$$

Formulation Model under Decentralized Supply Chain

Meanwhile under the decentralized condition, all the players make their own decision respectively. The supply chain performance become suboptimal, because each player want to maximize their own profit, so the double marginalization happened.

The expected profit of retailer is given below:

$$\prod_R^d = r\min[Q, D_{(r)}] - (\omega + c_R)Q. \quad (5)$$

The understock cost is calculated as $c_u = r - (\omega + c_R)$ and the overstock cost $c_o = (\omega + c_R)$, so that the optimal order quantity is given as follow:

$$Q^d = F^{-1}\frac{[r-(\omega+c_R)]}{r} \quad (6)$$

For distributor, the expected profit is given as follows:

$$\prod_D^d = \omega Q^d - (((1-\alpha)P + \alpha p_T) + c_D)Q^d \quad (7)$$

Likewise, for the TPLSP, the expected profit is given:

$$\prod_T^d = (((1-\alpha)P + \alpha p_T))Q^d - (c_T)Q^d \quad (8)$$

The order of decision making is described below:

a. Distributor will determine the wholesale price ω_i to maximize their own profit as:

$$\omega = max_\omega \prod_D^d = max_\omega\, \omega Q^d - \left(((1-\alpha)P + \alpha p_T) + C_D\right)Q^d \quad (9)$$

b. Retailer will determine the optimal order quantity Q^d as:

$$Q^d = F^{-1}\frac{[r-(\omega+c_R)]}{r} \quad (10)$$

c. The TPLSP will determine the logistics services price P to maximize their own profit and can be modeled as:

$$P = max_P \prod_T^d = max_P\, (((1-\alpha)P + \alpha p_T))Q^d - (c_T)Q^d \quad (11)$$

Formulation Model Under Revenue Sharing Contract

Under revenue sharing contract, retailer will share certain fraction of their revenue to the distributor. The parameter $(1 - \varphi_R)$ define the certain fraction of retailer revenue shared to distributor. So the expected profit of retailer is given below:

$$\prod_R^{RS} = \varphi_R\; r\,min[Q, D_{(r)}] - (\omega + c_R)Q \quad (12)$$

Likewise the distributor will share certain fraction of their revenue to the TPLSP, so that the expected profit of distributor is given as:

$$\prod_D^{RS} = \varphi_D\left[(1-\varphi_R)(r\; min[Q, D_{(r)}]) + \omega Q\right] - \left(((1-\alpha)P + \alpha p_T) + C_D\right)Q \quad (13)$$

For the player i = 3,4,…,n-1 the expected profit is given as: (14)

Meanwhile for the TPLSP the expected profit is given as:

$$\prod_T^{RS} = (1-\varphi_D)\left[(1-\varphi_R)(r\; min[Q, D_{(r)}]) + \omega Q\right] + ((1-\alpha)P + \alpha p_T)\,Q - C_T(Q) \quad (15)$$

If each player try to maximize their own profits, so the equation of optimal order quantity as follows:

$$Q_R^{RS} = F^{-1}\frac{[\varphi_R r-(\omega+c_R)]}{\varphi_R r} \quad (16)$$

while the $c_u = \varphi_R r - (\omega + c_R)$; $c_o = \omega + c_R$.

To obtain coordination in the supply chain, the contract parameter φ_R, φ_D, ω, and P are designed so that the contract can effectively coordinate all the players. To get the order quantity as $Q_R^{RS} = Q^c$, so we obtain the equations as follow:

$$F^{-1}\frac{[\varphi_R r-(\omega+c_R)]}{\varphi_R r} = F^{-1}\frac{r-(c_R+c_D+c_T)}{r}$$

$$\frac{[\varphi_R r-(\omega+c_R)]}{\varphi_R r}=\frac{r-(c_R+c_D+c_T)}{r} \quad (17)$$

$$\omega=(c_R+c_D+c_T)\varphi_R-c_R \quad (18)$$

$$P=(c_R+c_D+c_T)(\varphi_R+\varphi_D)(1-\varphi_R)-c_T$$

Contract parameter φ_R and φ_D range between 0 to 1, so we can obtain the equations as follow:

$$\varphi_R>\frac{c_R}{c_R+c_D+c_T} \quad (19)$$

$$\varphi_D>\frac{\frac{1}{(1-\varphi_R)}(c_R+c_D)}{[c_R+c_D+c_T]-(\varphi_R+\varphi_D)} \quad (20)$$

The order of decision making is described below:

a. Distributor will determine the wholesale price ω to maximize their own profit as:

$$\omega=max_\omega \prod_D^{rs}$$

$$\omega=max_\omega\, \varphi_D\left[(1-\varphi_R)\left(r\ min\left[Q^{rs},D_{(r)}\right]\right)+\omega Q^{rs}\right]-\left(\left((1-\alpha)P+\alpha p_T\right)+C_D\right)Q^{rs} \quad (21)$$

b. Retailer will determine the optimal order quantity Q^{RS} as:

$$Q_R^{rs}=Q^{rs}=F^{-1}\frac{[\varphi_R r-(\omega+c_R)]}{\varphi_R r} \quad (22)$$

c. The TPLSP will determine the logistics services price P to maximize their own profit as:

$$P=max_P \prod_T^{rs}$$

$$P=max_p(1-\varphi_D)\left[(1-\varphi_R)\left(r\ min\left[Q^{rs},D_{(r)}\right]\right)+\omega Q^{rs}\right]+\left((1-\alpha)P+\alpha p_T\right)Q^{rs}-C_T(Q^{rs}) \quad (23)$$

Numerical Experiment

Numerical example are performed to clarify the proposed model and verify if the model can create the win–win condition, by designing the contract parameters. We use the assumed data from the basic model of the research I. Giannoccaro and P. Pontrandolfo (2004).

Variable	Value
c_R	1
c_T	2
c_D	4
ω	2(P + c_D) = 16
P	$2c_T$ = 4
p_T	2
price r	30
demand D(r)	Normal distribution, mean =100, s.d=30

Table 2: Problem Data

For the purpose of comparing the expected profit, in this research using different ratio of under-ordered quantity received on time (0 ≤ α ≤1).

We can conclude that the supply chain as a whole always receives higher profits under the revenue-sharing contract under than without using the RS contract. Therefore it can shows the revenue sharing contract could coordinate the supply chain and get the better supply chain performance, which indicate by higher expected profit. Moreover the expected supply chain profit under RS contract higher than the ideal condition of centralized supply chain. It shows that the revenue sharing contract is helpful to coordinate the supply chain.

From Fig.4, if we compare all the player expected profit under RS contracts always higher than the expected profit without RS contracts. It means that RS contracts model has high desirability level for all SC players, that obtain higher profit than decentralized condition without RS contracts. Moreover, the rewards and punishment scheme for TPLSP to drive the punctuality of delivery. This scheme implemented to increase logistics outsourcing performance in the supply chain. In the distributor and retailer's perspective, the coordination effect on high profit, due to its benefit to improve the effectiveness and responsiveness to fulfill the customer demand.

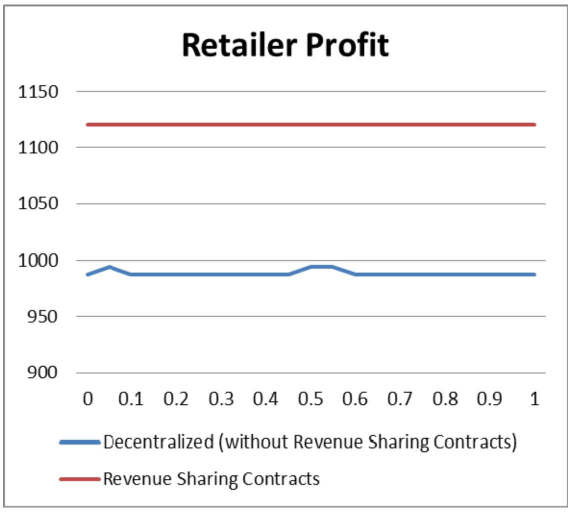

Figure 1: Retailer's expected profit under RS and without RS contract

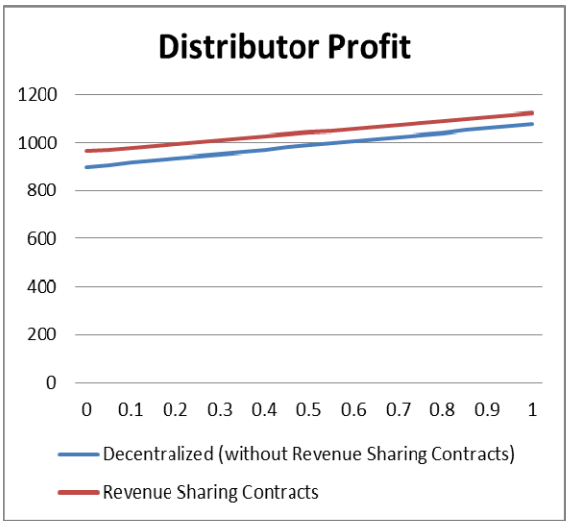

Figure 2: Distributor's expected profit under RS and without RS contract

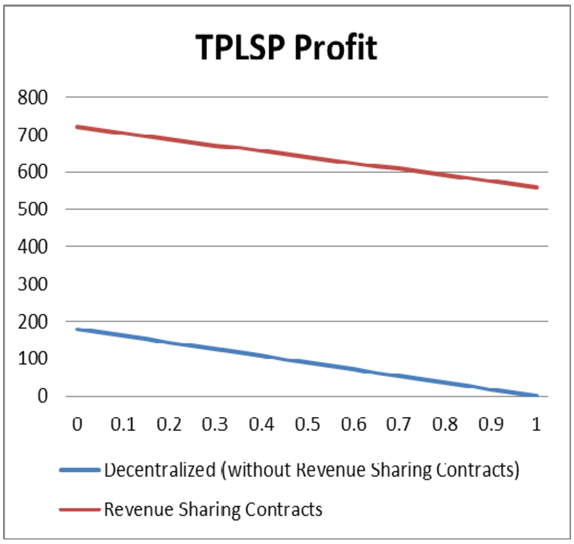

Figure 3: TPLSP's expected profit under RS and without RS contract

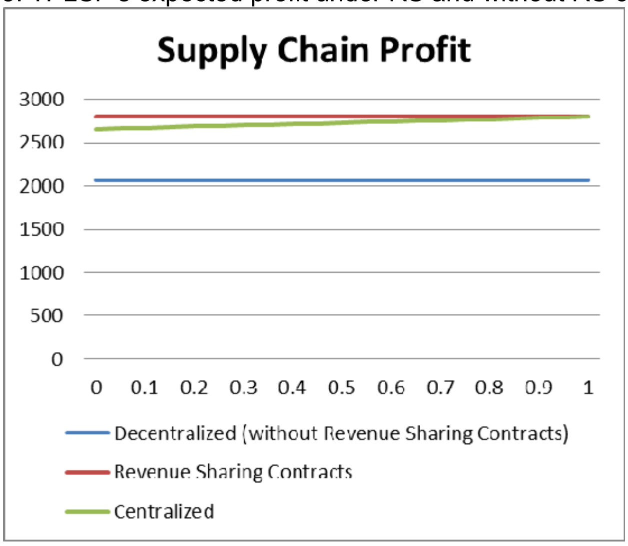

Figure 4: Supply chain's expected profit under RS and without RS contract

Conclusion

Revenue sharing contract model in supply chain involving logistics outsourcing were developed to allocate the profit and risk sharing between supply chain players by implementing the penalty and rewards scheme for TPLSP. Numerical experiment were conducted to simulate the sensitivity of model to the expected profit of each player and the supply chain profit as a whole system. To coordinate the supply chain, revenue sharing contract could be implemented to gain each player's profit. Moreover, the penalty and rewards scheme included in the model to improve the logistics outsourcing performance. The revenue sharing contract model could be implemented in decentralized supply chain to coordinate the logistics outsourcing. With this coordination mechanism model, each player in the supply chain could act with the aim of obtaining the optimal solution for supply chain and it prevents double marginalization practice.

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CUSTOMER ENGAGEMENT AND VALUE CREATION IN AM SUPPLY CHAINS

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Introduction
Recent developments in Additive Manufacturing technology have received increasing attention. Several authors have reported the potential of Additive Manufacturing (AM) in transforming the global supply chains (see e.g. Oettmeier and Hofmann, 2016; Fawcett and Waller, 2014; Despeisse et al. 2016). AM has been characterized as the third industrial revolution which illustrates the potential it is considered to have, not only to the product manufacturing but to the design and supply chain as well (The Economist, 2012). With AM the supply chains have better potential to access and respond to the end value demand by cutting out much of the traditional chain (Laplume et al., 2015). It is thus clear, that AM will change the way we produce value in the supply chains, and in order to capture the potential the technology holds, the roles and structures of the networks have to be reshaped accordingly.

While AM has gained the attention of many scholars and practitioners in different fields, the more recent studies have started to underline the gaps in the AM research. The technical and implementation aspects of the technology have received much of the attention of the previous research, however for example the lack of knowledge in the network and value perspectives of AM has been noticed (see e.g. Hämäläinen and Ojala, 2016; Christopher and Ryals, 2016). This is important especially, as many entrepreneurs are still struggling how to utilise this disruptive innovation technology in their business models and networks (Laplume et al. 2015). In addition, the consumer perspective of value creation has been mostly neglected. Considering the AM technology is estimated to shift the supply chain power to the customers side the perspective is of importance.

One of the most rapid growing trends is personalized manufacturing or desktop 3D printing with privately owned printer (The Economist, 2012; Blua, 2013). This trend has been increasing as the price of the printers have fallen to a fraction of the previous years. Currently a personal 3D printer can be purchased with just few hundred EUR (Laplume et al. 2015). The potential for printing complex and 3D products has become economically and technically viable which has enabled individuals not only to manufacture, but also design the products themselves (DeVor et al. 2012). In addition to this, open access services have enabled different stakeholders to share their design ideas and AM models online. These products include for example toys, tools or different kinds of prototypes (Pearce et al. 2010; Sells et al. 2010). As the manufacturing and designing of different products is available for a vast network online the companies have to find new ways to reach the customer where the understanding of value production is crucial.

Based on above discussion the main aim of this paper is to study the value creation process in open access manufacturing service network. In doing this our main contribution is two-fold: Firstly, we aim to illustrate the formation of value in open access additive manufacturing supply chains by synthesizing the theories from service and value research with supply chain management, and develop a framework which illustrates the customer engagement in creating different natures of value. Secondly, the empirical part of this study provides understanding on what type of products are currently printed with personal 3D printers. The proposed framework is applied to illustrate the different natures of co-created value in case of some representative product examples.

Theoretical Background
By design, the conventional supply chain system is designed to focus and compete mostly in terms of costs and time. With additive manufacturing the principles of mass customization can be utilised where the focus will shift towards the end customer demand and needs. With additive manufacturing the supply chains will become more local and the focus will be more in satisfying the end-user needs through value co-creation.

When considering the additive manufacturing from supply chain perspective, it becomes clear that there is only a sparse literature covering the subject. Overall, the research on AM can be divided into seven different streams of focus (adapted from Oettmeier and Hoffner, 2016): (1) Focus on outlining the current state-of-the-art in AM and its applications (e.g. Bak, 2003; Berman, 2012), (2) focus on developing materials or technologies (e.g. Murr et al., 2012; Janaki Ram et al., 2006), (3) focus on adoption of AM (e.g. Arvanitis and Hollenstein, 2001; Oettmeier and Hofmann, 2016), (4) focus on the costs of AM (e.g. Hopkinson and Dickens, 2003; Ruffo et al., 2006), (5) focus on the implementation of AM and make-or-buy decisions (Mellor et al., 2014; Ruffo et al., 2007), (6) focus on addressing AM in the context of SCM (e.g. Holmström et al., 2010; Khajavi et al., 2014; Nyman and Sarlin, 2014). Where most of the SCM focus has been directed on the impact of AM in spare part supply chain context. While many of the studies mention value of applying AM, only a few of the studies properly address the issue of how value is created through the technology.

By its nature the AM value creation in the supply chain can be considered closer to the nature of service value rather than traditional manufacturing. Overall the service supply chain perspective has been identified and discussed by several scholars, the specifics of their management, and how value is created in the supply chains has been addressed by relatively few (e.g., Vilko and Ritala, 2014; Arlbjørn et al., 2011) and can be considered unexplored in many ways. While the focus on the few existing studies on service supply chains has been in applying the existing traditional manufacturing frameworks in service context the feasibility of those has been considered poor (Vilko and Ritala, 2014; Cook et al., 2002). The benefits that service supply chain management include better coordination of processes, improved performance through process integration, and improvement of the customer interface (Giannakis, 2011) which are essential elements in customer value creation with AM as well, and illustrate the need for research in this area.

Still, several authors have identified the importance of looking at the bigger picture in how AM will impact the supply chain designs (see e.g. Mellor et al. 2014; Khajavi et al. 2014; Vilko et al. 2014; Rogers et al. 2016). Fawcett and Waller (2014) identified four different domains where AM is having an impact: New product development, spare parts management, inventing and customer shopping behavior. This illustrates the wideness of impact that the AM technique has over supply chains. According to Jones Lang Lasalle (2014) there are six major benefits that additive manufacturing provides for the supply chain, namely: Shorter lead times, customized production, better pull effect by the end customer, localized production, lower transportation cost and lower carbon foot print. Still, some professionals have seen AM’s ability to transform supply chains in years away still (see e.g. Banker, 2014)

From supply chain management perspective, the implementation of AM will require changes in roles and in value creation philosophies as the supply chains will have to become more aware of the end customer demand and needs and enable the customer involvement in the supply chain from design all the way to the actual manufacturing process. Therefore, the power in the supply chain will shift towards the customer demand side, and the upper stream value actors will have to adjust their offering accordingly (Christopher and Ryels, 2016).

Creating value in customer engaging AM supply chains

By its nature the AM value creation in the supply chain can be considered closer to the nature of service value rather than traditional manufacturing. Therefore, understanding customer value in AM contexts calls for applying a service logic (Grönroos, 2011) or service-dominant logic (Vargo and Lusch, 2004). In supply chain management literature, the perspective accounting for these issues is the service supply chain. This perspective has been identified and discussed by several scholars, the specifics of their management, and how value is created in the supply chains has been addressed by relatively few (e.g., Vilko and Ritala, 2014; Arlbjørn et al., 2011) and can be considered unexplored in many ways. While the focus on the few existing studies on service supply chains has been in applying the existing traditional manufacturing frameworks in service context the feasibility of those has been considered poor (Vilko and Ritala, 2014; Cook et al., 2002). The benefits that service supply chain management include better coordination of processes, improved performance through process integration, and improvement of the customer interface (Giannakis, 2011) which are essential elements in customer value creation with AM as well, and illustrate the need for research in this area.

By their nature customer value and value propositions are very complex phenomena, and there is no broad-based definition available (Anderson et al., 2006). To gain insight into the distinctive features of value in AM supply chain context, we refer to categorization introduced by Rintamäki et al. (2007) and Talonen et al. (2016), where customer value is divided into four categories: 1) economic, 2) functional, 3) emotional (and experimental) and 4) symbolic (and social). Each value proposition pursues to create value to the customer in one or several 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

Similarly to services, in AM supply chains the value creation process becomes more complex when compared to dyad-level analysis between provider and customer. While the functional and economic value creation has been seen as very difficult issue to handle in complicated, multiparty logistics services, the issue is even more pronounced when it comes to emotional and symbolic value.

Customer engaging value creation in AM networks
Customer engagement in value co-creation refers to the customer provision of resources, that occur in interaction with the focal firm and/or other stakeholders, thereby affecting their respective value creation and outcomes (adapted from Jaakkola and Alexander, 2014). The customer engagement in value creation have been adopted from Jaakkola and Alexander (2014) to four different ways of contribution, namely: 1) Augmental, which refers to the customer contributions of resources such as knowledge, skills, labor, and time, to directly augment and add to the value network's offering beyond the basic level of value. 2) Codeveloping, which means, which refers to the customer contributions of resources such as knowledge, skills, and time, to facilitate the value network's development of its offering. 3) Influental/Defining which refers to customer contributions of resources such as knowledge, experience, and time, to impact other actors' perceptions, preferences, or knowledge regarding the network's offering of value and 4) Mobilizational customer contributions of resources, such as relationships and time, to mobilize other stakeholders' actions toward the network's offering of value.

By synthesising on the previous research we connect the natures of customer value with the natures of customer engagement in the value creation process in supply network context.

		Functional	Economic	Emotional and Experiental	Symbolic and Social
Nature of customer engagement in supply chain value creation	Augmental	Knowledge, skills, labor and/or time augment and add to the networks offering beyond the basic level of functional value	Knowledge, skills, labor and/or time to augment and add to the networks offering beyond the basic level of economic value	Knowledge, skills, labor and/or time to augment and add to the networks offering beyond the basic level of emotional and experiential value	Knowledge, skills, labor and/or time to augment and add to the networks offering beyond the basic level of symbolic and social value
	Codeveloping	Knowledge, skills, and time facilitate the supply networks development of its offering of functional value	Knowledge, skills, and time facilitate the supply networks development of its offering of economic value	Knowledge, skills, and time facilitate the supply networks development of its offering of emotional and experimental value	Knowledge, skills, and time facilitate the supply networks development of its offering of symbolic and social value

	Influential /Defining	Knowledge, experience, and time affect other actors' perceptions, preferences, or knowledge regarding the supply network's offering of functional value	Knowledge, experience, and time affect other actors' perceptions, preferences, or knowledge regarding the supply network's offering of economic value	Knowledge, experience, and time affect other actors' perceptions, preferences, or knowledge regarding the supply network's offering of emotional and Experiential value	Knowledge, experience, and time affect other actors' perceptions, preferences, or knowledge regarding the supply network's offering of Symbolic and Social value
	Mobilizational	Relationships and time mobilize other stakeholders' actions toward the supply network's offering of functional value	Relationships and time mobilize other stakeholders' actions toward the supply network's offering of economic value	Relationships and time mobilize other stakeholders' actions toward the supply network's offering of emotional and experiential value	Relationships and time mobilize other stakeholders' actions toward the supply network's offering of symbolic and social value

Table 1. Customer contributions of different resources to create value in the network

Research Design

The focus of our study was to discover the customer engaging value creation process of the open access additive manufacturing service supply chains. Given the limited amount of research on the subject we chose the explorative case study as our research approach (Yin, 1994). The case study form was seen to work well in serving the information-oriented focus of the research and discovering causalities of the phenomenon (Jensen and Rodgers, 2001; Yin, 1994). The study is based on the integrated literature review of AM, value, service and supply chain perspectives as well as primary data collected from the additive manufacturing service provider Thingiverse data base.

The research was conducted in a four-step research process (see Figure below): Firstly, the identification and forming of the research problem was done based on the experiences of the additive manufacturing technology researchers and a cross-section of the scientific and managerial literature was screened to validate the identified gap both in scholarly discussion and managerial relevance. Secondly, an integrated literature review was conducted and relevant case data was collected from the Thingiverse online open access service. The Thingiverse service provider was contacted to inform about the research interest and to validate the relevancy of the case and information collected. Thirdly, based on the synthesis of relevant sources, a theoretical framework was developed and finally applied in the fourth step to illustrate the customer engaging value creation in open access AM service network.

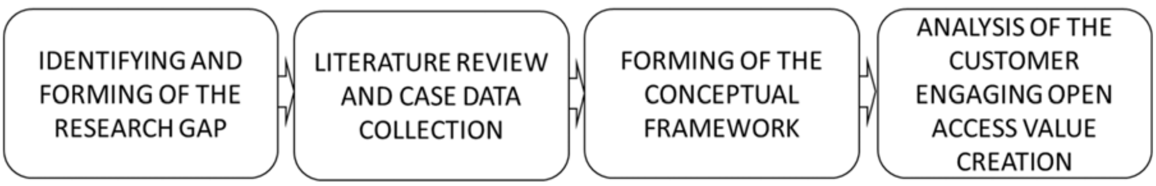

Figure 1. Research process

Case

The empirical case research data component comprises an analysis of metadata collected from design files hosted by Thingiverse, which reveal the content and scale of supply and use of free AM designs. Thingiverse is one of the most well-known file repositories available for the semi-public distribution of files for use in 3D printers. Thingiverse was selected as a case study due to the information value and relevance as a leading position in the field. In addition the service had an application programming interface (API) that allowed to collect the relevant case data.

The leading online service in open access AM is Thingiverse (owned by MakerBot). In a reasonably short time Thingiverse has become the leading repository of user-submitted design files and holds the world's largest online 3D printing community. Unlike in some other platforms serving similar purpose, all designs are free to upload and download. Its commercial function for MakerBot is to add value to printer sales by offering a free and easy way for users to find designs they can print off at home. Moilanen et al. (2014)
Thingiverse offers an application for customizing the designs. If the user uses OpenSCAD program for modelling, the design can be made customizable. Then specified desing parameters, can be selected according to users need. Customizing a Thing takes a couple of minutes, and users can publish their customized objects for other users as new Things. A clear preference for printing 3D printer parts indicates that personal 3D printing is still in its early steps and hobbyists are tuning their printers with printed parts.

The case example of a 3D-printable product, namely a *Customizable 3D printer belt clip (see figure 2)* was selected based on its popularity and tags received. Such belt clip can be used for closing a toothed belt loop e.g. when replacing a broken toothed belt. Typically, toothed belts are used in printers to transmit power to the printer heads. The below Table 2 illustrates the feasibility of the framework combining the perspectives of natures of customer value and engagement.

		Functional	Economic	Emotional and Experiental	Symbolic and Social
Nature of customer engagement in supply chain value creation	Augmental	Customers design adds value of toothed belts by offering an attachment method.	Customers design offers an economic way to produce a special spare part.	A convenient part designed by customer can get positive feedback from other users about the design	The customer increases the visibility of his/her "personal brand" as a designer.
	Codeveloping	Other customers test, comment and thereby help in introducing a new spare part designed by a customer.	Other customers' experience sharing may save time when selecting a replacement method for a printer part.	Customers may feel fellowship when sharing experiences of repair work.	The customer designing the part may gain visibility as a potential co-operator of equipment manufacturers.
	Influential /Defining	Customers design enhances know-how on replacing broken printer parts.	Using a customer-designed belt clip to close a belt instead of using a belt loop may offer economic benefit	Being able to replace a broken belt may cause users feel happy	Availability of spare parts increases the sustainability of products. Sustainability may belong to customers' personal values.

	Mobilizational	Customers design may serve as an inspiration to other users to design and share more spare parts.	Greater selection of 3D-printable accessories provided by customers increases the cost-benefit ratio of a personal 3D printer purchase	The experience sharing of other customers may inspire other users to participate in experience sharing.	The availability of spare parts may inspire customers to prefer sustainable purchasing in general.

Table 2. Case illustrations of customer contributions to create value in open access AM value network

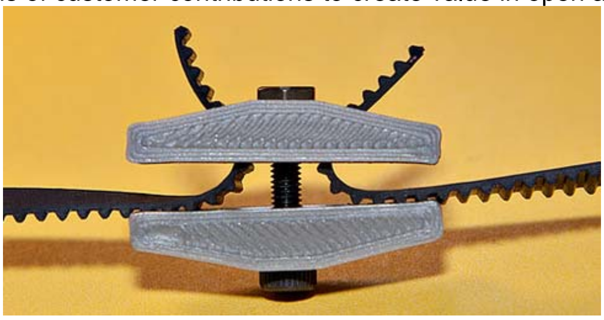

Figure 2: Thing 212873: "Though belt clip"

Discussion and Conclusions

The importance of collaborative service value creation is increasing in importance as additive manufacturing allows more flexible and dynamic supply chain models. Through the additive manufacturing technologies development, customer role in value co-creation is gaining more relevance. To our knowledge this article makes the first attempt to conceptualize the connection between the nature and customer engagement of service value in open access additive manufacturing context. The value of our research is both in instigating discussion of the unexplored research gap and furthermore to propose a framework to illustrate the creation and structure of customer engaging value creation.

Theoretical implications

The current contributions on uncertainty in additive manufacturing value creation are still quite scarce, and only a few scholars have studied the phenomenon. So far the research, the research has concentrated mainly on the technical aspects of AM and only narrow body of scientific literature has taken into account the supply chain side for example. Several authors have identifies the need for further research in this field, and this is the gap at which the core contribution of this study aims. There is, however, some work that comes close to our aims here. For example, in the demand chain context, Christopher and Ryals (2016) underline the need for a better understanding of AM, and approach the issue from demand chain management perspective. Similarly, we analyse the customer perspective in the value management domain from the perspective of the customer engagement, and we concentrate on the different ways of customer contributions to value creation and how those contribute to different natures of value.

In building our argument, we have combined theories of service value and marketing (Jaakkola and Alexander, 2014; Rintamäki et al. 2011; Vilko and Ritala, 2016) in the context of additive manufacturing value network. The ways of customer contribution to value creation presented in the developed framework were augmenting, codeveloping, influencing/defining and mobilizing. The classification presented here facilitates is connected with the different natures of customer value which enables deeper exploration of the concept and its implications.

Our framework for customer engaged value creation contributes to the existing literature in two distinct ways. First, it illustrates the different natures of value and therefore enhances understanding of the structure of the customer value. This could help researchers in the field to better assess the value creation in additive manufacturing service networks, and thus make recommendations in how customer value should be managed. Complementing on the previous literature in additive manufacturing and building on the existing knowledge from the service management and value management fields, our research work takes a step in explicating the customer role in creating value in service network. The illustrated case of open access additive manufacturing service is to our knowledge first contribution in the service value network field. Our study carries implications for decision making in developing value offering in the network and how the roles of creating value will change via additive manufacturing technology.

Practical implications
The results of this study enhance the practitioner's understanding about the different roles and possibilities that the open access additive manufacturing services can bring. In addition, the empirical part of this study identified some fields that are primarily facing the phenomenon of open source AM innovation (e.g. 3D printers, R/C Vehicles, mobile phone accessories). The results imply that open source AM innovation currently concerns mainly special hobbyist groups, but still is inevitably a grooving phenomenon.

Limitations and suggestions for future
The most obvious limitation is in the conceptual nature of the study. There is a need for further empirical studies, as well as for the further refinement of the analysis framework from several viewpoints.

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DEVELOPING A HUMANITARIAN SUPPLY CHAIN ASSESSMENT TOOL

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Introduction

Humanitarian supply chains tend to be unstable, prone to political and military influence, and inefficient due to lack of joint planning and inter-organisational collaboration (McLachlin et al., 2009). This means that humanitarian supply chain management not only deals with delivering goods, materials or information to the point of consumption for the purpose of alleviating the suffering of vulnerable people, but also to manage value for donors and other stakeholders. Many humanitarian organisations have tried to develop several performance tools in order to assess their supply chain capability such as the Post Disaster Need Assessment by UNPD and Disaster Preparedness tools by the Red Cross. However, these tools were developed from functional ghettos and so, on their own, do not fit well with more cross-functional assessment tools required by today's best organisations. Furthermore, the academic's evidence showed that the total number of research articles in this specific field of performance measurement is still low compared to the commercial sector. There are many valuable contributions based on theory and models, but the number of contributions that deal with tools developments in humanitarian supply chains performance measurement is limited (Banomyong et al., 2017).

It is therefore necessary to be able to assess humanitarian organisations' supply chain performance as their capabilities are reflected when providing humanitarian aid. Even though each humanitarian disaster is different, there is still a need to assess the initial supply chain response capability of humanitarian organisations involved in each disaster phase. The purpose of the paper is to propose a "toolbox" to assess humanitarian supply chain performance under different phases. The paper will present the scope and the main tools that are used according to disaster phases. The contribution of this proposed toolbox is to become a reference toolkit when assessing the supply chain performance of humanitarian organisations. Figure 1 define the scope of the developed Humanitarian Supply Chain Assessment Toolbox (HumSCAT).

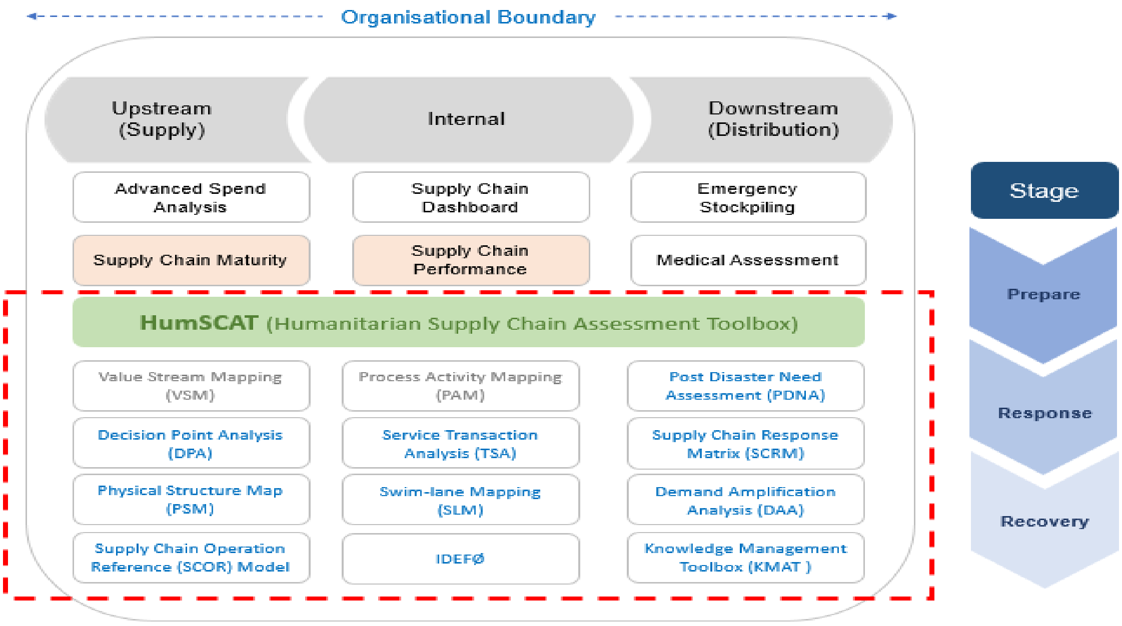

Figure 1 : HumSCAT in the Unified Humanitarian Supply Chain Reference Model

The initial version of this toolbox was developed based on the Quick Scan Audit Methodology or the QSAM which has been used in the automotive and retail industry. It was observed that the QSAM could not fully fit the humanitarian context and it is necessary to map processes within different phases of disasters. The proposed Humanitarian Supply Chain Assessment Toolbox (HumSCAT) has been developed as a diagnostic approach designed to perform health checks of a given humanitarian logistics and supply chain. The objective of the HumSCAT is to enable logistics and supply chain researchers/consultants to obtain operational assessment and accurate performance while minimising disturbance to the organisation. The HumSCAT provides a set of assessment and analyticval tools in the three main phases of humanitarian supply chain; (1) prepare, (2) response and (3) recovery. HumSCAT should be used when assessing the initial preparedness capability of humanitarian organisations or after response has been delivered. The overview of the three stages of humanitarian supply chain used in the HumSCAT can be outlined according to each phases' objectives and the mapping and evaluation tools described in Figure 1.

The HumSCAT methodology

The HumSCAT is a team-based approach that includes 'key stakeholders' from the host humanitarian organisation so that both sides contribute considerably to the assessment programme. It takes four researchers one man-week each to fully audit the supply chain of a humanitarian organisation; during which period around half of the time is spent onsite disrupting managers' time. The HumSCAT allow researchers with a range of expertise to work together and build a consensus view of real-world humanitarian supply chains. To this end a battery of tools and checklists are used that ensure comparability and standardisation. There are 13 of quantitative and qualitative tools that facilitate cross-comparisons and triangulation of subjective data sources. There are seven potential tools which can contribute to the objectives of each stage and certain identified tools can even be used in more than one phase as shown in Figure 2.

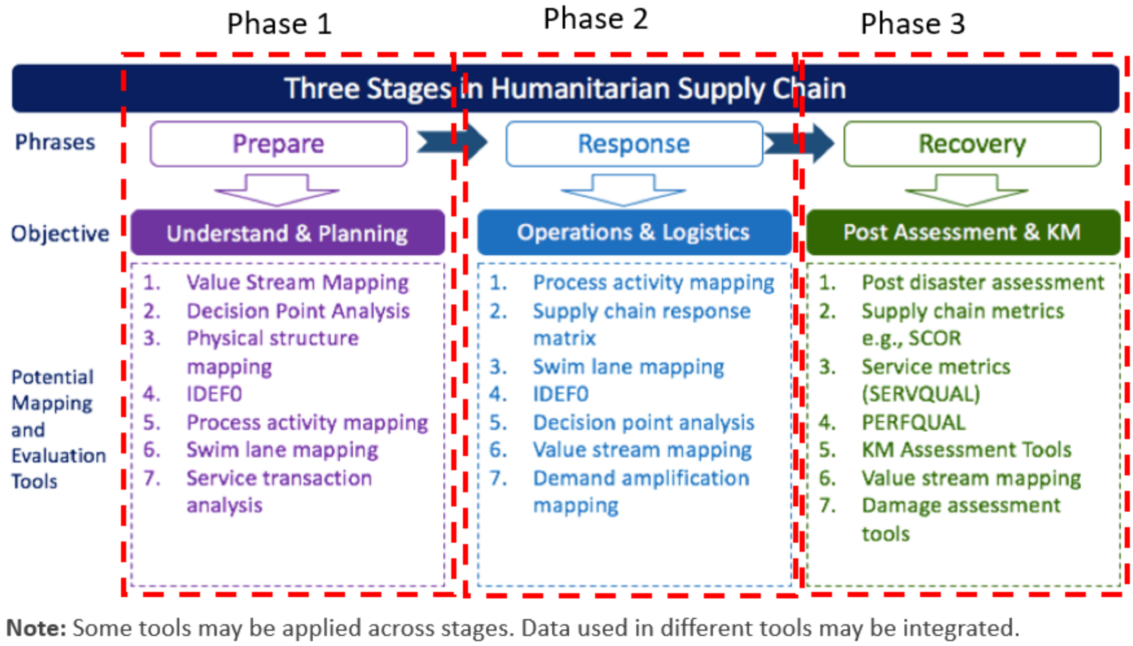

Figure 2: HumSCAT framework stages

The first phase of "prepare" is to understand the nature and characteristics of the current humanitarian supply chain so that one can design and plan accordingly. The "response" phase is when humanitarian supply chains need to be operated according to the plan and logistics need to flow as designed. The last phase is to recover the situation back to default where the objective of the toolbox is to assess the performance and create a learning culture with knowledge management (KM). Last but not the least, a critical phase of HumSCAT is the final feedback presentation, during which the improvement opportunities are discussed, constraints regarding the proposed solutions are identified and future action plans are agreed which needs to be done for each stage. To summarise the role and expected benefits of each tool over the three phases, the following Table 1 compare the applications of each tool in each phase of humanitarian supply chain.

Tool	Prepare	Response	Recovery
Objective	**To understand**	**To respond**	**Post assessment & Knowledge Mgt.**
1) Value Stream Mapping	whole picture	To track the whole picture	To simplify the workflow
2) Decision Point Analysis	decision making process	Decision making	To synchronise the decision making (collaboration)
3) Physical structure map	physical distribution structure	physical distribution structure	NA
4) IDEFØ	I-O/Control/ Mechanism	To understand the IOCM in response	IOCM in the recovery process
5) Process activity mapping	Activities (VA/NVA/NNVA)	To map the response operations	Confirm final process
6) Swimlane mapping	service delivery by whom	Service delivery in the response	NA
7) Service transaction analysis	service quality	NA	NA
8) Supply Chain response matrix	NA	Inventory control	NA
9) Demand amplification	NA	Avoid bullwhip effect	NA
10) Post disaster assessment	NA	NA	Overall assessment
11) SCOR model	Framework	NA	Supply Chain Performance
12) SERVQUAL	NA	NA	Service Quality Gap
13) KMAT Assessment tools	NA	NA	KM capability

Table 1 : an applications of each tool in each phase of humanitarian supply chain
Source: The Authors

The 13 identified tools in HumSCAT are described hereunder:

Value Stream Mapping
The main purpose of value stream mapping (VSM) is to obtain a holistic picture of the whole supply chain. VSM include a set of symbols for players and activities in a given supply chain. Time and distance can be identified in the VSM. The knowledge of all key players in the supply chain, time and distance between each stage, information flow and methods of communication, and number of staffs are required. The expected output is the current state in order to understand what is going on in the supply chain and the future state for improvement purposes.

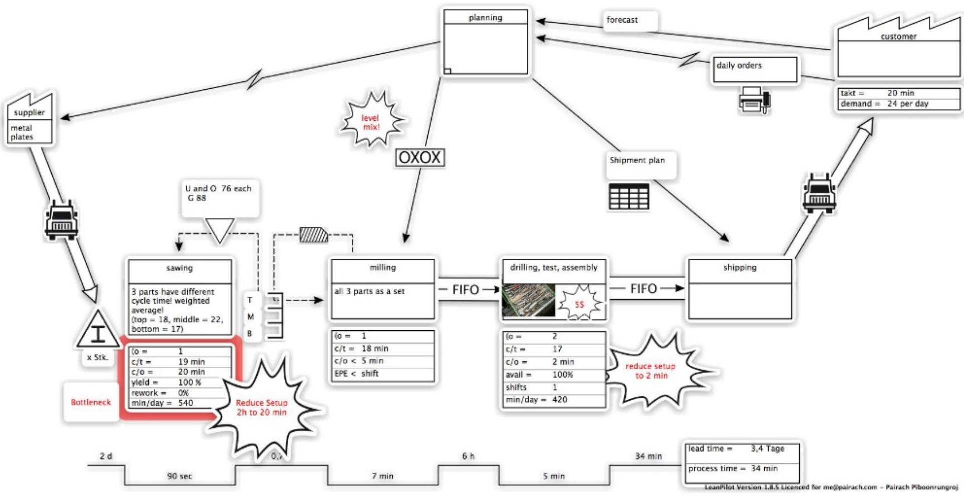

Figure 3: Value Stream Mapping

Decision Point Analysis (DPA)

The decision point is the point in the supply chain where actual demand-pull gives way to forecast-driven push. In other words, it is the point at which products stop being made according to actual demand and instead are made against forecasts alone (Hines and Rich, 1997). DPA requires access to the decision-making process for demand pulling system and forecast-based decision making in the supply chain.

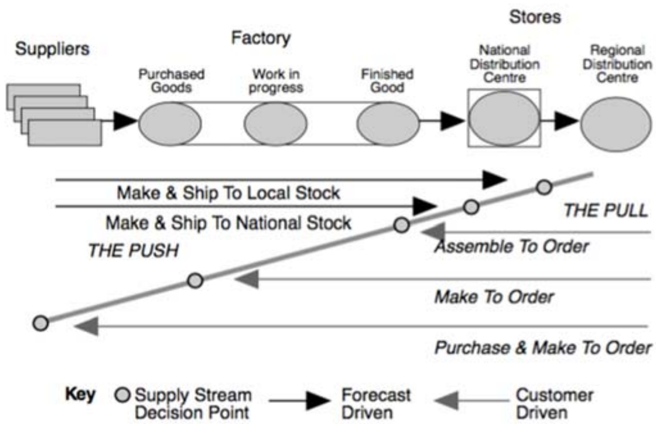

Figure 4: Decision Point Analysis

Physical Structure Map (PSM)

The physical structure map is useful in understanding what a particular supply chain looks like from an overview or industry level. The use of PSM could inform the humanitarian logistics and supply chain manager to understand how a particular supply chain may look like from an overview level. The knowledge of the structure of the event relief such as number of organisations, tiers in the humanitarian supply chain, and cost added in each tier.

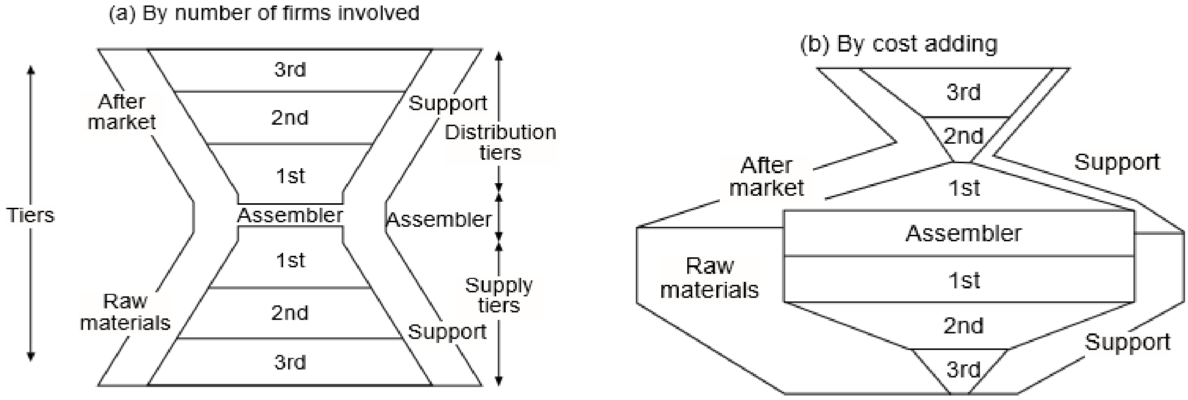

Figure 5: Physical Structure Mapping-an automotive industry example

Integration Definition for Function Modelling (IDEFØ)

IDEFØ is a method designed to model the decisions, actions, and activities of an organization or system. Effective IDEFØ models help to organize the analysis of a system and to promote good communication between the analyst and the customer. IDEFØ is useful in establishing the scope of an analysis, especially for a functional analysis. As a communication tool, IDEFØ enhances domain expert involvement and consensus decision-making through simplified graphical devices. As an analysis tool, IDEFØ assists the modeller in identifying what functions are performed, what is needed to perform those functions, what the current system does right, and what the current system does wrong. Thus, IDEFØ models are often created as one of the first tasks of a system development effort.

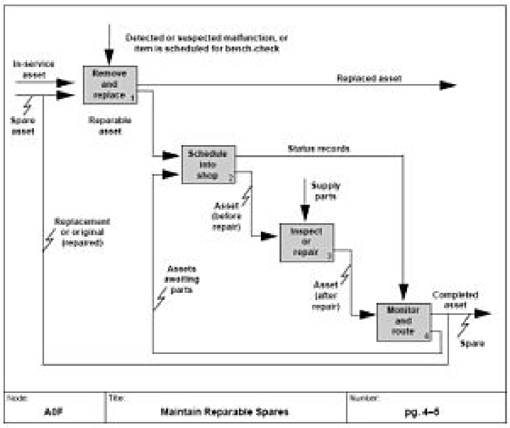

Figure 6 : IDEFØ

Process Activity Mapping (PAM)

Process activity mapping has its origins in industrial engineering. Industrial engineering comprises a group of techniques that can be used to eliminate from the workplace, waste, inconsistencies and irrationalities, and provide high-quality goods and services easily, quickly and inexpensively. The completed diagram can then be used as the basis for further analysis and subsequent improvement.

Time Use	Current Process	Improved Processes	Changes
Value added activities (Minutes)	64.4	62.5	-1.9
Non-alue added activities (Minutes)	214.8	90.5	-124.3
All activities (Minutes)	279.2	153.1	-126.1
Proportion of value added activities	23.07%	40.82%	17.75
Number of people in processes	10	7	-3
Number of steps	29	20	-9
Average steps per staff	2.90	2.86	-0.04

Steps	Descriptions	Symbol	Time (Minutes)	Distance (Metres)	People (Persons)
1	Receive patient	○	0.5	0	
2	Register new patient	○	4	0	
3	Input new illness information	○	2	0	1
4	Print patient profile sheet	○	1	0	
5	Validate patient information	□	0.5	0	
6	Sent profile sheet to primary examination unit	⇨	1	20	1
7	Hold patient wait in waiting area	▽	60	0	-
8	Continue hold due to unexpected huge number of patients	D	60	0	-
9	Call a patient for primary examination	○	0.5	0	1
10	Primary examine by nurse	○	10	0	2
11	Write a primary result	○	2	0	1
12	Send to a primary result to a doctor	⇨	1	5	1
13	Hold a patient in waiting area	▽	30	0	-
14	Continue hold due to unexpected huge number of patients	D	60	0	-
15	Call a patient for medical treatment	○	0.5	0	
16	Examine the illness	○	10	0	
17	Explain a patient the surgery results	○	5	0	
18	Take a treatment	○	20	0	1
19	Write an order for medicines	○	3	0	
20	Give an order to patient	⇨	0.1	0.1	
21	Write a note for next appointment	○	1.5	0	
22	Give a appointment note to a patient	⇨	0.1	0.1	
23	Receive a recipe from a patient	○	0.2	0	
24	Find medicines	⇨	2	2	1
25	Validate a patient	□	0.5	0	
26	Give medicine to a patient	⇨	0.5	0.1	
27	Receive an appointment note from patient	○	0.2	0	
28	Book an appointment	○	3	0	1
29	Send an appointment card to a patient	⇨	0.1	0.1	

Source: Author, 2007.

Note: ○ = operation, □ = inspection, ⇨ = transport, ▽ = store, D = delay

Figure 7: Process Activity Mapping

Swim Lane Mapping (SLM)

Swim lane diagram is a visual element used in process flow diagrams, or flowcharts that visually distinguishes job sharing and responsibilities for sub-processes within a business process. Swim lanes may be arranged either horizontally or vertically. It is useful for service operations where there are multiple operators serving customers in each process. This fits the humanitarian supply chain context.

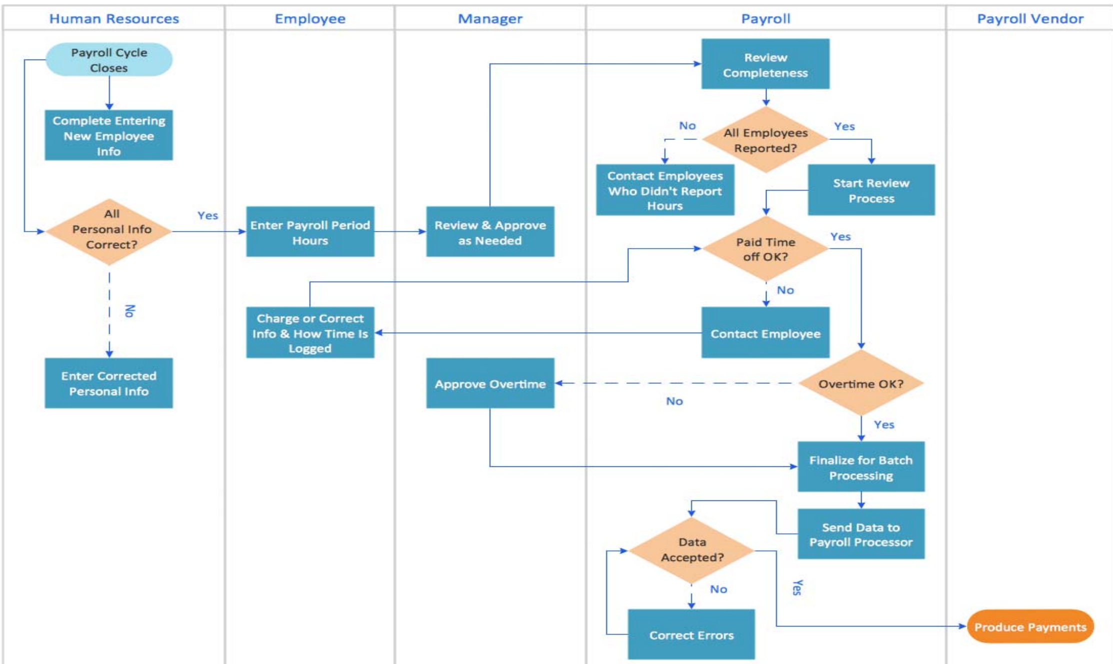

Figure 8: Swim Lane Mapping

Service Transaction Analysis (STA)

Customer experience, along the service process and transactions can be assessed and mapped along with the processes in service operations, using the tool called 'Service Transaction Analysis" or STA.

This technique could be implemented by either in-house operators or external consultants (Johnston, 1999).

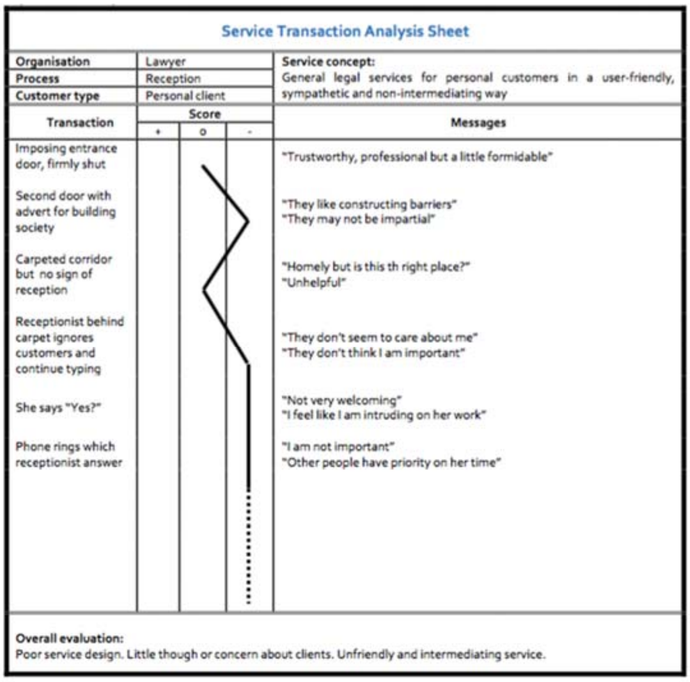

Figure 9: Service Transaction Analysis

Supply Chain Response Matrix (SCRM)

Supply Chain Response Matrix focus on logistics operations and their time-constrained. It was used by New (1993) and by Forza et al. (1993) in a textile supply chain setting. This mapping approach seeks to portray in a simple diagram the critical lead-time constraint for a particular process.

In this case, it is the cumulative lead time in a distribution company, its suppliers and its downstream retailer. In Figure 10 the horizontal measurements show the lead time for the product both internally and externally. The vertical plot shows the average amount of standing inventory (in days) at specific points in the supply chain.

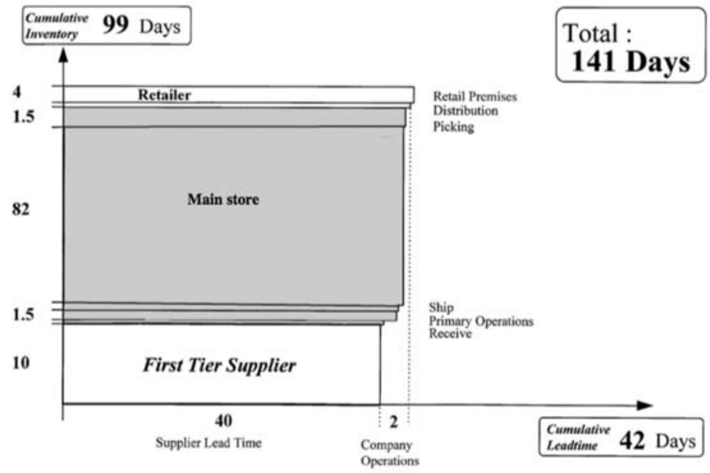

Figure 10: Supply Chain Response Matrix

Demand Amplification Analysis (DAA)

Demand Amplification Analysis aim is to detect a supply chain problem when variation of demand is amplified from downstream to upstream, called the "Bullwhip Effect". This problem may cause increased supply chain cost and lower service level. DAA required the knowledge of:

(1) Ordering demand at each stage of supply chain, and;

(2) Ordering policy of each supply chain member.

This simple analytic tool can be used to show how demand changes along the supply chain in varying time buckets.

This information then can be used as the basis for decision making and further analysis to try to redesign the value stream configuration, manage the fluctuations, reduce the fluctuation or to set up dual-mode solutions where regular demand can be managed in one way and exceptional or promotional demand can be managed in a separate way.

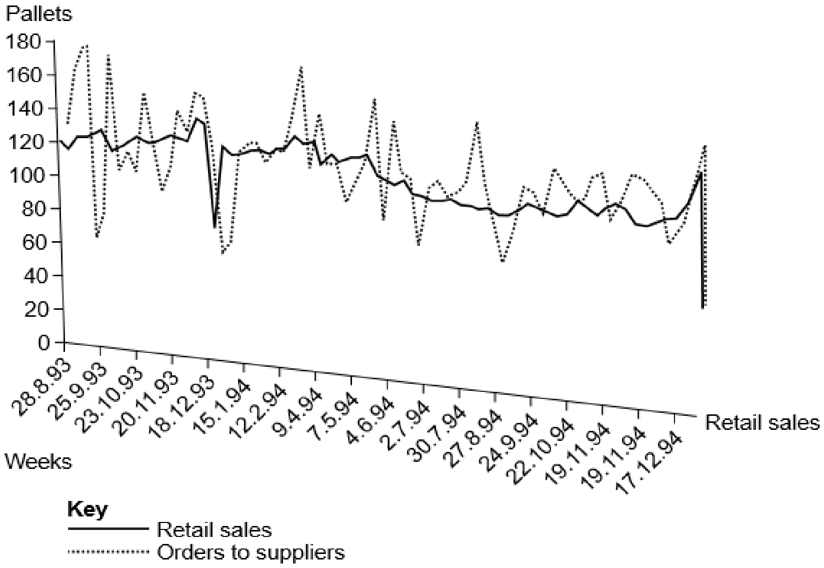

Figure 11: Demand Amplification Analysis

The Post Disaster Need Assessment (PDNA) Guide

The overarching purpose of the PDNA Guide is to provide improved support to governments in post-disaster recovery assessments and planning through a more coordinated approach. The more immediate objective of the PNDA Guide is to provide an agreed framework and predictable arrangements for effective and efficient coordinated support from the EU, the UN and the WB to governments requesting international assistance for post-disaster recovery and reconstruction.

The SCOR Model

One of the more famous supply chain diagnostic methods which has been used, referred, and implemented so far is the, "Supply Chain Operations Reference Model" (called as SCOR model). The implementation of a SCOR Model within a firm could benefit the business through the benchmarking of a holistic view of the supply chain, both internally and externally. This important supply chain model was created and developed by the Supply-Chain Council. The latest version of SCOR model is 9.0.

The SERVQUAL

The SERVQUAL (service quality) model was developed by Parasuraman, Zeithaml and Berry in 1988.

It highlights the main components of high quality service. The SERVQUAL authors originally identified ten elements of service quality, but in later work, these elements were collapsed into five dimensions: reliability, assurance, tangibles, empathy and responsiveness.

Businesses using SERVQUAL to measure and manage service quality deploy a questionnaire that measures both the customer expectations of service quality in terms of these five dimensions, and their perceptions of the service they receive. When customer expectations are greater than their perceptions of received delivery, service quality is deemed low. Key outputs of SERVQUAL is the knowledge of the 7 gaps in the current state of services.

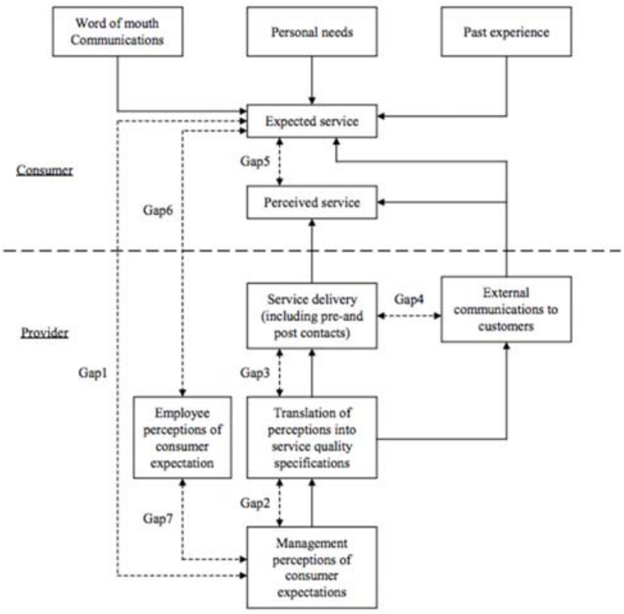

Figure 12: SERVQUAL

The Knowledge Management Assessment Tools (KMAT)

The KMAT was developed jointly by Arthur Andersen and the American Productivity and Quality Center. The database currently contains data from more than 140 companies, ensuring benchmarking of the highest quality. KMAT aims to assess knowledge management of an organization. KMAT focuses on five sections: (1) Process; (2) Leadership; (3) Culture; (4) Technology; and (5) Measurement. KMAT is a diagnostic survey that helps an organization determine the effectiveness of its knowledge management practices. Includes a thirty-question survey, administer and employee scoring sheets, and scoring interpretation instructions.

<u>Summary</u>

The purpose of the paper was to propose a “toolbox” to assess humanitarian supply chain performance under different phases. The identified tools can effectively be applied, singularly or in combination to the requirements of the individual disaster phase. The HumSCAT has been designed to be largely conceptual in nature and it is useful to suggest a number of missing pieces or unresolved issues in our knowledge and application of humanitarian logistics and supply chain management. The main development of HumSCAT is to offer a set of appropriate assessment and analytical tools in the three main humanitarian phases: (1) prepare, (2) response and (3) recovery. In each phase, seven potential identified tools can contribute to the objectives of each stage as highlighted in Table1. Some tools can be used in more than one phase so in total there are 13 tools available within HumSCAT. Such tools are adapted from those used in manufacturing and service based supply chain.

The limitations of HumSCAT is that it: (1) requires a considerable amount of tactic knowledge from the team members; (2) is not easily transferable to organizations as a change management tool; and (3) requires considerable amount of training of team members for them to be conversant in the various tools. In order to mitigate these limitations while retaining the strengths further validation and research is being undertaken to improve the HumSCAT. The HumSCAT is intended to be a self-assessment toolbox so that individual organisations may undertake their own diagnostic and enable the participation of all stakeholders in evaluating overall humanitarian supply chain processes. In undertaking this task, it is necessary to further validate the various tools in HumSCAT within a number of humanitarian supply chains so as to finalise the toolbox.

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EMERGENCY LOGISTICS IN NZ: LEARNING FROM AID ORGANISATIONS

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Introduction

New Zealand (NZ) is prone to natural disasters, including earthquakes, floods and storms. The consequent need for rapid and well-coordinated emergency responses led the NZ Government to establish the Ministry of Civil Defence and Emergency Management (MCDEM), which is the lead agency for in-country disaster management. Among its many responsibilities, MCDEM supports the development of disaster management structures and systems and facilitates the cooperation across a range of responding agencies at the local, regional and national response levels (Webb and McEntire, 2014). These include the NZ Police, Fire Service, Ministry of Health, and Defence Force (Fogarty, 2014). Although a robust disaster management framework exists comprising legislation, plans, guidelines, processes and procedures, acknowledged deficiencies include the management of critical resources, the availability of professional logistics expertise, and the performance of the distribution of relief supplies (MCDEM, 2015c).

The responses to international humanitarian and domestic emergencies share common requirements. They need to be rapidly organised and require the swift mobilisation of human and material resources, as well as the fast delivery of supplies. However, global aid organisations have considerable expertise in managing agile supply chains (Charles *et al.*, 2010). They have developed a range of good practices that enable them to adapt to rapidly changing and unpredictable circumstances and to move swiftly from a 'dormant' and temporarily inactive operating state to an active, fully operative one (Kovács and Tatham, 2009). Hence, this paper aims to identify whether the supply chain procedures practised by global aid organisations might offer insights for improving responses to domestic emergencies.

To that purpose, logistics practices utilised by two well-respected global aid organisations are examined and good practices from the humanitarian logistics field are identified. Then, a review of the publicly available emergency management and logistics-focused documentation, including MCDEM's logistics guidelines (MCDEM, 2015b), is used to ascertain whether these practices are used by the NZ's emergency management agencies. Conducting such a comparative study is expected to support the identification of mechanisms and tactics having the potential to improve the flow of relief items in the aftermath of a disaster in NZ.

Good practices in humanitarian logistics

The sampled organisations

The two humanitarian aid organisations selected for this study, namely the United Nations (UN) World Food Programme (WFP) and the International Federation of Red Cross and Red Crescent Societies (IFRC), are well-recognised for their extended logistics expertise. This expertise has led to both organisations receiving supply chain excellence awards (IFRC, 2017f; Logistics Manager, 2014) and making their services available to other humanitarian organisations (IFRC, 2017e; WFP, 2015).

WFP is the UN agency specialising in the provision of food assistance to a yearly average of 80 million people in 80 countries. WFP views logistics as a key part of its humanitarian work and operates 5,000 trucks, 20 ships and 70 aircraft on an average day (WFP, 2017a). This proven logistics expertise has resulted in WFP being mandated to lead the UN Logistics Cluster that coordinates the logistics and supply chain activities of UN agencies and other organisations in emergency operations that require a joint response (Logistics Cluster, 2017a).

IFRC is another prominent humanitarian actor that reaches 150 million people worldwide each year through 189 National Societies. Based on its 90 years of experience with humanitarian deliveries, logistics has come to play a central role in IFRC's operations. Its reputation has resulted in IFRC becoming a recognised provider of emergency supplies and logistics services in international disaster situations (Chomelier *et al.*, 2003; IFRC, 2017f).

The following sections examine the logistics practices of WFP and IFRC, identified by reviewing their websites and other publicly available documentation. As confirmed by the humanitarian logistics and supply chain management literature, the following six practices were identified for their ability to support the rapid mobilisation and deployment of emergency supplies.

Decentralised stockpiles
Both WFP and IFRC maintain a permanent network of logistics units strategically located close to disaster-prone areas as well as ports, airports and major roads. In particular, WFP manages the UN Humanitarian Response Depots (UNHRDs) on behalf of 82 partners (UN agencies, governmental as well as non-governmental organisations). This network of six logistics units located in Italy, Spain, Ghana, Dubai, Malaysia and Panama enables the delivery of stockpiled emergency supplies within 24-48 hours to any disaster-affected area (UNHRD, 2017a; WFP, 2017c).

Similarly, IFRC operates a permanent network of five regional logistics units (in Malaysia, Dubai, Kenya, Spain and Panama) plus smaller stockpiles of relief items in different parts of the world. Pre-positioning contingency stock enables IFRC to deliver urgently needed supplies within 24 to 48 hours of an emergency and to meet the immediate needs of 450,000 people anytime (IFRC, 2017f).

In short, maintaining decentralised stockpiles in well-connected regional logistics units enables humanitarian organisations to rapidly push emergency supplies to the field in the immediate aftermath of a disaster, i.e. before the actual needs of those affected is established and the supply chain is switched into its pull configuration. Pre-positioning supplies at strategic locations also improves response times (mostly due to the shorter geographical distances needing to be covered) and supports cost-efficiencies due to the more efficient management of infrastructures and inventory (Laguna Salvadó *et al.*, 2016).

Product standardisation and the development of a catalogue of standard items
Product standardisation is common in the humanitarian sector. For example, within the framework of the UNHRD initiative, WFP has developed a catalogue of standardised items including health products, food supplies, and shelter items (UNHRD, 2017c). IFRC similarly maintains a catalogue of 4,000 standard products that facilitate the selection of relief items and streamlines their purchase; two benefits that are particularly valuable in emergency situations (IFRC, 2017c).

Identifying the most suitable/demanded relief supplies and including them in a catalogue of standard items enables humanitarian organisations to reduce the number of goods that are purchased and maintained in stock, to increase inventory turnover and, as a consequence, to reduce the complexity of logistics systems (McGuire, 2015). Thus, product standardisation supports economies of scale and process efficiencies which, in turn, streamline logistics operations and lead to cost reductions in the procurement and storage of relief items. Product standardisation also increases inter-agency compatibility and, ultimately, enhances cooperation between humanitarian organisations as well as flexibility through stock exchanges (Schulz, 2008). Finally, standardisation enhances product consistency and improves the quality of the relief items when organisations specify clear product characteristics as well as a minimum level of quality requirements to be met by suppliers, e.g. through tests and controls (IFRC, 2017g).

Framework agreements with suppliers
Framework agreements are long-term arrangements set up with specific suppliers in advance of an emergency to establish the general purchasing terms and conditions (Balcik and Ak, 2014; Schulz, 2008). They reflect the reality that procurement is a time-consuming process involving the meticulous qualification and selection of suitable suppliers through strict tendering procedures. Also, in the aftermath of a major disaster, competition arises between humanitarian organisations that seek to purchase the same types of items at short notice. Such rivalry creates shortages of goods in the market and leads to inflated prices. Framework agreements provide a solution to such unfavourable factors (Balcik and Ak, 2014; Schulz, 2008).

IFRC first introduced framework agreements in 2001 to secure appropriate prices, to guarantee the quality and quantity of the goods purchased, and to ensure that delivery terms meet predefined requirements. IFRC mostly uses global framework agreements for the procurement of standard emergency supplies such as blankets, tarpaulins, kitchen sets and mosquito nets. Some of these agreements cover a minimum level of stock to be maintained by the suppliers, either at IFRC's above mentioned regional warehouses or the supplier's premises. In doing so, IFRC ensures that stocks are available in sufficient quantities at any given time to respond promptly to emergencies (IFRC, 2017d). WFP also negotiates and concludes framework agreements with UNHRD's core suppliers to secure favourable prices and guarantee quality and timely deliveries (UNHRD, 2017b).

Information management and visibility

Making the right information available to the right people at the right time is key to a successful emergency response. Critical logistics information includes demand information (where and when aid is required and in what quantities), cargo information (the actual location and quantities of the relief items, stored or in transit), as well as planning maps containing access information (e.g. ports and airports, road conditions, blockages, etc.). Information is essential to provide visibility over humanitarian logistics and supply chain operations and to support analysis and decision-making (Logistics Cluster, 2015; Tomasini and Van Wassenhove, 2009).

Both IFRC and WFP have developed information management systems that enable them to capture and disseminate critical supply chain information (e.g. to track and trace the relief items). In particular, IFRC has developed a web-based information platform called the Disaster Management Information System (DMIS) which provides timely information about disaster trends and the level of resources available, and enables users to coordinate their actions and share disaster management best practice (IFRC, 2004, 2017b).

WFP has gone a step further and developed an integrated platform that retrieves data from its various information management systems and consolidates all of the relevant supply chain information to provide end-to-end visibility of WFP's operations. The information available for every operation in the Supply Chain Management Dashboard (SCM-D) includes funding details, resource requirements and shortfalls, procurement information, and logistics-relevant data (e.g. transport as well as stock volumes and locations). This integration of supply chain information enables informed decision-making and enhances collaboration between organisational departments/units by breaking down the organisational silos. It also enables WFP to identify potential supply chain risks, challenges and opportunities (Sithole *et al.*, 2016).

Similarly, WFP's Relief Item Tracking Application (RITA) is an online tracking tool that provides easily accessible information on stock levels, movement requests, consignments, and delivery performance (Logistics Cluster, 2017b). To support timely and effective decision-making, WFP also uses early warning systems to anticipate natural, political and economic risks and, ultimately, to identify vulnerabilities and potential disasters. Geographic information systems (GIS) generate paper and digital maps of WFP's operational environments (WFP, 2013).

Inter-agency collaboration

Since a humanitarian response typically goes beyond the capacity of any single organisation, inter-agency cooperation is critical in the aid sector (Tatham *et al.*, 2017). Collaborative initiatives range from exchanging information to sharing logistics resources (e.g. warehousing and transport) and pooling procurement efforts. The benefits of collaboration include cost savings through volume consolidation, the better use of available logistics resources, the reduction of overlaps, and less competition between organisations striving to secure the same resources (e.g. relief items, storage space and transport capacity) (Schulz, 2008).

Both IFRC and WFP actively engage in collaborative partnerships with other humanitarian organisations. For example, IFRC has a partnership agreement with the UN Refugee Agency for the delivery of humanitarian aid to the people affected by conflicts in the Middle Eastern region, and one with UNICEF for matters concerning health, water sanitation and logistics (IFRC, 2017a).

WFP similarly supports inter-organisational logistics cooperation within the extensive UNHRD network by creating opportunities for sharing warehousing infrastructure, improving inventory management, and achieving more flexible and rapid disaster responses. In particular, UNHRD uses three stock pooling mechanisms. Firstly, in addition to storing and managing the stocks owned by its partners, UNHRD maintains ‘white stocks’, namely relief items owned by suppliers but stored in the UNHRD depots based on framework agreements concluded with the suppliers. As white stocks do not carry a logo, they can be released and ownership transferred to partners in response to actual needs. The benefits of this system are, for the partners, the availability of stocks without having to pay for them until they are needed and, for the suppliers, the storage of the goods free of charge (Schulz, 2008; UNHRD, 2011). Secondly, UNHRD supports the use of ‘virtual stocks’, i.e. relief items owned and stored by the suppliers on their premises but allocated to the UNHRD network by a framework agreement. The goods are released at a pre-negotiated price as soon as a partner needs them and UNHRD issues a purchase order. Such a system reduces inventory carrying costs (the capital, storage and insurance costs) as well as the risk of obsolescence for the UNHRD partners (Schulz, 2008; UNHRD, 2011). Finally, to further facilitate the sharing of relief items, UNHRD has implemented a system of stock loaning and borrowing. Under this arrangement, partners can borrow items owned by other humanitarian organisations and replenish them at a later stage. The advantages of this system are, for the borrowing organisation, the immediate availability of stocks (due to the absence of order lead time) and, for the lending organisation, a higher level of stock turnover (Schulz, 2008; UNHRD, 2011).

External partnerships

Partnerships maintained by IFRC and WFP go beyond those with other humanitarian organisations to include collaborative agreements with the private sector and with standby partners. Private sector partnerships enable aid agencies to benefit from the technical expertise and experience of companies that have core competencies in logistics or logistics-related fields. Thus, WFP has teamed up with global companies that can support and complement their logistics and supply chain management operations (e.g. Agility and UPS), as well as with transport and equipment manufacturers. For example, Renault Trucks deploys technicians to train WFP mechanics throughout Central and West Africa (Renault Trucks, 2017), and Caterpillar*,* the manufacturer of construction equipment and engines, regularly donates equipment to support WFP’s operations (WFP, 2014, 2017b). IFRC has also established private-sector partnerships. For example, it signed an agreement with Airbus Corporate Foundation which is designed, among other things, to facilitate the transport of humanitarian supplies to the field, and to exchange logistics training staff (IFRC, 2012).

WFP and IFRC also have standby partnership programmes in place with government agencies, non-governmental organisations as well as private companies to maintain a roster of trained and experienced professionals who can be deployed at short notice. The use of such standby partners allows humanitarian organisations to rapidly complement their capacity and gain access to staff with specialised skills that are not available internally (WFP, 2017b).

Emergency logistics practices in NZ

Background information

This section examines the extent to which NZ emergency responders use the above six humanitarian logistics practices. Initially, the publicly available documentation produced by MCDEM was reviewed because of its recognition that logistics plays a critical role in disaster response. MCDEM also provides guidance on what constitutes good logistics practice in support of effective and efficient relief operations (MCDEM, 2015a). Additional items were sourced, for example by exploring the references contained in MCDEM’s documents. Table 1 outlines the reviewed documents.

Title	Author	Year	Pages
Logistics in Civil Defence Emergency Management	Ministry of Civil Defence and Emergency Management	2015	122
CDEM coordination centre – Logistics	Ministry of Civil Defence and Emergency Management	2015	42
The NZ Coordinated Incident Management System (CIMS)	Officials’ Committee for Domestic and External Security Coordination,	2014	2 (Section 4.2.5)

	Department of the Prime Minister and Cabinet		
Guide to the national civil defence emergency management plan	Department of the Prime Minister and Cabinet	2015	8 (Section 29)
Quick guide to emergency procurement	Ministry of Business, Innovation and Employment	2014	4
Guidelines for T-card use	National Rural Fire Authority	2014	10
Exploring NZ's capability to strategically manage logistical responses to major civil defence and emergency management events	Shaun Fogarty (Massey University)	2014	231
National Reserve Supplies	Ministry of Health	2015	Webpage

Table 1: Documentary sources used

Decentralised stockpiles

The logistic guidelines of MCDEM (2015b) emphasise that swift responses to emergencies are supported by the procurement and storage of critical resources in advance of the actual disaster event. In particular, responding agencies are advised to hold stocks of the supplies and equipment typically needed in the immediate aftermath of a disaster, especially if the affected area is likely to be cut-off. Critical resources include welfare items (e.g. blankets, bedding, cots, lighting, sanitation equipment), construction materials (e.g. sandbags, shovels, chainsaws), and information and communication equipment (e.g. laptops, phones, radios).

No mention is made of national stockpiles of critical emergency items being strategically located in NZ beyond the national reserve of health stocks managed by the Ministry of Health. This stockpile of drugs and medical items is designed to support a swift response to a pandemic or other health emergency, for example in the aftermath of a disaster. The stock items are stored at multiple sites across NZ to facilitate distribution and reduce risks (Ministry of Health, 2015). Apart from this national health reserve, it seems that no national contingency stock of emergency items is being maintained (i.e. beyond the stocks built and held by individual agencies).

Product standardisation and the development of a catalogue of standard items

Mechanisms to expedite the purchase of resources in emergency situations are in place in NZ (e.g. the arrangement of pre-approved financial delegations and the implementation of a flexible purchasing process deviating from the normal procurement rules) (MBIE, 2014; MCDEM, 2015b). However, it appears that no product standardisation process has been attempted to rationalise procurement operations. Since emergency management in NZ is based on cooperation between agencies and levels of response, product standardisation and the development of a joint catalogue of standard items would appear to offer significant value, such as facilitating stock exchanges, reducing operational complexity and streamlining logistics operations.

Framework agreements with suppliers

Framework agreements, which ensure the availability of resources in emergencies and secure price and delivery conditions do form part of the NZ emergency management practices. According to MCDEM's logistics guidelines, formal contracts, or Memoranda of Understanding, should be negotiated and concluded by NZ response agencies for resources that are not available internally, and that cannot be made available by other response levels (e.g. regional and national levels) or by other agencies. Such purchase arrangements are typically established for critical resources and resources regularly needed in emergency responses (MCDEM, 2015b).

Information management and visibility

In NZ, ongoing communication and interaction among functions and agencies are critical to emergency operations. Mechanisms are in place to capture and disseminate timely and accurate information and to provide visibility on logistics operations during emergency responses. In particular, responding agencies use a common, web-based information management tool called Emergency Management Information System (EMIS) that is designed to maintain situational awareness, record information, track data and generate reports. From a logistics perspective, EMIS is used to track tasks and resources, to create and process resource requests, and to store documents (e.g. request forms). Moreover, to enhance supply chain visibility, resources are tracked through several processes from the time a responding agency has requested them to the time they are no longer needed. The records are maintained/updated when resources are requested, received, stored, issued to field teams, and returned/disposed of (MCDEM, 2015b).

If EMIS is not available to support resource management, other mechanisms can be used to track resources, including whiteboards and T-cards. T-cards are a paper-based recording tool developed by the NZ National Rural Fire Authority. They are also used by other agencies to track key resources during emergency operations. Different colours are assigned to different types of resources, and each card records the status of each resource (e.g. available, required, allocated) and its location (National Rural Fire Authority, 2014).

Inter-agency collaboration

Collaboration is a key characteristic of responses to NZ emergencies because emergency management takes place across a range of responding agencies at the incident, local, regional and national response levels (MCDEM, 2015b). When an agency is unable to meet its own resource needs, it must cooperate with other agencies and response levels. Thus, emergency responders must coordinate their logistics activities and resources (DPMC, 2015).

A common framework ensures consistency and supports coordination across agencies (e.g. emergency management groups, governmental agencies, fire services, police, the NZ Defence Force, and ambulance services). Specifically, the logistics guidelines of MCDEM (2015b) are focused on creating a common understanding of logistics, on providing a consistent and coordinated approach to logistics operations across all stakeholders, and on streamlining their logistics actions. With all this in mind, the guidelines advise logistics staff of responding agencies to ensure that processes and procedures are in place for accessing internal and external resources (for example, for issuing and processing resource requests). Inter-agency logistical collaboration extends to the exchange of staff and skills (in procurement, supply, transport) to increase capacity and capabilities when gaps are identified in response to an emergency (MCDEM, 2015b).

External partnerships

In NZ, the military organisations seem to be well integrated into emergency management operations. In particular, the Defence Force usually conducts aerial reconnaissance and supports transport operations and medical evacuations in the initial response phase. Similarly, the utility organisations (telecommunication, construction, water and energy) play their part by restoring essential infrastructure services damaged by a disaster event (Fogarty, 2014). Except for these important collaborations, partnerships with the private sector appear to be insufficient. As highlighted by McLean *et al.* (2012), who independently reviewed the emergency response to the February 2011 Christchurch earthquake, the skills and expertise of commercial logistics companies are essential to successful responses to large-scale disasters and should, therefore, be more extensively used. According to Fogarty (2014), who surveyed 84 emergency management professionals in NZ, there remains a lack of knowledge and understanding of the way in which NZ logistical resources and expertise can be mobilised and used, and the value that commercial businesses can add to emergency management. Going a step further, Fogarty (2014) argues that partnerships should also be developed with NZ's fast-moving consumer goods companies due to their extensive logistics and supply chain expertise and their ability to ensure that foodstuffs will be available on the shelves of local retailers in the aftermath of a disaster.

Discussion: lessons learned from humanitarian logistics

Reviewing the emergency logistics practices in NZ in the light of those employed by WFP and by IFRC enables us to identify some important similarities and differences. Firstly, both in the humanitarian and NZ emergency contexts, framework agreements with pre-selected suppliers are used to establish the purchasing terms and conditions for resources likely to be in high demand during the initial disaster response phase. Doing so enables the responding agencies to speed up the mobilisation and deployment of resources in an emergency, and to avoid goods shortages and inflated prices following a disaster. Secondly, the comparative study shows the importance of information communication and resource visibility in both the humanitarian and NZ emergency contexts. Accurate and timely logistics information (in particular, resource tracking) is needed to support prompt decision-making and to ensure that available resources are deployed and managed most efficiently and effectively. Thirdly, the need for inter-agency collaboration is common to the humanitarian and NZ emergency contexts because responding to a disaster typically goes well beyond the capacity of any single agency. Rather, a successful response comes from people, teams and agencies sharing information and coordinating their actions to avoid gaps and overlaps and to achieve alignment.

Beyond these similarities, it appears that lessons can be learned from humanitarian logistics and could be invaluable if applied to the NZ emergency context. Firstly, product standardisation and the development of a catalogue of standard items could be an effective way to improve emergency management in NZ as these practices have the potential to simplify and streamline procurement processes and the downstream logistics activities. Most importantly, standardisation would support inter-agency compatibility and the exchange of resources that is a cornerstone of the emergency management system in place in NZ. Secondly, the NZ responding agencies could consider pooling and pre-positioning critical supplies at strategic locations, while also implementing resource-sharing mechanisms such as stock loaning and borrowing, and white and virtual stock sharing. In the immediate aftermath of a disaster, such mechanisms can support the timely availability of urgently needed relief items, speed up their deployment and reduce the cost of stockpiled resources. Thirdly, the NZ responding agencies could consider developing external partnerships beyond those that exist with the military and the utility organisations. In particular, collaborative agreements with commercial companies (especially in the logistics/supply chain management and fast-moving consumer goods sectors) would offer clear opportunities (including access to technical expertise about the rapid mobilisation of resources, the implementation and management of responsive supply chains, and the application of new and innovative methods).

Contribution, limitations and further research avenues

The authors agree with Fogarty's contention that humanitarian logistics concepts and practices apply to the management of disasters that occur in developed nations (Fogarty, 2014). This paper confirms that the consideration of humanitarian logistics practices does present opportunities to improve the emergency response to disasters in NZ. In particular, three potential areas are identified: product standardisation, the pre-positioning of pooled supplies, and the use of external partnerships to gain logistics skills and apply new techniques.

This pilot study is not designed to evaluate the current logistics and supply chain capacities and capabilities of NZ's emergency agencies. Its findings are based on documents that are available online and not on an exhaustive review of actual emergency management practices. Rather, this study reflects on good humanitarian logistics practice and aims to stimulate discussion and further investigation on the improvement of the current emergency logistics mechanisms in NZ. Hence, additional research is needed to establish a complete overview of NZ's emergency management landscape and to identify gaps and areas for improvement more systematically and exhaustively. It is also fully accepted that this paper does not explore every good practice that is used by humanitarian organisations, but only those that could be identified within WFP's and IFRC's publicly available documents. Additional topics highlighted in the broader humanitarian logistics literature (e.g. rapid and flexible funding practices, a culture of continuous improvement, and the use of emerging technologies such as 3D printing, drones and airships) also deserve further attention.

Conclusion

In the context of highly complex disaster management operations, such as those organised in response to the 2010 and 2011 Christchurch earthquakes and the 2016 Kaikoura earthquake, emergency management authorities and agencies should reflect on how they operate. The global aid organisations have developed expertise in the implementation and management of responsive and flexible relief supply chains, and have developed humanitarian logistics practices that appear to have significant potential for NZ's disaster responders.

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ESTIMATING THE SHIP DISMANTLING CAPACITY IN COMPLIANCE WITH THE EUROPEAN UNION'S SHIP RECYCLING REGULATION

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Purpose
End-of-life ships are often dismantled in substandard conditions, causing environmental and health concerns. The European Commission has introduced a new Directive on the matter inspired by IMO's so-called Hong Kong Convention. The Directive calls that by the end of 2018, if not earlier, EU-flagged ships must be dismantled sustainably in shipyards certified by EU. This paper addresses two questions: i) what is the level of capacity needed in order to dismantle the existing EU-flagged fleet; and ii) how available EU-certified recycling capacity is able to match this need.

Methodology
The level of required dismantling capacity is estimated by size and age structure for all merchant ships under the EU-flag as per Jan. 1, 2017. Main research methods include descriptive statistics, regression analysis and ANOVA. The fleet data is obtained from the Clarkson World Fleet Register and dismantling capacity data is compiled based on official statistics.

Results
Based on actual fleet data, more EU-certified dismantling capacity is needed in the future. This suggests that EU shipyard certification process must be extended well beyond the borders of EU. Additionally, EU-regulation will most likely shift the dismantling market balance towards Europe, and thus increase the prices of dismantling.

Originality / Value
Literature that investigates fit between existing and required dismantling capacity of EU-flagged ships is both scarce and outdated. This research, derived from state-of-the-art statistics, answers this evident need. The paper contributes to policymaking by evaluating the implications of EU Ship Recycling Regulation while also providing valuable insights for the future.

Keywords

Ship dismantling, EU Ship Recycling Regulation, dismantling capacity

Introduction

The global merchant fleet comprises tens of thousands of ships, of which a portion comes to the end of their life each year. Ship dismantling refers to activity that breaks end-of-life (EOL) ships into pieces and puts the materials into further use. Shipping market cycles, technical obsolescence and demand for scrap metal are among the factors that drive dismantling activity (Buxton 1991).

Currently, over 90% of the global fleet is dismantled in the shores of South Asia, dominated by the shipyards in Bangladesh, India and Pakistan (CRSL 2017). Dismantling of EOL ships has both positive and negative impacts on the dismantling locations. Besides industry's labour intensity, ship's hull, machinery and other equipment offer valuable reusable materials, such as steel, non-ferrous metals and second-hand items (Sarraf et al. 2010), all of which are vital to local economies, especially in South Asia. At the same time, conditions of dismantling in terms of occupational health and safety as well as environmental aspects are often substandard (Andresen 2001; Abdullah et al. 2013).

For the past decades, policymakers around the world have been developing international regulatory framework to address ship dismantling industry's negative impacts as a response to growing concerns among the general public. The work started in 1989 when United Nations' Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (henceforth referred as Basel Convention) was signed, and was followed by Ban Amendment in 1995 (Moen 2008). Hong Kong Convention on Ship Recycling (HKC) was introduced by IMO in 2009. Notwithstanding of the efforts, the results are not convincing due to interpretation differences, ineffective enforcement or pending ratification (Moncayo 2016).

The European Union (EU) has taken active stance on ship dismantling by introducing the EU Ship Recycling Regulation (EUSRR) in 2013, which largely is inspired by the HKC. Consistent with the HKC terminology, and to illustrate sustainable and sound nature of the activity, EUSRR refers to ship recycling. The EUSRR contains a list of certificated shipyards (European List) that are allowed to recycle EU-flagged fleet (henceforth referred as EU fleet) (European Commission 2016). The first version of the European List accounts for around 1.1 Million lightweight tonnes (MLDT) so far, but the provision will enter in force by the end of 2018 or earlier if active certified dismantling capacity exceeds threshold value of 2.5 MLDT.

However, the adoption of EUSRR is not without controversy. One of the key concerns is the sufficiency of dismantling capacity of the European List (Alcaide et al. 2017). The availability of suitable capacity is one side of the matter but more importantly it comes down to the quantification of the need for the service. Estimating dismantling demand is a difficult task (Chang et al. 2010), while being subject to prevailing market conditions. For example, the preparatory study that formed the grounds of the EUSRR was based on statistics that differ the ones dominant since the global financial crisis (European Commission 2012).

The purpose of this paper is to evaluate what is the level of capacity needed to dismantle the existing EU fleet; and to estimate how the dismantling capacity in accordance with the European List is able to match this need, while taking into account the prevailing market conditions. More specifically, the future demand of ship dismantling is estimated by first calculating the average dismantling age of ships and then the annual fleet size.

The paper is structured as follows: First, key literature on ship dismantling, the regulatory framework and previous estimates on ship dismantling capacity are presented, followed by the empirical results from the statistical analysis. Finally, the results are discussed together with conclusion and suggestions for further research.

Literature review

Ship dismantling

After being acknowledged to be uneconomical to trade at sea, a ship is usually temporarily laid up, sold either in second-hand market or to a shipyard for dismantling (Buxton 1991). The rationale behind shipyards interest in dismantling EOL ships relates to the materials they are carrying. Lloyd's Register (2011) estimates that the recyclable materials account for 95% to even 98% of a ship's weight. According to Yujuico (2014) and Jain et al. (2017), about 80% of a ship's LDT is mostly recyclable steel scrap.

Currently, over 90% of global merchant fleet dismantling takes place in Asian countries and only less than 5% in OECD countries (CRSL 2017). Yujuico (2014) has estimated that approximately one third of global merchant fleet recycled in Asia is registered under EU flag. European Commission (2012) estimates that the dismantling volume of EU fleet ships accounted for over 0.8 MLDT in 2009. Reason why global dismantling market is so concentrated relates to the basic market fundaments. Asian shipyards are usually able to outbid their rivals due to number of reasons: high domestic demand for scrap steel; abundant supply of cheap labour; lax regulations in reference to environmental and safety aspects that entail low cost (Matz-Lûck 2010).
The choice of dismantling method – between landing, alongside, dry-docking, or beaching – determines much of the cost, safety and environmental effects (Choi et al. 2016). The use of methods is geographically focused. The most common method of dismantling in Indian subcontinent is beaching, where a ship is driven on a shore at high tide and dismantled once the tide has receded (Matz-Lück 2010). After sinking or abandoning it is considered as the most polluting method as harmful substances are soaked directly into environment (Yujuico 2014).

International regulation on ship dismantling
Over the past decades, international regulations have been established to control ship dismantling industry in an attempt to guarantee adequate level of environmental, safety and and health conditions. The Basel Convention became effective in 1992 to control the movement of hazardous waste. Its main purpose was to control the transportation of EOL ships, which potentially contained hazardous materials, to be dismantled in developing countries if they were detected (Matz-Lück 2010). In 1995, a more stringent approach was to follow through the adoption of the Ban amendment, whereby prohibiting transboundary movements of hazardous waste of which EOL ships are included (Moen 2008).

The HKC was established already in 2009, but in mid-2017 it is still waiting for ratification. It aims to protect workers as well as prevent pollution caused by shipyards, among other things, through stipulation that new ships must carry inventory of hazardous materials (Yujuico 2014). HKC does not explicitly take position against beaching as a dismantling method, which has been widely criticized (Mats-Lück 2010; Chang et al. 2010). Since it is not sustainable for the environment and the costs of dismantling ships in European countries are considerably higher according to Chang et al. (2010) and Matz-Lûck (2010), the EU has been adopting the most advanced regulation yet for ship dismantling (Yujuico 2014).

Numerous researchers have studied the possible effects of these regulations. Chang et al. (2010) have argued that new regulations will lead to growing need of reporting and wider documentation. Alcaidea et al. (2016) argue that new regulations has already had consequences for the ship dismantling industry because the market has been restructured and there has occurred more of third States flag use and setting up new yards in developing countries. More stringent environmental regulations are bound to increase costs for the South Asian shipyards. Yujuico (2014) suggests that the 'demandeur pays' would be a suitable approach in funding the transition towards more sustainable practices.

According to EU Green Paper on Better Ship Dismantling (2007) all ships's flying the flag of a European Union's Member State are to be recycled in facilities listed in the European List (European Commission 2016) which was established in December 2016 (European Commission 2007). Knapp et al. (2008) point out that the purpose of the Green Paper has mostly been addressing the issue of health and environmental concerns rather than propose a reinforcement of EU's ship dismantling volumes. The facilities listed in the European List need to meet strict requirements in order to be certified and have the right to recycle ships from EU flagged owner countries (Mikelis 2013). Paris and Mukherji (2013) have argued that the EU regulation will influence EU's member states to ratify the Hong Kong Convention as well. Moreover, Knapp et al. (2008) argue that it is more likely for a European country to ratify the HKC having already a wide range of EOL ship's and ship dismantling regulations compared to countries outside the EU.

Ship dismantling capacity

There is a reasonably extensive record of studies concerning global ship dismantling capacity. According to Chang et al. (2010) estimating dismantling capacity is a difficult task given the differences in the fleet databases and often insufficient data reporting methods. More importantly, it appears that figures are subject to market conditions at a given time.

International Maritime Organization (2010) estimated that annual global ship dismantling demand would account for 15 MLDT, while Abdullah et al. (2012) provides a considerably higher figure of 60-70 MLDT. Similar variation is notable when annual demand is measured in number of ships: 500-700 ships (Andresen 2001); 900-1,000 ships (Mikelis 2007); up to 4,000 ships (Vedeler 2006). Considering the "safe and green" –capacity relevant for the upcoming EU regulation, Abdullah et al. (2013) have estimated the global green capacity to be approximately 0.78 MLDT annually.

The European Parliament has stated in 2013 the current ship dismantling capacity in OECD countries to be insufficient for EU fleet. However, it is also said that the ship dismantling capacity in locations that operate in an environmentally sound manner but are not located in OECD countries, is already enough to treat all recyclable ships from owners from the EU and will continue expanding. The European Commission's paper estimates that the need for ship dismantling capacity would account for about 1.64 MLDT in 2012-2030 to be able to recycle all EU flagged ships. These estimates, presented in the European Commission Green Paper on ship dismantling (2012) are based on data collected in 2009. Considering the drastic changes in the world economy and the shipping market since then, regarding ship dismantling it is imperative to conduct a research based on updated data.

Results

One of the first assumptions affecting the demand for dismantling is the average lifetime of the ships. The European Commission (2012) estimates the average lifecycle to be 31.7 years, based on the average age of ships dismantled in 2008 and 2009. However, such a short sample period neglects the development of the economy, and in particular the transport volumes, as well as the development of the world fleet, which all contribute first to the freight levels, and the dismantling age of the ships. For this purpose, the average dismantling age was calculated, based on the dismantling statistics of the Clarkson World Fleet Register (2017). Figure 1 presents the LDT weighted dismantling age of merchant fleet in 2005-2016.

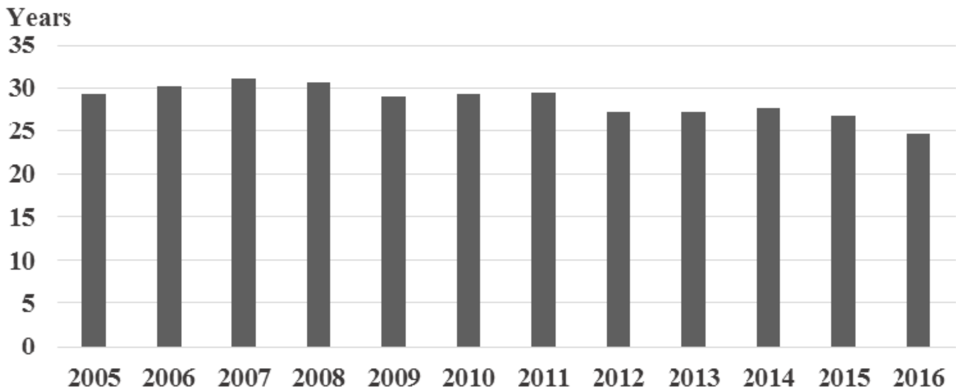

Figure 1. Average dismantling age of merchant fleet 2005-2016

The first observation from the figure is that the average dismantling age of the ships was on its highest in 2007 and 2008, exceeding 30 years. As a results of the financial crisis and the overcapacity in the supply of the ships, the average age of dismantling has since then declined into 24.7 years in 2016. This would indicate that the previous estimates of the European Commission severely overestimate the average lifetime of the ships in the current situation. Further, recent development has shown that potentially the average lifetime of a ship will most likely shorten even more, due to inappropriateness for the current situation (for example the expansion of the Panama canal) and to upcoming stricter environmental regulation.

The upcoming EUSRR (European Parliament 2013) requires that all the ships under the EU flag have to be dismantled in EU-certified dismantling facilities. The future demand for this dismantling capacity was estimated by calculating the LDT of all the commercial ships under EU flag in the Clarkson World Fleet Register Database, and by calculating the yearly sums based on the building year of the ship. As the most common measure for the ship size was DWT, and only a smaller portion of LDT:s were reported, the first step was to estimate the LDT to DWT ratio by ship type. At the same time, these ratios were tested with ANOVA to confirm, whether there were significant differences between the LDT to DWT ratios of different ship types. The estimated LDT to DWT ratios by ship type are presented in Table 1.

Ship type	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower	Upper		
Tanker	5861	0.244	0.097	0.001	0.241	0.246	0.060	1.650
Bulker	1897	0.195	0.062	0.001	0.192	0.198	0.080	0.710
Container	635	0.365	0.065	0.003	0.360	0.370	0.210	0.730
Dredger	239	1.786	2.984	0.193	1.406	2.167	0.000	35.580
Ferry	122	2.260	3.494	0.316	1.634	2.886	0.190	18.670
Gas	450	0.468	0.133	0.006	0.456	0.481	0.250	1.370
General cargo	341	0.335	0.102	0.006	0.325	0.346	0.200	1.410
Multi-purpose	894	0.395	0.084	0.003	0.390	0.401	0.220	0.930
Offshore	106	0.814	1.870	0.182	0.454	1.174	0.020	16.980
Oth non cargo	5	3.493	5.045	2.256	-2.771	9.758	0.180	11.670
PCC	84	0.965	0.184	0.020	0.925	1.005	0.540	1.460
Reefer	53	0.631	0.150	0.021	0.589	0.672	0.410	1.200
Ropax	14	0.829	0.285	0.076	0.664	0.994	0.270	1.290
RoRo	105	0.760	0.327	0.032	0.697	0.823	0.350	3.350
Tug	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cruise	7	4.669	2.053	0.776	2.770	6.568	2.480	7.590
Average	**10813**	**0.347**	**0.714**	**0.007**	**0.334**	**0.361**	**0.000**	**35.580**

Table 1. Estimated LDT to DWT –ratio by ship type

The average LDT to DWT ratio of commercial ships was found to be 0.347. However, as can be seen from Table 1, there are large differences between the ship types, the lowest (0.195 LDT per DWT) for the bulk-ships, and the highest (4.669) for the cruise ships. Based on ANOVA, the differences between the ship categories were mainly significant, confirming that the demand in LDT should be estimated by ship type.

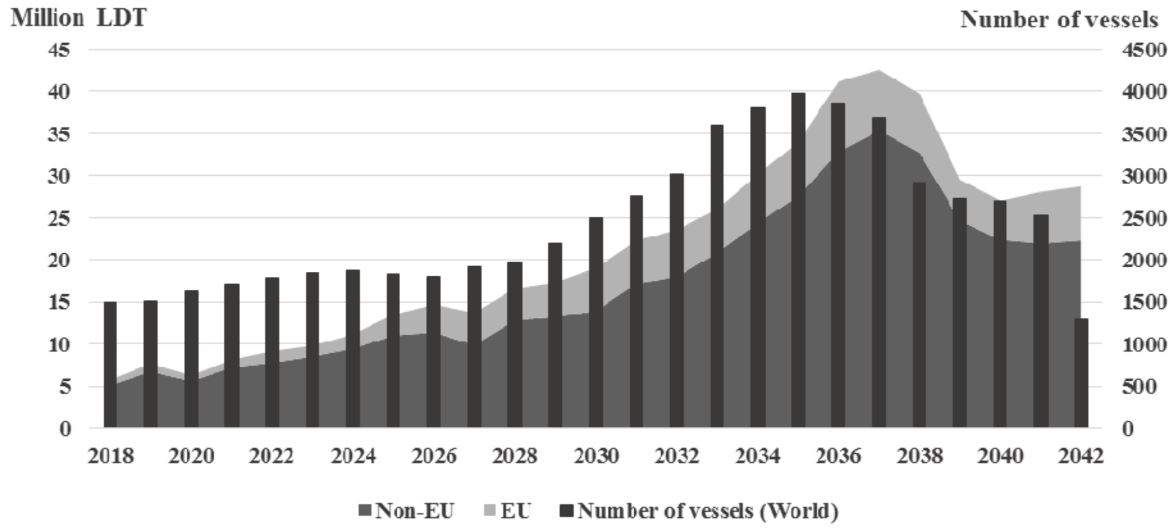

Figure 2. Estimated demand for ship dismantling 2018-2042

Figure 2. presents the estimated demand for ship dismantling in 2018-2042. For this, the size of the world merchant fleet (by ship type and building year) was calculated by using the LDT to DWT ratios in Table 1. As the existing fleet also contains ships over 25 years old, they were smoothened evenly over the time period.

Based on the assumption of 25 years average lifetime, global demand for ship dismantling is expected to increase from around 5.1 MLDT in 2018 to 42.6 MLDT in 2037, after which the demand for dismantling will decline to around 28 MLDT in 2041. For the EU fleet the demand will increase from 0.6 MLDT in 2018 to 8.4 MLDT in 2036. In case demand is measured in number of ships, respective numbers for the global fleet in 2018–2034 increases from 1,495 to 3,981 until dropping to 1,288 by 2042. A similar trend – albeit in a smaller scale – is notable for the EU fleet as the number of grows from 130 to 652 in 2018–2035 till declining to around 320 by 2042.

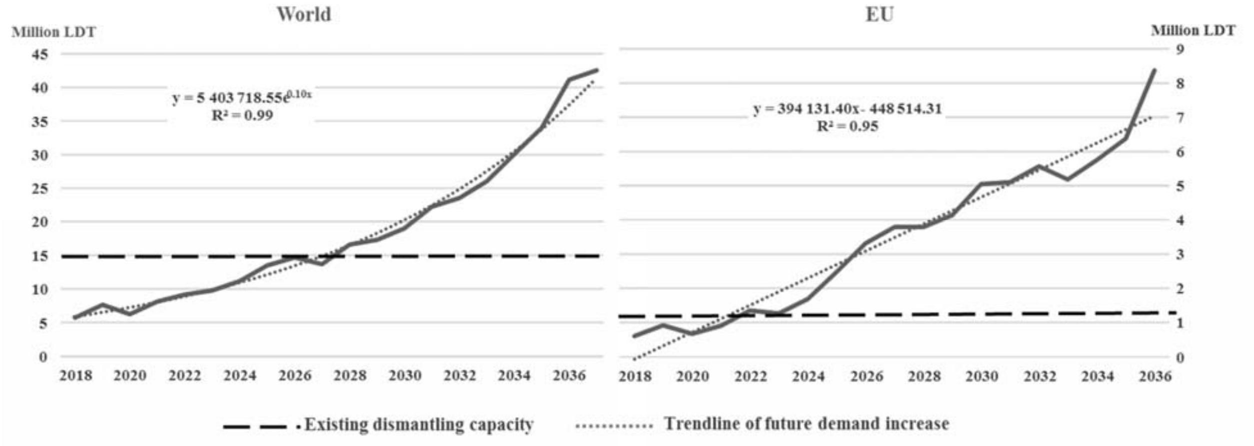

Figure 3. Estimated increase in demand for ship dismantling capacity in 2018-2037

The yearly increases or ship dismantling capacity between 2018 and the year of estimated peak demand (EU 2036, world 2037) was estimated with regression analysis. For the world, the demand for ship dismantling capacity was estimated to increase exponentially, around 10% per year between 2018 and 2037 ($y=5403718^{0.10x}$, R^2=99%). For the EU fleet, and at the same time for the EU-certified dismantling capacity, the increase is estimated to be linear, increasing around 0.4 MLDT per year between 2018 and 2036.

The level and increase of demand can be compared with the estimates on existing dismantling capacity. Even as the current global capacity can be considered insufficient for the future demand (Stuer-Lauridsen et al. 2003), especially the dismantling locations with low infrastructure and equipment requirements (Bangladesh, India etc.) and abundance of labour supply can be assumed to be able to meet the increasing demand. The situation with the EU-certified “green” dismantling capacity, however, is more challenging. The theoretical maximum of the currently EU-certified capacity is assumed to be around 1.1 MLDT (European Commission 2016), whereas the world demolition volume has been on average around 15 MLDT during the last five years. Compared to the estimated future demand, this theoretical maximum will be exceeded already in 2022. At the same time, this theoretical maximum has not been tested yet. The realized capacity of the EU-certified dismantling locations has been around 0.3 MLDT. This as such would mean that after 2022, the EU-certified capacity should increase roughly on a pace of the current realized capacity.

Discussion and conclusions

The motivation of this paper originates from the upcoming EUSRR, in which the key contribution in relation to previous regulation is that in the future ships flying the flag of any of the EU member states are to be recycled in ship dismantling facilities certified by the EU. Prior to the regulation, the European Commission estimated that the current and available certified capacity meeting the requirements would be sufficient to handle the demand. However, these estimates are based on analysis conducted already years ago, based on data mainly from a completely different macroeconomic situation. This paper analysed whether the market fundaments have changed, and whether the previous estimates of the European Commission are still valid.

In 2012, the European Commission (2012) estimated the average lifecycle to be 31.7 years, based on the average age of ships dismantled in 2008 and 2009. The findings of this paper are conflicting. Ship dismantling data from Clarkson World Fleet Register (2017) show that after 2007 the average age of recycled ships has declined into 24.7 years. This in practice indicates that the demand for ship dismantling capacity of EU fleet and other ships will increase significantly faster than anticipated. Similarly, during the pre-crisis years the increased transport volumes and the soaring freight rates triggered investments that increased the size of the fleet significantly. In combination with the declined dismantling age of the ships, this further increases the imbalance between the previously estimated and realized ship dismantling demand in the future.

In this paper, the future demand for ship dismantling capacity was estimated by analysing the size and age structure of the existing fleet. Assumptions were made that the ships would be recycled when they reach the age of 25 years. The fleet size in LDT was estimated by using the LDT-DWT –ratios calculated from the fleet data of Clarkson World Fleet Register. The results showed that the global demand for ship dismantling is expected to reach its peak, 42.6 MLDT in 2037. For the EU fleet the peak of demand, 8.4 MLDT, will be in 2036. This would mean that the global demand for dismantling between 2018 and 2036 will increase exponentially, at an average rate of 10% per year. For the European Union, the increase will be around 0.4 MLDT per year between 2018 and 2036. So far the realized capacity of the EU-certified dismantling locations has been around 0.3 MLDT. This as such would mean that after 2022, the EU-certified capacity should increase roughly on a pace of the current realized capacity.

To generalize the results, it would seem that the future demand for ship dismantling for both the global and the EU fleet have been underestimated. This finding supports the doubts of Alcaide et al. (2017) over inadequacy of the dismantling capacity of the European List. The pace of fleet growth has been phenomenal over the past decade, which explains the low estimates by Andresen (2001) and Mikelis (2007), and puts the Vedeler's (2006) figure in a new perspective. For the global fleet, the supply is more likely to be able to meet the demand, as capacity constraints in beaching are less likely to occur. For the EU fleet, increasing capacity at the required pace might be more challenging, as the accepted methods of dismantling are both more capital intensive, and require more skilled labour.

As usual, the changes in market balance will most likely have its effects. The challenges in meeting the demand will most likely drive up the cost of dismantling, meaning additional costs for the ship-owners. At the same time, shipyards that will be able to meet the standard, will most likely benefit. From the policy perspective, it would seem obvious that the challenge will be in keeping the certification process in the right pace to prevent serious market effects from occurring. The worst case scenario would be that the certification process of the European Union will be watered down and the standards will be lowered to solve the issue.

This analysis is by no means without limitations. The results are based on the currently available data, market conditions and international regulatory framework. In case major changes would occur, the results should be updated. As one of the examples of possible changes is the environmental regulation of ships, in which many major changes are to be implemented in the near future. Some of these regulations (SOx, NOx etc.) will lead to a major retrofitting of the existing fleet or in some cases in early dismantling of the ships. In the former case, the demand for retrofitting would reserve some of the dismantling capacity, further aggravating the problem. In the latter case, the effect would be in escalating the problem even before than anticipated. As a natural stream for further research, both should be taken into account.

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EVIDENCE-BASED ROLE OF SUPPLIERS IN SUPPLY CHAIN SUSTAINABILITY

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Introduction

Sustainable development is defined as 'development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs' (WCED, 1987). Integrated into corporate operations, under the banner of Corporate Social Responsibility (CSR) – 'the responsibility of enterprises for their impacts on society' (European Commission, 2012), sustainability is considered from multiple aspects, for instance, social and environmental responsibility (Dahlsrud, 2006), environment, health and safety, labour rights, human rights and corruption (Ayuso et al., 2013, Jorgensen and Knudsen, 2006), or the natural environment, society, and economic performance philanthropy (Carter and Rogers, 2008).

The widely accepted concept of CSR includes three dimensions: environmental, social and economic (Wilhelm et al., 2016, Wu and Pagell, 2011). CSR involves integrating environmental issues (e.g. waste, pollution, emissions, energy consumption, recycled material, eco-labelling, design for assembly, and clean technologies); and social issues like working conditions and employee's health and safety into the value chain. It also includes efforts to ensure financial health to meet the requirements of investors/shareholders. Of note is existence of synergies and trade-offs between the three sustainability pillars (Morioka and Carvalho, 2016, Gualandris and Kalchschmidt, 2016), that managers are confronted with (Azapagic, 2003). As argued by Savitz and Weber (2007), in some cases, 'sweet spots' could be obtained when a win-win relationship between sustainability pillars materialises. Evidence of such positive outcomes has been found in studies by Golici and Smith (2013), Das et al. (2008), Pagell et al. (2013) and Wang and Sarkis (2013). Yet, when this is not the case, organisations have to deal with tradeoffs, given limited resources and defined priorities (Morioka and Carvalho, 2016).

There exist different perspectives regarding the extent to which corporations are held responsible for CSR. Those ascribing to shareholder perspective argue that 'the only social responsibility that businesses have is to maximise profits, which in turn maximises shareholder wealth and satisfaction' (McWilliams and Williams, 2014: 65), i.e. economic sustainability. Those holding a stakeholder perspective on the other hand believe that in addition to shareholders, companies have to respond to requirements of those with legitimate interest in a company (Donaldson and Preston, 1995), including employees, customers, governments, local communities, media, trade unions and special interest groups (McWilliams and Williams, 2014). In other words, organisations should be responsible for all three bottom lines. The recent emergence of outsourcing practice has also raised a question if companies should be held responsible for outsourced activities that they do not perform themselves.

The current climate has seen the stakeholders' model seemingly taking over the shareholder's view in sustainability. Increasingly, managers believe that it is unethical to focus on just shareholders (McWilliams and Williams, 2014). Recent developments have also seen increasingly stringent regulations on environmental and social sustainability at different levels: supernational (e.g. EU), national and industrial. Sustainability is therefore no longer just a matter of choice, or as put by Epstein and Roy (2001: 586), 'it's not the question whether to implement CSR, but how'.

Also, outsourced activities are increasingly considered as an integrated part of the focal company (Jorgensen and Knudsen, 2006) - a firm that generally owns a brand, is involved in the designing of products and services, and rules the supply chain (Seuring and Muller, 2008). Recent examples of damages that focal firms suffer, both legally and materially (e.g. Mattel case in 2007 (Hora et al., 2016) and Zara case in 2011 (Burgen and Phillips, 2011)), uphold the expectations for focal firms to take ultimate responsibility for their supply chain's offerings. The emergence of such a notion of 'chain liability' (Hartmann and Moeller, 2014: 281) has been recognised by various scholars, including Handfield et al. (1997), Ayuso et al. (2013), Jorgensen and Knudsen (2006) and Grimm et al. (2014).

Various empirical studies have been conducted to explore different avenues to sustainability, especially in the context of supply chain (see for instance, Lee and Wu (2014), Gualandris and Kalchschmidt (2016), Green et al. (2012), Vachon and Klassen (2008), etc.). However gaps remain. In line with findings by Ayuso et al. (2013), Lee (2016) and Miemczyk and Johnsen (2012), our literature review identified a bias towards studies from customers' perspective, mostly large-sized and international buying firms (Lee, 2016). 'The standpoint of suppliers and how they deal with the increasing environmental and social requests has been explored to a much lesser degree' (Ayuso et al., 2013: 498). The bias is worse for second- and third-tier suppliers (Miemczyk and Johnsen, 2012).

This is an unfortunate shortcoming, as suppliers are arguably critical to successful implementation of sustainability requirements in a supply chain context. In a supply chain with only one tier of suppliers, a focal firm's sustainability effort is expectedly to be limited to successfully getting its immediate suppliers to implement its sustainability requirements. The relationship between the focal firm and its immediate suppliers is direct and contractually binding, or in other words, the focal firm could exert some extent of influence on its suppliers in pursuit of its sustainability endeavor. However, in a multi-tier supply chain, the task would be much more complex. In addition to securing its immediate suppliers' (i.e. 1st tier suppliers) engagement, the focal firm needs such requirements to be as well passed down to and implemented by suppliers' suppliers (i.e. 2nd tier suppliers), suppliers' suppliers' suppliers (i.e. 3rd tier of suppliers) and so on.

Without a direct contractual relationship between the focal firm and tiers of suppliers beyond the 1st, successful implementation of the supply chain sustainability requirements would greatly depend on the 1st tier suppliers' willingness to disseminate and monitor the implementation of such requirements by the 2nd tier suppliers; the 2nd tier suppliers' willingness to convey and monitor the implementation of the 3rd tier suppliers, and so on. Put differently, suppliers need to be activated in two ways: (1) by incorporating the requirements of sustainability into their own operations (known as primary agency role), and (2) by disseminating and monitoring the implementation of such requirements by their suppliers (so-called secondary agency role) for supply chain sustainability to be achieved. These two roles combined are known as double agency roles (Wilhelm et al., 2016).

Among few studies that look at the problem from suppliers' perspective, e.g. Zhu and Sarkis (2004), Lee (2016), Lee and Klassen (2008), those that duly investigate the roles of suppliers in the upstream movement of focal firm's sustainability along the supply chain (e.g. Wilhelm et al. (2016), Bhakoo and Choi (2013)) have been rare. Drawing on the model developed by Wilhelm et al. (2016), we aim to fill this gap by empirically investigating factors that potentially impact suppliers' propensity to be engaged in the double agency roles, from principal-agency and institutional theories. Unlike Wilhelm et al.'s (2016) research which mainly focused on 1st suppliers and case-based, we extended to include various tiers of suppliers along the supply chain via surveys.

This study adopted a quantitative approach using survey in the context of manufacturing companies in Vietnam – a developing country where many sub-suppliers operate (Wilhelm et al., 2016, Jorgensen and Knudsen, 2006) for the purpose of addressing two additional gaps identified in the extent literature: biases towards (1) a qualitative approach (Tachizawa and Wong, 2014) with great reliance on case studies or case examples (Ayuso et al., 2013); and (2) developed countries as study contexts (Lee, 2016). Also, Vietnam - as a country that many big companies are outsourcing to, including Nike, Adidas, Zara, Intel, Samsung, Nokia, Canon, Fujitsu, Foxcom, Microsoft, Panasonic, and IKEA (TMA Solutions, 2015) expectedly provides a rich study context for this research. Manufacturing industry was chosen due to its perceived stronger social and environmental impacts (Gualandris and Kalchschmidt, 2016).

The article is structured as follows. Section 2 discussion theoretical background and development of research hypotheses. Methodology of the study is explained in Section 3. The results are outlined in Section 4, then comes Discussion and Managerial Implications in Section 5. Section 6 continues with some concluding remarks, with a brief discussion on limitations of the research and directions for future research.

Theoretical background and development of hypotheses:

Principal-agency theory

Modern economies have seen the popularity of situations where a person or group of persons (also called agents) is asked to perform a task on behalf of others (also called owners/principals) (Besley and Ghatak, 2014). 'Delegating tasks to those with appropriate expertise is essential to unlocking the gains from the division of labour' (Besley and Ghatak, 2014: 2, Wallis and Douglass, 1986), e.g. improved productivity, which in turn generates better economic performance (Eigen-Zucchi, 2001). Such a practice, however, as stipulated in the principal-agency theory, creates a situation where ownership is separated from control, which gives rise to principal-agent problems. More specifically, principals' welfare is at risk when agents engage in opportunistic behaviours which maximize their own personal interests and expend insufficient effort towards achieving agreed-upon objectives (Jensen and Meckling, 1976).

The problem that this theory aims to address - the agency dilemma, is fuelled by a set of information deficits that arise in any complex set of organisational transactions. Principal-agent theories specifically identify information asymmetry between parties to all transactions. Information asymmetry, refers to a situation in which one party in a transaction has greater or superior information compared to another, for instance, the seller knows more than the buyer and vice versa. This situation may lead to such harmful outcomes such as adverse selection (i.e. misrepresentation of the ability of the agent) and moral hazard (i.e. lack of the agent's effort to fulfil the principals' order) when one party can take advantage of the other party's lack of knowledge (Williamson, 1985). In a principal-agent relationship, the agent who is directly involved in the control of the operations of organisations/activities is thought to have superior knowledge and information, and consequently can act opportunistically (e.g. multiple forms of system gaming, including lying, cheating, stealing, and other short term strategies) if they decide to do so.

Various mechanisms that have been in use to incentivize agents to act in the principals' best interest, including a contract design that aligns the incentives of each party in a more efficient manner, use of various monitoring practices (e.g. performance monitoring via board of directors, stockholders or outside auditors), a set of reward mechanisms (e.g. compensation, bonus, threat of firing, threat of takeover); and multiple information sharing mechanisms to have information distributive inefficiency corrected (Eisenhardt, 1989). Implementation of all these measures, however, is costly, and gives rise to so-called agency costs.

The relationship between a focal firm and its immediate suppliers in a supply chain context, is essentially one of agency type, wherein the focal firm, as a principal, hires the supplier(s) – as agent(s), to conduct certain activities that are essential to the production of its offerings. The focal firm is held responsible for problems, both technical and sustainable, associated with their sales, while partial or whole production lies in the hands of the suppliers. The same holds true for the relationships between the 1st and 2nd tier suppliers, and so on. As previously discussed, the achievement of sustainability depends on the focal firm's sustainability requirements being effectively implemented by tiers of suppliers. It however, in line with the principal-agency theory, is arguably disturbed by information asymmetry between involved parties in each agency relationship, e.g. focal firm – 1st tier suppliers; 1st-2nd tier suppliers and so on. This calls for different sets of incentives and information sharing mechanisms to get suppliers at different tiers along the supply chain activated.

It could therefore be argued that the availability of incentives motivates suppliers' engagement in their customers' sustainability endeavour by implementing two agency roles: primary and secondary. For the purpose of this study, we chose to focus on one specific set of incentives - benefits/penalties to be expected from conforming to customers' requirements. Specifically, it is hypothesized that:

> *H1a: The greater the incentives for primary agency role (PI), the more engaged the suppliers are in such role implementation (PR)*

H1b: The greater the incentives for secondary agency role (SI), the more engaged the suppliers are in such role implementation (SR)

Also according to the principal-agency theory, the use of information sharing mechanisms is expected to reduce information asymmetry and improve information transparency - the degree to which one has sufficient insight into its partners' operations and behaviours (Wilhelm et al., 2016). Again, we argue that:

H2a: The higher degree of information transparency between customers and suppliers (PT), the more engaged the suppliers are in primary agency role implementation (PR)

It is true that buyers have less information about their suppliers' suppliers (Choi and Hong, 2002). In response, many firms, via their suppliers, have tried to improve interactions with their suppliers' suppliers in their sustainability endeavour, for instance, site visits or providing support for suppliers. Such interactions, while not necessarily contractually binding, arguably have effect to reduce information asymmetry between the customers and suppliers' suppliers. They also clearly create a triad relationship: customers – suppliers – suppliers' suppliers (Tachizawa and Wong, 2014), which in turn arguably influences the propensity of suppliers to better cooperate with their suppliers. It is therefore hypothesized that:

H2b: The higher degree of information transparency between customers and their suppliers' suppliers (ST), the more engaged the suppliers are in secondary agency role implementation (SR)

Institutional theory

As previously mentioned, more and more firms adopt CSR by incorporating sustainability requirements into their operations or management of their supply chain, due to increasing pressures from various stakeholders, including government regulators, customers, activists organisations etc. (Handfield et al., 1997, Ayuso et al., 2013, Jorgensen and Knudsen, 2006, Grimm et al., 2014). This is happening despite widely recognised tradeoffs among three pillars of CSR (Morioka and Carvalho, 2016, Gualandris and Kalchschmidt, 2016), i.e. sustainability requirements met at the expense of economic rewards.

Such a phenomenon, generally described as organisations adopting certain 'practices as a product of social rather than economic pressures' (Suddaby, 2013: 379) has long been of interest of scholars subscribing to institutional theory. From institutional theory perspective, organisations adopt and keep many organizational practices for the purpose of conformity and legitimacy, instead of economic performance (Suddaby, 2013). In Zoogah (2014: 114)'s words, 'organisations elaborate rules and requirements to which individual organizations must conform in order to receive legitimacy and support'.

Sources of social pressures on organisations to conform could be grouped into coercive, normative and mimetic isomorphism (DiMaggio and Powell, 1983). The first group - *coercive isomorphism* is 'largely political in nature and arises from organizations' need to appear legitimate to other, more powerful actors, such as the state' (Suddaby, 2013: 381). Put differently, they are pressures exerted on organizations by powerful constituents usually in the interest of driving compliance with prevailing norms, rules and beliefs, 'often, but not necessarily, explicitly articulated in the form of rules or laws' (Suddaby, 2013: 381). *Normative isomorphism* is defined as the 'need to adopt practices assumed to be right or proper by morally significant actors, such as the professions (Suddaby, 2013:381). *Mimetic isomorphism* on the other hand refers to 'the tendency of some organizations to copy other organizations that are perceived to be successful or legitimate under conditions of ambiguity—that is, when the criteria for or path to success is not apparent' (Suddaby, 2013: 381).

In DiMaggio and Powell's (1983) perspective, the most significant sources of social pressures to conform arise from the professions and the state, that is, coercive and normative isomorphism. We therefore mainly focus on these two sources of institutional factors in this study in a slightly different structure. Specifically, social pressures in supply sustainability are grouped into (1) regulatory pressures (RG) - ones that stem government, consumers, and other stakeholders within the direct institutional environment for a company; and (2) customers' pressures - ones that stem from suppliers' direct customers (Wilhelm et al., 2016). The latter is further divided into (1) those focusing on primary role (PCP), and (2) those targeting secondary role (SCP). We argue that while regulatory pressures place direct impact on suppliers' sustainability implementation, i.e. primary agency role, while those from customers tend to impact both, thus:

> *H3a: The greater the regulatory pressures (RG) are, the more likely suppliers are to implement their primary agency role (PR)*
> *H3b: The greater the customer pressures on primary agency role are (PCP), the more likely suppliers are to implement their primary agency role (PR)*
> *H3c: The greater the customer pressures on secondary agency role are (SCP), the more likely suppliers are to implement their secondary agency role (SR)*

Connecting primary and secondary agency roles

Some interactions between the two agency roles could be contemplated. The primary one, i.e. suppliers' implementation of customers' sustainability requirements in its own operations, is potentially a priority to the secondary one (i.e. suppliers' dissemination of sustainability standards to their suppliers' operations). Logically, limited available resources for sustainability are to be expended on firms' own operations, or put differently, used for their own benefits, before being extended to others. Also, it could be argued that successes on both fronts would positively and mutually influence one another. Experience in one role would help facilitate the implementation of the other and vice versa. However, there remains scant theoretical support for a clear direction of that relationship, we therefore attempt to explore that relationship by hypothesizing that:

> *H4: The implementation of primary agency role (PR) and the implementation of secondary agency role (SR) happen and/or change together.*

The conceptual model comprising of three submodels is illustrated in Figure 1 below:

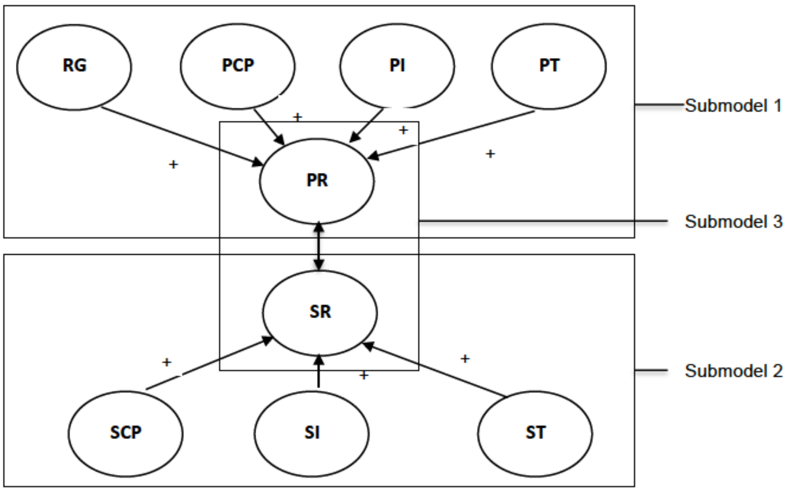

Figure 1: Conceptual model

Methodology

Survey development

Initial indicators of constructs were developed from the following sources: (1) Indicators from previous related studies; and (2) newly developed items based on theoretical definitions. For the purpose of measuring the constructs, a minimum five-point Likert scale (i.e. 1 = Strongly disagree; 2 = Somewhat disagree; 3 = Neither disagree nor agree; 4 = Somewhat agree and 5 = Strongly agree) was used. The survey was tested for content validity by asking opinions from senior researchers in the field. On the basis of the replies received, the variables were then modified. As the conceptual model involves multiple causal relationships among latent constructs, SEM is a relevant technique to be employed (Hair et al., 2009). Statistical significance was tested at the 0.05 level.

Data collection:

Manufacturing enterprises in various provinces of Vietnam, including Hai Duong, Hanoi, Thai Nguyen, Ninh Binh, Thanh Hoa, Ho Chi Minh city, Dong Nai, were identified via multiple sources, including: (1) Vietnam Young Entrepreneurs Association; (2) General Department of Taxation; (3) Vietnam Association of Accountants and Auditors (VAA); (4) Yellow Book; and (5) researchers' personal contacts with enterprises. Companies were contacted by phone/email in the first instance. Respondents were senior people in the company, who were expectedly to know about the company operations at both strategic and operational level (e.g. sustainability, procurement, sales, general managers, accounting and finance). Only companies that identified themselves as suppliers of a supply chain with at least 3 tiers were included. Recognising that one company could belong to more than one supply chain, we also asked the respondents to identify one, and relate to it while answering survey questions. In addition, an online survey was created. Invitations to participate were sent to Yellow book manufacturing enterprises. In total, 197 responses were received.

Due to certain regional associations' (e.g. Department of Taxation) administrative policy, surveys were circulated to members by the associations themselves, and the exact number of invitations was not known to researchers. A response rate was unfortunately not reached with some certainty, thus not reported accordingly.

Findings

All constructs showed high level of internal reliability, with Cronbach's alphas ranging from 0.74 to 0.95, well beyond the recommended cutoff of 0.7. Three SEM analyses were conducted to test the causality relationships between PR and SR with their relevant independent constructs, i.e. Submodel 1 and Submodel 2; and the correlation between PR and SR (Submodel 3). The Goodness-of-fit test of Submodel 2 indicates a strong model fit, with RMSEA, CFI and TLI of 0.06, 0.934 and 0.925; all satisfactorily meet the recommended cutoffs (<0.07, >0.9 and >0.9 respectively). The statistics of RMSEA, CFI and TLI for Submodel 1 are 0.07, 0.870 and 0.859; and for Submodel 3 being 0.08, 0.928 and 0.915 respectively. While the goodness-of-fit statistics for these two models are not optimal, they are just marginally shy of the recommended cutoffs; the models' fit is argued to be acceptable.

The SEM tests confirm four positive relationships: RG-PR and PI-PR in Submodel 1, and SI-SR and ST-SR in Submodel 2; while the other three hypothesized relationships were found statistically insignificant with p-values higher than 0.05 (i.e. PCP-PR, PT-PR and SCP-SR) (see Table 1 below). Specifically, regulatory pressures and economic incentives were found to exert positive impact on suppliers' incorporation of sustainability requirements into their own operations. Suppliers' willingness to engage their suppliers in their sustainability endeavour was also positively influenced by potential benefits they could derive from doing so, and the extent of information transparency between their immediate customers and their suppliers. Pressures from customers (i.e. PCP and SCP) on the other hand proved not to affect the implementation of both agency roles by the suppliers. Insignificant effect of information transparency on the primary role was also revealed. Also as shown in Table 1, PR was also found to move in the same direction with SR as expected, at the p-value smaller than 0.0001. Put differently, suppliers tend to assume both roles in tandem.

	Coefficients	P value
RG → PR	0.453	0.0000
PI → PR	0.484	0.002
PCP → PR	-0.105	0.504
PT → PR	0.111	0.546
SCP → SR	0.081	0.439
SI → SR	0.392	0.024
ST → SR	0.228	0.001
PR ⇔ SR	0.88	0.0000

Table 1: Regression weights

Discussion and Managerial implications

Findings of the study provided evidence-based understanding of the interactions between suppliers' propensity to implement their double agency roles, and agency and institutional factors. They expectedly act as guidelines for not only focal firms, but also suppliers on how to invest their resources in order to ensure sustainability along the supply chain. Specifically, according to our findings, suppliers are motivated to engage in their primary agency role in sustainability by a strong regulatory system, involving multiple stakeholders, including international and national governments, industrial associations as well as ultimate consumers who have a final say on the demand of a supply chain. Put differently, this finding justifies the need for a set of strong coercive and normative pressures to engage suppliers in this role. This is even more important for suppliers upstream a supply chain, as sub-suppliers are argued not to be subject to the same level of pressure as their customers are. Reasons include sub-suppliers tend not to be under as much pressure from the focal firms (Plambeck, 2012); they are usually located in countries where environmental and social regulations are less demanding (Esty and Winston, 2006); lower-tier suppliers tend to be less susceptible to environmental pressure from society, because they are often small and medium enterprises (SMEs), 'not well-known to the general public or 'are sheltered from the glare of the general public'' (Lee et al. (2012) as cited in Tachizawa and Wong (2014: 643)). Not to mention, sub-suppliers are lower-tier suppliers who 'tend to have a more unstable relationship with the rest of the supply chain, because they can be changed easily' (Ponce and Prida (2004) as cited in Tachizawa and Wong (2014: 643)).

Our data analysis also supports the perspective that direct benefits that suppliers are also expected to receive from the performance of the double agency roles are to be made as explicit as possible for effective implementation of both agency role to materialise. Practically, one of the biggest challenges in supply chain management is to get supply chain members engaged via an effective risk and benefit sharing mechanism across the supply chain. Clearly, the further the suppliers are from the consumption point, the more difficult it is for the suppliers to understand the magnitude of their contribution to the competitive advantage of the supply chain as a whole, and to claim their share accordingly, which would in turn discourages their collaboration. Thus, we argue that this finding of our study confirms the key role of a fair and explicit benefit and risk sharing across the supply chain plays in activating suppliers in supply chain sustainability. It would not be an easy challenge to take on, but a potential area of focus if relevant improvements are to be achieved.

In our study, customers' role in motivating suppliers' implementation of both agency roles was reflected by four factors: customers' pressures (PCP and SCP) and information transparency at both levels (PT and ST). Nonetheless, the data showed no evidence of some effect of customers' pressures and information transparency at the primary level. While this is contrary to our initial expectations, this might be explained by the argument that coercive and normative isomorphism, i.e. social pressures from the professions and the state, are the most important ones (DiMaggio and Powell, 1983). Given limited resources, companies might be selective, or prioritize the source of pressure to respond to while implementation sustainability requirements.

As previously discussed, while there emerged some support for the companies to assume the responsibilities for outsourced activities (Jorgensen and Knudsen, 2006), most of the time, the actions on the part of regulatory entities have mainly targeted big focal companies, with suppliers mainly being left out of the picture. Put differently, suppliers are not subject to high level of regulatory pressures, and thus, implementation of the secondary role should depend more on the other sources of pressures, i.e. those from customers, either direct or via strengthened collaboration between the customers and the suppliers' suppliers. Interestingly, we found that at this level, suppliers at different tiers of a supply chain appeared to effectively respond to information transparency, while direct pressures rom customers seem to be of no avail. Puzzling as it is, a difference between two types of customers' impact at this level should however be differentiated: while the former implies one directional pressure from the customers, the latter is indicative of a more proactive and collaborative approach from the customers' part in sustainability issues. This might underlie suppliers' positive response to information transparency as a motivator at this level.

Finally, our data confirms that expectation that the implementation of both roles 'fluctuate' together. In other words, they were found to move together and in the same direction. While further research is required for a conclusion about the causality between the two to be reached, this finding indicates that suppliers benefit more by investing in sustainability on both fronts.

Conclusion, limitations and further study

Our study investigated the under-researched roles of suppliers in supply chain sustainability; they are primary agency role and secondary agency role. This is one of the first research that quantitatively operationalized agency and institutional factors in the context of supply chain sustainability. It also effectively contributed to the literature in the field by filling the gaps in terms of methodology and study context.

However, it is not exempt from limitations. First, one big question could be raised about the possibility of combining all three submodels into one integrated analysis. While this is impossible at this stage due to the sheer complexity of the model, not to mention a quite modest sample size, this would definitely be an interesting research gap that could be filled in the future.

Second, this study while considering key agency and institutional factors, did not incorporate additional contingency factors that could influence suppliers' engagement in the double agency roles, for instance, focal firm's focus on triple bottom line, functional alignment, use of power and suppliers' resource availability (Wilhelm et al., 2016). Also, our study mainly focused on the causal relationships between agency and institutional factors and suppliers' integration of customers' sustainability standards into their operations, and the passing of such requirements onto their own suppliers. Whether such efforts bear fruits, e.g. better sustainability performance, or if there's any connection between sustainability effort and involved parties' bottom lines is not addressed in this research. Furthermore, according to DiMaggio and Powell (1983), the rate of institutional isomorphism, i.e. adoption of organisational and management practices by firms, could be influenced by factors such as the extent to which organisations are dependent on institutional environment, existence of high uncertainty or ambiguous goals, or reliance on professionals. They were however not considered in this study. Further studies that address the identified shortcomings are therefore desirable.

Last but not least, while Vietnam clearly provided a rich context for untangling suppliers' role in the age of booming outsourcing practices, replication of this study in another context – e.g. a different industry in a different country that is also a major destination for outsourcing activities, would make an interesting triangulation of our research findings.

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EXPLORING OPTIMAL AID MIX IN HUMANITARIAN INTERVENTIONS: AN ARCHIPELAGIC PERSPECTIVE

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ABSTRACT
Purpose: The purpose of this manuscript is to explore whether a combined humanitarian assistance involving traditional aid delivery and cash transfer modalities is the optimal response in an archipelagic country? This paper aims to assess whether in such context, cash-based intervention may rise as a more suitable transfer model that is rapidly scalable given the wide-reach of the banking, mobile technology and financial sectors compared to the traditional aid delivery model.

Design/methodology/approach: A qualitative approach has been selected for the study. Data has been collected through a series of semi-structured interviews, and unstructured observations to obtain perspectives from various stakeholders.

Findings: The use of digital money, mobile wallets and e-cash arguably serves as an effective modality for humanitarian intervention in remote places in archipelagic countries. These cash based interventions offer greater flexibility for the disaster affected populations to restore their livelihoods and resume their normal lives. However, traditional aid delivery cannot be totally eliminated because of limited access to information, communication and technology infrastructure.

Research limitations/implications (if applicable): The study is an exploratory research and therefore is more conceptual than empirical. It is intended to gain further information to suggest hypotheses to the topic under review.

Practical implications (if applicable): Insights will be obtained from practitioners on the optimal mix of between traditional aid delivery and cash based programmes based on experiences in archipelagic countries.

Originality/value: As cash-based programming is anticipated to grow larger than the traditional supply chain of aid delivery within the next decade, many relief organisations have attempted to come up with the most suitable operational setup for both cash-based and voucher-based interventions but are lacking guidelines on the optimal mix.

Keywords: Cash-based programming, Archipelagic, humanitarian intervention

Background

The sheer challenge to effectively respond to disaster situations have led the humanitarian community to recognise the need to promote a more collaborative, effective and accountable responses to crises. The recognition and eventual inclusion of NGOs in the response platform indicates the openness for stronger and closer partnerships on the basis of equality and humanity

Disaster situations are generally complex events with increasing magnitudes, potentially due to extreme weather conditions and climatic change. Developing countries are the ones who suffer the most. Lack of infrastructures, lack of response capabilities and capacity are among the two main challenges being faced, particularly in the case of Indonesia and Philippines. On several occasions during the last 15 years, Indonesia has made global headlines due to devastating natural disasters that resulted in hundreds of thousands of lives lost, and numerous damages to infrastructure, thus resulting in economic costs (Alamsjah et al, 2015) The same can be observed in the Philippines.

Indonesia and the Philippines are among the most disaster-prone countries in the world. Its geographic feature as a vast archipelago, located on The Pacific Ring of Fire (marked by numerous tectonic activities), poses a unique situation in terms of hazards and opportunities to deal with them. The ability to cope with constant tsunami risks, hydrological disasters, earthquake, and volcanic eruptions is a crucial requirement for the archipelagic state. Many regions within the country remain at risk in terms of dealing with both natural and man-made disaster hazards. Communities as well as regional government bodies have no choice but to deal with the challenge to prepare and respond to disasters.

Indonesia's 95.181 kilometres of coastline potentially offers an opportunity beyond the commonly pursued natural resources utilization for economic development, but rather for a more effective Humanitarian Assistance Disaster Response (HADR) operation to be conducted when disaster strikes (Kementerian Kelautan dan Perikanan, 2014). It offers accessibility when roads are destroyed, particularly in remote areas where infrastructures remain weak. There is another crucial need to have adequate amphibious capability through the availability of amphibious hardware as well as air force capabilities.

The availability of alternative solutions beyond traditional relief aid delivery through the introduction of cash-based program intervention is considered as one of the most feasible solutions given its lower threshold on immediate operational logistics requirement among NGOs that respond to emergencies in archipelagic countries, such as Indonesia and Philippines. However, the success of these programs is based on various external factors, including the bankability of the beneficiary groups identified, authorisation and control of restrictions associated to the approved commodities recognised under the cash-based program, as well as the need for proper coordination to allow both traditional and cash-based aid programs to run effectively at the appropriate phase of the response.

Disaster Management and Cash-based Programming

Cash-based programming as an alternative solution to traditional relief aid delivery has picked up momentum over the recent years as the characteristics of humanitarian crises has pushed many aid organisations to their limits. The complexity of crises require many aid organisations to stay longer and to provide aid to higher number of beneficiaries despite a depletion of resources. Technological advancements, improved banking access and government's preference to adopt cash-based programming offers a new opportunity for aid agencies to look for alternative ways to provide their service to disaster-affected population. Cash-based programming have increased in popularity among various government programs both in the Philippines and in Indonesia.

Given the archipelagic nature of the above two countries, traditional aid remains a critical response element in the event of a disaster situation. However, poor or destroyed transport and logistics infrastructure, negatively impacts traditional aid delivery and therefore cannot provide to the population in need. The capability to recover the transport and logistics infrastructure is going to be more costly than cash-based intervention as the countries struggle with physical deliveries during an emergency response.

Research methodology

The approach for this study is based on a qualitative paradigm as not much is known related to the phenomenon under study. Primary data will be collected through a series of unstructured interviews and observations to obtain an initial understanding of the perspectives from various stakeholders. This paper aims to offer exploratory insights on the issue being discussed by basing the analysis from different stakeholders involved in humanitarian assistance.

Research questions

Based on the conditions outlined above, it is therefore important to clarify on 2 particular issues:
1. What are the key lessons learned from recent humanitarian operations conducted in Indonesia and in the Philippines as both share similar geographical challenge as an archipelagic country?
2. Will a combined humanitarian assistance involving traditional aid delivery and cash transfer modalities be the most optimal response in an archipelagic country?

Discussion

The International Federation of Red Cross defines the term of disaster as a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources (IFRC, n.d.). Vulnerability with regard to a disaster situation is essentially the lack of capacity of a population affected by the disaster to anticipate, respond and recover from the impact of a hazard.

Disasters have been traditionally categorized according to their causes (natural or man-made) as well as according to their speed of onset. On the latter, there are 3 categorizations that WHO define for all its emergency operations (World Health Organization, 2008), namely:

- Sudden-onset Disasters - This category to refer to disasters, regardless of their cause, for which there is little or no warning to the affected populations.
- Slow-onset Disasters – Disasters that take a long time to produce emergency conditions, for instance, natural disasters such as drought, marine ecological damages or socio economic decline, which are normally accompanied by early warning signs. At times, this category is aggravated industrial development that led to environmental damages.
- Complex Humanitarian Emergencies – A humanitarian crisis in a country, region, or society where there is total or considerable breakdown of authority resulting from internal or external conflict and requires an international response that goes beyond the mandate or capacity of any single and/or ongoing UN country program.

Disaster management is the sum of all activities, programmes and measures which can be taken up pre-, during, and post-disaster with a purpose to avoid, reduce its impact and recover from the losses caused by the unfortunate event (Khan, 2008). The most widely adopted cycle of disaster/emergency management activities are grouped in 4 main phases as illustrated in Figure 1 below. The model has been adopted by The United States Federal Emergency Management Agency (FEMA) since its early inception in early 1980s. It relates closely to measures to ensure that public safety and order is maintained and that continuity of public services is achieved to the best extent possible.

The Indian Ocean Tsunami of 2014 demonstrated that the scale and magnitude of natural disasters have a devastating regional impact across the region. The impact of recent disasters is not confined to a national border and that global issues, such as climate change may lead to a more severe disaster situation in the future.

Rising costs, more severe natural disasters, higher risks of man-made disasters increasingly require for a swift humanitarian response. Aid agencies, the first responders to the disaster emergencies, continue to suffer from donor pressures to be more effective and efficient, essentially demanded to do more with less. Such a situation is no longer sustainable without the participation of military capabilities to alleviate the burden and address the logistical challenges often faced by these agencies due to resources constraint and lack of capability to deal with the situation on the ground.

In the regional context, The ASEAN Agreement on Disaster Management and Emergency Response (AADMER) was established in July 2005 to essentially strengthen the cooperation and collaboration among the ASEAN nations to deal with emergency situation in the South East Asia. AADMER's effectiveness is leveraged by stronger collaboration and preparedness initiatives through AHA Center, the humanitarian arm of ASEAN. Such cooperation will undoubtedly enhance ASEAN capacity to deal with disaster situations and stimulate trust among the various government actors that deal with emergency situations in terms of working collectively to ease the burden of the ASEAN population affected by the disaster events.

The integration of ASEAN as a community is taking shape across three fronts: economic, socio-cultural, and defence cooperation. This would imply a greater interdependence among the ASEAN nations to maintain peace and stability, as well as building trust and strengthen cooperation in responding to non-traditional security threats, such as in disaster situations. This position is derived from the risk possibility that a large scale disaster event will potentially disrupt regional stability and may lead to economic and social chaos in a prolonged crisis. In order to understand the scale of disaster risks in the region, more than 50 percent of global disaster mortalities occurred in South East Asia region during the period of 2004 to 2014. 354,000 of the 700,000 deaths due to disaster events occurred in the region with more than US$ 90 billion economic losses incurred (The Jakarta Post, 2015).

In the context of Indonesia, beyond the issue of humanitarian assistance, challenges remain with regards to inter-agency coordination of agencies involved in disaster response operations. Integrative capabilities with regards to surveillance, and emergency response remain far from ideal. Progress has been made with efforts from the public sector through the establishment of national cluster, however, there is still a long road ahead to reform and/or streamline Indonesia's disaster preparedness readiness from where it stands today across all levels of government leadership, especially in the remote areas of the country. The challenge to cover such a vast archipelago requires not only adequate hardware, software / systems and brain-ware to deal with all the potential threats that arise from a disaster situation.

Lessons Learned

Based on recent events of disasters that took place in both countries and within the South East Asia region, there are a number of key lessons that can be drawn from multiple sources of post-action review and lessons learned reports based on disaster events in the above respective locations. This paper highlights the top three key findings that are very much relevant to the situations in both Indonesia and Philippines:

1. **The need for a more effective working mechanism with regards to aid delivery** due to lack of coordination in terms of assessment, lack of capacity on programme management or lack of resources (human, assets, supplies and access). In complex disaster situations that have devastating effects on poor infrastructures, such as Cyclone Nargis and Typhoon Haiyan. International response operations must systematically work with existing national and response coordination mechanisms (IRIS / Save The Children, 2013).

2. **There is still room for improvement for all participating humanitarian actors**, including local military forces, to be more efficient and effective provider of humanitarian operations based on the post-action review during The Padang earthquake in 2009 (Rand Corporation, 2013). Better coordination and improved communications between military and civilian partners are generally the common issues in every major / medium-scale disaster given the logistical requirements.

3. **The need to be able to respond to multiple disasters at the same time**. South East Asia has experienced a number of major disasters in the past decades. In particular countries, in Indonesia and the Philippines, occurrences of multiple natural disasters will require a better-prepared and effective response mechanism to be in place.

In the Incident Command System that The National Disaster Management Agency of The Philippines and Indonesia adopt in performing their roles and responsibilities during disaster situations, effective emergency response management requires a systematic approach that guides the management of resources, organizations, information and personnel involved in the response operations. This is due to the consideration that series of events that unfold may fall outside of normal circumstances, which carries a great potential for confusion or a loss of control to occur (FEMA, n.d.).

- **Preparedness Phase** – Readily prepare for any potential disasters by prepositioning relief supplies and equipment for deployment as soon as disaster strikes. The Navy can provide general facilities for the internally displaced populations that can be managed either by disaster volunteers or internal personnel. On immediate basis, coordination is arranged with BNPB /

BPBD in support of their efforts to respond to the emergency. Know-how support can be obtained from traditional fishermen and sailors on geographical knowledge of the area.
- **Response Phase** - Conduct surveillance missions to obtain aerial knowledge of the disaster affected areas and ensure that evacuation has proceeded accordingly and adequately. Provide logistical support and set up a command post to facilitate aid provision and provide logistical support using military or civilian assets. Traditional fishermen and sailors can assist in providing guidance for big ships carrying relief supplies operating in the area. Oil companies can offer provision of communication support and evacuation assistance in their rig platforms upon request from government or local military force. Local Fisheries industry can provide assistance in disaster situations by delivering aid supplies to the disaster zones. All local ports, regardless of size, can provide key side assistance and temporary storage / staging arrangement for relief cargo prior to delivery to the disaster zone.
- **Recovery Phase** – Focus efforts on recovery operations by rebuilding damaged infrastructures, and provide temporary facilities to relieve the suffering of disaster affected population. Conduct performance evaluation / post-action review in order to analyse on what went well and what went wrong for future improvements.
- **Mitigation Phase** – The local government unit / provincial NDMO can direct the general populations towards safety, provide safety shelters, and provide arrangements and protections in the displacement area

The role of cash-based programming

In an archipelago the size of Indonesia, it is unrealistic to put the burden of responding to disaster situations solely on the National Disaster Management Office. Local capacity building among the communities and local BPBD agencies is critical as they will be among the first responders with local knowledge. Such capacity building initiative can take many forms from transfer of knowledge, simulation exercises, practical drills, installation of early warning / alert systems and instituting disaster preparedness aspect in government infrastructure projects.

Centuries of local practices, way of living, and cultural values should be embodied in developing thousands of resilient kampongs (viallges) or Desa Tangguh (National Geographic Indonesia, 2012). They will become a network of capable first responders when urgency arises in a disaster situation. The various humanitarian actors must proactively be involved in these capacity building programs in collaboration with BNPB/BPBDs and other local agencies for coastal villages as potentially when land access to these areas are hindered, delivery of humanitarian assistance will need to be done by sea. This is where identified respondents recognised the need to enhance the effectiveness of emergency response through the introduction of cash-based program.

Within this domestic context, the local military forces in both countries are arguably the only institution that has the mobility and means to be able to arrive at a crisis area in strength. Their presence carries two-fold benefits of providing a sense of security in the disaster area, and be ready to provide assistance by delivering humanitarian relief operations directly or by supporting other relief agencies or the government bodies already responding in the disaster area. This is the distinctive factor which, demonstrates the capability of military professionalism and efficiency when and where it is desperately needed. However, it does not eliminate the need for significant funding required to support the necessary response operation. The respondents highlighted inconsistencies of preparedness level within the provincial and municipality level suggesting the risk of inefficiencies and ineffectiveness during response operations.

Respondents' suggest that there is further need for government agencies to explore and introduce a stronger mechanism of cash-based intervention through proper management of risks associated with the implementation of various cash-based programs. Weaknesses, at times detected at the identification phase, of the right beneficiary groups due to a lack of governance on identity management is recognised. This single identification system is inadequate among government services in Indonesia, or the limited control mechanism imposed on cash program distribution operated by government agencies in the Philippines.

Most of the respondents agree that cash-based programs carry the potential to be central to future humanitarian response while reserving the role of traditional relief aid to be complementary to address market breakdowns in the immediate effect of a disaster event. There are also suggestions to replicate existing e-money solutions that exist within the financial sector that can carry specific restrictions in terms of its usage for a specific period declared under emergency response phase and to make it usable by retail merchants / vendors that have demonstrated resilience in their supply chain, primarily modern trade retailers.

Conclusions

Given the lack of empirical evidence that exist in both Indonesia and Philippines with regards to the significance of efficiency and effectiveness of cash-based intervention program in comparison to traditional relief aid delivery, the respondents suggest that there is a need to conduct a systematic comparative/benchmarking analysis of the two types of interventions. Some respondents also suggested the maintenance of consistency of the program and disbursement characteristics during and post-disaster emergency response phase. Coordination is a risk area recognised among most of the respondents as they express concerns related to the transparency and robustness of such a cash transfer program involving government services.

An initial solution can be initiated through the use of commercially available electronic cash solutions, be it in the form of mobile phone credit or e-money solutions that are already widely accepted across the country.

However, respondents disagreed on the conditionality of cash-based intervention as some respondents consider it as a limiting factor to the beneficiaries in their efforts to restore their livelihoods. However, imposing conditional restrictions to the cash transfer program also has its merits in educating the beneficiaries in streamlining their priorities by imposing certain rules and restrictions in the usage of the cash offered through the program. Government and aid agencies also need to be more aligned in their response and to be more selective in their assessment process to ensure effective and fair distribution of cash transfer program to have a wider reach to the beneficiaries in need.

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IMPACT OF LOGISTICS SERVICE PROVIDER ON AGING PRODUCT FIRMS: A CONCEPTUAL FRAMEWORK

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Abstract

Purpose: Aging crisis can be seemed as a worldwide concern. This particular phenomenon has led the world to realize the importance of such market sector and need to increase the value of choice and logistics services. This study proposed a conceptual framework of causal diagram and impact of variables on aging product firms with logistics service provider. In additionally, the indicators and definitions for each latent variable in the proposed structural equation model (SEM) will also be revealed.

Design/methodology/approach: The literature review of logistics service, customer satisfaction, business performance and SEM are conducted then use linkage among latent variables to set the hypothesis and form conceptual framework of SEM.

Findings: The indicators, interaction and also causal diagram among Logistics Service Quality, Flexibility Capability, Customer Satisfaction, Customer Loyalty and Business Performance will be focused.

Research limitations/implications: The study aims to use the perspective of potentially aging product firms in Thailand. The tendency of the result may be debatable due to the time conducted is before the actual aging crisis.

Practical implications: The proposed model will allowed the potential aging product firms to investigate and identify the impact of logistics service provider to their business performance throughout Flexibility Capability of provider to Customer Satisfaction and Loyalty.

Originality/value: This conceptual framework shows the interaction of Flexibility Capability on logistics service provider in order to be able to change to the market aged sector.

Keywords: Logistics Service Quality, Customer Satisfaction, Flexibility Capability, Business Performance, Structural Equation Modeling

Introduction

According to the report by World Health Organization (WHO), between 2015 and 2050, the proportion of the world's population over 60 years will nearly double due to the rise of “Baby Boomer” group. Painstakingly, Thailand also has to face this crisis and will become a complete aged society in 2020, which estimated over 20% of the national population will be citizens of 60 years or older and this phenomenon will be exponentially increased. This brings to survey of Nielsen in 2016 who predicts that Fast Moving Consumer Goods such (FMCG) as Milk, Pet Food, Pre Packed Rice and etc. will have their sale increased.

In order to prepare for this crisis, it is important for the mentioned firms to be aware and starts to prepare their business performance related operations to compete with others. The profit of company can be obtained from many sources, but the certain thing is that they need to have a strong customer base. That means the loyalty of customer or customer retention will guarantee to extend the breathe for the organization but it is common that dissatisfied customers will not likely to keep in touch with the same seller. That is why customer satisfaction is the crucial topic in business world.

For today business world, manufacturer may not be the most powerful character among the supply chain anymore due to the ability to directly contact with the customer of retailer that hold all the powers. This forced the firm to deal with the retailer through logistics activities which the better the quality, the better the retailer's satisfaction. To cope with the uncertainty of FMCG that rely on the forecasting, the flexibility of the firm's logistics has become more and more important in order to satisfy the customer needs that can be vary.

This paper provides the definition and attributes for each variable measurement. Then, the causal diagram among variables will be formed from the hypothesis that conducts from the literature review for the future research.

Literature Review

This section, the definition and related researches on Logistics Service Quality (LSQ), Logistics Flexibility Capability (LFC), Customer Satisfaction, Customer Loyalty (LAT) and Business Performance (BP) will be mentioned to form hypothesizes base on each characters.

Logistics Flexibility Capability (LFC)

In order to deal with the business environment uncertainty, firms have to create the flexible in many elements to gain competitive advantages by adapting to meet customer needs (Reactive) or changing to survive (Proactive). The term flexibility itself is a very vague concept, it can be divided into 2 categories which are Flexibility Capability and Flexibility Competence (Zhang et al., 2002). These 2 elements are crucial to logistics flexibility but the customer will be able to notice the only just the Capability while Competence is something hidden inside the form that customer cannot be noticed or feel (De Toni and Tonchia, 1998). Zhang et al. (2005) has discussed that the firm can be able to achieve more customer satisfaction by LFC improvement. Dave et al. (2014) also said that LFC can enhances the firm's customer satisfaction. The term does not only affect the customer satisfaction but also related to logistics service quality as well (Yu et al., 2017)

These researches can be used to form 2 hypothesis on LFC, LSQ and CS which are:

H1 : LFC has positive impact on LSQ.
H2 : LFC has positive impact on CS.

Logistics Service Quality (LSQ)

Logistics Service Quality (LSQ) can be defined as a degree of quality in logistics related activities among the firms. It has been realized around the globe and ahs become the core source of powerful business success creation, nonetheless, it can also be considered as a heart pulse of business itself due to logistics activities that drive the processes of product or process. Mentzer et al. (2001) has pointed out that logistics service quality can affects firm's customer satisfaction in all business type but the result in each elements can be variance due to the firm's segment. Thai (2013) also mentioned the link between LSQ and customer satisfaction that it is critical and related to each other.

These researches can be used to form a hypothesis on LSQ and CS which is:

H3 : LSQ has positive impact on firm's CS.

Customer Satisfaction (CS)

Customer satisfaction might be an ultimate goal for some businesses to make clearly that the firm can maintain the market share. Measuring customer satisfaction can be used to spectate the gap actual perceived performance and the ideal performance customers would like to get from the business (Parasuraman et al., 1998). Many people may be confused with the concept of CS and loyalty, while they are not the same (Mägi, 2003). Customer can be satisfied without having to be loyalty with the firm (eg. Many choices to be chosen) and vise versa. Huang et al. (2009) has done the Structural Equation Modeling (SEM) that proposed the point that CS has positive impact on loyalty on retailing service. The research from Juga et al. (2010) also concluded that logistics service provider loyalty could be influenced through overall satisfaction. The CS does not only has an impact on LAT but also the BP. It has been

confirmed that CS has an impact on firm's financial performance such as total revenue, net income and earning per share (Williams and Naumann, 2011)
These researches can be used to form 2 hypothesis on CS, LAT and BP which are:

H4 : CS has positive impact on LAT.
H5 : CS has positive impact on BP.

Customer Loyalty (LAT)
Customer Loyalty usually means the behavior of customer that repeatedly purchases the product or service over and over again. It is normal that the customer will be easily be lured to the firm who offers a better deal (Bhardwaj, 2007). Thus, the loyalty of customer is very valuable that can be considered as the assets of the company. It is found that the cost of firms successfully getting new customers is approximately 6 times more expensive than the cost of maintaining the old customers to stick with the company (Rosenberg and Czeoiel, 1984). It has been clarified that customer relationship improving will lead to more in LAT then increases the grow in sales and BP (Akroush et al., 2011).

This research can be used to form a hypothesis on LAT and BP as:

H6 : LAT has positive impact on BP

Business Performance (BP)
BP usually refers to the responsibilities of the firm and their shareholders (Rappaport, 1987), it can be divided into 2 dimensions which are Market Performance that often refers to the side of the seller (Somani and Tesfatsion, 2008) and Financial Performance that refers to the money related metrics (Chi et. al., 2009).

Research Methodology
This paper aims to find the attributes for each variable by conducting 5 literature researches that has high number of citations for each one excluding CS whose measurement is likely to be the average scores to create a table showing the attribute that has been mentioned then check the frequency for each time the attribute has been used on those particular papers then select the attributes with at least 3 mentions. The table will also provide the name of the author and the year that the paper has been published in order to inform the readers for future research purpose.

The found information will be used to form a causal diagram of Impact of logistics service provider on firms with aging products. The hypothesis on literature review section will be used to set the relationship among each latent variable, which are LFC, LSQ, CS, LAT and BP while the attributes from the result of findings will be used to explored the observed variables for each latent variable.

Result
Logistics Flexibility Capability (LFC)
It can clearly be seen from all the literature review that LFC can be divided into 2 dimensions, which are Physical Distribution Flexibility that refers to the ability of the Logistics Service Providers to adjust the movement or reaction to customer needs of tangible goods that has show in Table 1.

Dimension	**Attribute**	**Reference**					
		Zhang et al., 2002	Zhang et al., 2005	Hua et al., 2009	Dave et al., 2014	Tosun and Uysal, 2016	**Total**
Physical Distribution Flexibility	Adjust inventory	✓	✓	✓	✓	✓	5

	Adjust packaging	✓	✓		✓	✓	4
	Adjust warehousing	✓	✓		✓	✓	4
	Adjust transportation	✓	✓	✓	✓	✓	5
	Adjust quality			✓			1
Demand Management Flexibility	Response to customer service	✓	✓	✓	✓	✓	5
	Response to delivery time	✓	✓	✓	✓	✓	5
	Response to price	✓	✓	✓	✓	✓	5

Table 1: LFC Attributes

Logistics Service Quality (LSQ)

The attributes gathered as in Table 2 has shown the range of activities that will refer to the quality of logistics between the focal firm's logistics service provider and focal firm's customers. There are many variations in term of dimension but the frequency of the attribute can be pointed out that there are dimensions that are less likely to be considered, which are Order Release Quantities, Order Accuracy, Technical Service and Image.

Dimension	**Attribute**	**Reference**					
		Mentzer et al., 2001	Gil Saura et al., 2008	Huang et al., 2009	Juga et al., 2010	Thai, 2013	**Total**
Timeliness (Time)	Time between placing and receiving	✓	✓	✓	✓	✓	5
	On time delivery	✓	✓	✓	✓	✓	5
	Orders not delivered in time are subsequently sent quickly	✓	✓	✓		✓	4
	Reverse efficiently		✓				1
Personnel Quality (PQ)	The contact person appointed makes an effort to understand my position	✓	✓			✓	3
	The product knowledge/experience of the firm's personnel is adequate	✓	✓		✓	✓	4
	Help to resolve their problem	✓			✓	✓	3
	Accessibility of personnel				✓		1
	Staff's attitude and behavior					✓	1
Order Release Quantities	Requisition quantities are not challenged Difficulties never occur due to max/min release quantities	✓					1
	Requisition quantities are not challenged	✓			✓		2
Information Quality (IQ)	The information about the order is available and appropriate for its purpose	✓	✓			✓	3
	Provided timely information on delivery			✓		✓	2
	Provided accurate information on delivery			✓		✓	2
	Application of IT and electronic data interchange (EDI) in customer service					✓	1
	Introduction of IT innovation in customer service					✓	1
	Shipment tracing capability					✓	1
Order Accuracy	Rarely contain substituted items	✓				✓	2
	Rarely contain an incorrect quantity	✓				✓	2

	Shipments rarely contain the wrong items	✓				✓	2
Order Condition (OC)	Damage rarely occurs as a result of the transport mode or carrier	✓		✓		✓	3
	Material received is undamaged	✓		✓		✓	3
Order Quality (OQ)	Ordering procedures are effective and easy to use	✓	✓	✓	✓	✓	5
	Products ordered from the firm meet technical requirements	✓	✓				2
	Problem is solved in a satisfactory form		✓				1
	Products are rarely non conforming	✓					1
	Loosening restriction on the size of goods			✓			1
	Substituted items work fine	✓					1
	Total order cycling time					✓	1
Order Discrepancy Handling (ODH)	Correction of delivered quality discrepancies is satisfactory.	✓		✓		✓	3
	Discrepancy process report is adequate	✓				✓	2
	Response to quality discrepancy report is satisfactory	✓		✓		✓	3
	Consistency in order handling					✓	1
Technical Service	Technical quality of physical resources				✓		1
	Technical quality of information systems				✓		1
	Problem-free electronic communication				✓		1
Image	Handling of customer feedbacks					✓	1
	Reputation for reliability in the market					✓	1
	Record of professionalism and consistency in satisfying customers					✓	1
	Reputation for matching words with action					✓	1
	Company's ethical image					✓	1

Table 2 : LSQ Attributes

Customer Loyalty (LAT)
From the finding, there are many theories explaining about the attributes in Customer Loyalty. The attributes came from the way or the behavior of the customers would react to the firm. The result from 5 literatures shows that the most considered attributes as in Table 3, which are Consider the provider to be the first choice, Would repurchase even if the deal is similar to others, Would say good things about this provider and Would recommend this provider to other.

Attribute	**Reference**					
	Gil Saura et al., 2008	Chen and Lee, 2008	Huang et al., 2009	Wallenburg, 2009	Chou et al., 2014	**Total**
Consider to be the first choice (LAT1)	✓	✓			✓	3
Would buy again even if everything is	✓	✓		✓	✓	4

similar to others (LAT2)						
Classified myself as a loyal customer		✓	✓			2
Would say good things about this provider (LAT3)		✓	✓	✓	✓	4
Would recommend (LAT4)		✓	✓	✓	✓	4
Would do additional purchases				✓		1
Encourage other people to use					✓	1

Table 3 : LAT attributes

Business Performance (BP)
Many researches have discussed the attributes of BP in the same way and concluded market and financial side in their paper. Basically, most attributes refer to the measurement on what firm will get after operationalize their business.

Attribute	**Reference**					
	Yang et al., 2010	Chao, 2011	Qi et al., 2011	Agus and Hajinoor, 2012	Zhao et al., 2015	**Total**
Profitability		✓		✓	✓	3
Sales	✓	✓			✓	3
Market Share	✓	✓	✓	✓	✓	5
Return on sales (ROS)	✓	✓		✓	✓	4
Return on asset (ROA)			✓	✓		2
Return on investment (ROI)	✓	✓	✓		✓	4

Table 4 : BP attributes

Conceptual framework of Structural Equation Model
Combining the Hypothesis and highly mentioned observed variables (attribute) for each latent variable will be able to form a conceptual for structural equation model as illustrate in Figure 1. Note that this conceptual framework does not include sub-attribute for each observed variable.

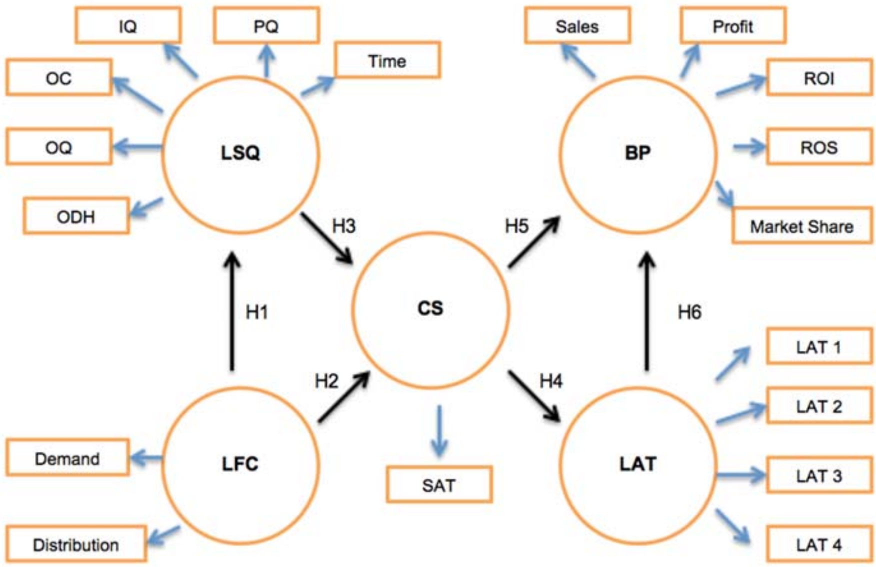

Figure 1 : Conceptual framework of Structural Equation Model

Discussions and Conclusion

Discussion

The linkage and relationship for hypothesis of each latent variable can be extended due to some researches that simplified other latent variables apart from the proposed conceptual framework that proposes only the highest possible relationship impact from the literature review. The relationship of LFC can also be connected with BP and LAT while LSQ can be connected with BP and LAT as well.

Be reminded that this framework is a conceptual framework of SEM, it can also uses Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) in Factor Analysis method to gain a better reliability and validity of each attributes in the proposed model. The future work should also use more literature reviews in order to identify the attributes.

Conclusion

This paper has been done by gathering all informations on the related literature review. It can be used to set 6 hypotheses of relationship as mentioned in section 2 of this paper then use again to identify attributes for each latent variable with frequency checking that most papers have discussed in the same manner. The conceptual framework has proposed the structure for SEM with symbols showing the type of its relationship.

The latent variable in the model consists of 5 variables which are Logistics Flexibility Capability (LFC), Logistics Service Quality (LSQ), Customer Satisfaction (CS), Customer Loyalty (LAT) and Business Performance (BP). For the observed variable, LFC attributes consist of Demand management flexibility and Physical distribution flexibility, LSQ attributes consist of Timeliness, Personnel Quality, Information Quality, Order Condition, Order Quality and Order Discrepancy Handling, LAT attributes consist of Consider the provider to be the first choice, Would repurchase even if the deal is similar to others, Would say good things about this provider and Would recommend this provider to other and BP attributes consist of Sales, Profitability, Market Share, Return on investment and Return on sales. The attribute in CS is an exception because it is most likely to be the average score from the customer and measurement that might be complicated for this model due to the concept that has similarity with LSQ. The future research can combine this model with Factor Analysis first in order to gain the validity and reliability to form the Structural Equation Modeling (SEM).

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IMPACT OF MARITIME CONNECTIVITY ON ECONOMIC GROWTH

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ABSTRACT

Purpose:
Much have been mentioned of the linkage between trade and transport connectivity on economic development. As such, this paper seeks to investigate the impact of maritime connectivity on the economic development of a country in the context of ASEAN specifically Singapore. Our intent is to determine if there is indeed a direct linkage between the constructs of maritime connectivity and economic growth.

Design/methodology/approach:
We adopt a system dynamics approach to understand the causal loops influencing economic development through industry growth, the multiplier effects, and maritime connectivity. For the data, we will draw on public domain information available on the web. The software AnyLogic will be employed for our analysis in this paper. In the analysis, GDP growth is taken as the dependent variable while factors such as import taxes, labor productivity, and connectivity index (outbound and inbound) are treated as the independent variables.

Findings:
Our results show that as maritime connectivity improves, economic growth proxy-ed by more GDP per year follows.

Research limitations/implications:
The quality of this effort depends very much on the quality and extent of data available in the public domain.

Practical implications:
Our work serves to inform policy makers, business strategists on how to string maritime connectivity into greater trade impact and hence the economic development for a country in ASEAN. Next, we can through, systems dynamics, appreciate the effects of vertical and horizontal integration between different segments of the economic cogwheel.

Originality/value:
The paper brings to focus the importance of effective maritime connectivity for the economic development of a nation in a quantitative and statistical manner through the simulation of a real world system. This work serves to inform policy makers, business strategists on how to string maritime connectivity into greater trade impact and hence the economic development for a country. While some of this work has been undertaken in Europe and other trading blocs, it remains un-investigated in ASEAN specifically Singapore.

Keywords: AnyLogic, Economic growth, Maritime connectivity, Singapore

Paper Type: Research paper

Introduction

A wide range of services is provided by the maritime sector worldwide, including freight and passenger transportation and the other related port services such as pilotage, towing and tug assistance, emergency repairs, anchorage, and berthing services. Since sea conveyance is the cheapest mode of transport of heavy goods, there has an uptake in the export, import and transshipment of cargo via ocean freight compared to the other modes of transport. The seaports connect the economic hinterland to other supply chain nodes overseas. Such ports not only provide economic benefits but also social benefits such as providing livelihood.

From Oxford Economics (2013), the UK ports industry has contributed nearly £7.9 billion to UK's GDP in 2011 (equivalent to 0.5% of UK's GDP). This was greater than the combined contribution of the aerospace, and the advertising and market research industries. As for Singapore, the maritime sector contributes 6 to 7 percent of the nation's gross domestic product, and employs over 170,000 people (http://www.mpa.gov.sg/web/portal/home/media-centre/news-releases/detail/05460688-fe49-42e7-9740-4ce88b157b46). According to Jacobs (2011), countries that have invested heavily in trade infrastructure and have reformed port management have benefited from global trade. There are a number of methods available (for example, the input-output model to measure port traffic and regional employment). Enhanced port connectivity allows for more transactions of goods and services. This may lift exports and imports, suggesting economic growth.

Therefore, this paper seeks to examine the impact of port connectivity on the economic growth of a nation. Specifically, we look at the impact of the Port of Singapore on the economic growth of Singapore.

The rest of this paper is organized as follows. Section 2 reviews the existing literature in maritime trade and economic growth. Section 3 provides the research method used to address the research question in the paper. In Section 4, we provide the model design, validation criteria, and assumptions. Section 5 presents the results and discussion. In this Section, we look at the effect on the GDP and total ship calls in a year by varying the outbound container shipping connectivity. Section 6 concludes with some research directions.

Literature Review

The extant literature on the impact of trade and transport on economic development has provided some interesting results. For instance, Balassa (1978) applied regression analysis to a sample of eleven developing countries that have already established an industrial base and found that a country's economic growth increases with exports. Likewise, Zou et al. (2008), who examined the effect of transport infrastructure on economic growth and poverty alleviation in Eastern and Central China, found that improved transport infrastructure enhances economic growth. Furuoka (2009), using panel data, found a positive significant relationship between exports and economic growth in five ASEAN countries. Similarly, Sampathkumar and Rajeshkumar (2016) have investigated the relationship between export and economic growth in the SAARC countries.

Further, several studies have focused on the effects of maritime trade and transport on economic growth. For instance, Wildenboer (2015) focused on the impact of the economic development of a country on the performance of a port. Berköz and Tekba (1999) applied regression analysis to examine the role of the port as a part of transportation services on a country's development. Koner and Purandare (2017) have examined the impact of container traffic flow on gross domestic product (GDP) in India and measured the impact on GDP from selected container ports in India.

Using the Cobb-Douglas production function on the Pearl River Delta, Zhang et al. (2005) investigated the relationship between container throughput, foreign direct investment (FDI), and gross product value of industry. They found that regional economic growth and FDI depend on local container transport development. In Liu (2012), the correlation between port logistics and regional economic development were analyzed using a vector auto-regressive model and Liu found that port logistics development can improve the economic growth of Qinhuangdao. Recently, Rijkure and Sare (2013) studied the role of Latvian ports in the Baltic. Despite this development, not much have been discussed on the impact of the maritime connectivity on the economic development of a country. Thus, we seek to fill this research gap.

Method

In this paper, the system dynamics approach is used to understand the causal effects influencing economic development through the multiplier effect and maritime connectivity. For the data, we draw on public domain information available on the web (For e.g. the website of the Maritime Ports Authority). The software AnyLogic has been employed for our analysis. For simplicity, we focus on the container vessels visiting the Port of Singapore. In the analysis, GDP growth, a proxy for economic growth, is taken as the dependent variable while factors such as import taxes, labour productivity, and connectivity index (outbound and inbound) are treated as the independent variables.

We use the Container Port Connectivity Index (CPCI), as discussed in Bartholdi et al. (2016), to measure the trade connectivity of ports within the network of container shipping. The impact of the variation of the outbound connectivity index is compared to the change in the GDP over a year.

Model Design

The following assumptions were made and the validation criterion below was followed.

Assumptions

As access to public domain data available on the web is limited, we assume the following for the AnyLogic model:

- Cost per TEU is SGD 450.
- Total import per second (includes domestic and transhipment demand) is 7 TEUs.
- Ratio split for imported goods as finished goods and raw materials is 3:1.
- Goods produced domestically for export per second (raw materials and finished goods) are 2.5 TEUs.
- The value of the goods carried by the container ships is proportional to the number of the container vessel arrivals.

Validation

We validate the AnyLogic model by satisfying the numerical values of the given dynamic variable.

- TSCallFY, from the number of vessel arrivals obtained from the MPA.

GDP calculation
Using the consideration that the value of the goods carried by the container ships is proportional to the number of the container vessel arrivals we calculate the contribution of the container vessels on Singapore's annual GDP.

Import tax
To account for the causal effect by the variation in the import taxes, the ratio between the taxes after and before the change over a year is taken as the independent variable, "ImpTx".

Export tax
Since there is no export tax in Singapore, we model in a way that the causal effect of variable "ExTx" on the variable "ToExp" to be zero.

Labor productivity
Based on Trading Economics (https://tradingeconomics.com/singapore/productivity), labor productivity in Singapore is measured using the index points. We fix the boundaries in the AnyLogic model for the highest and lowest labor productivity as 127.2 and 102.6 respectively considering the data from July 2014 to Jan 2017. The ratio of the current index point to the baseline index point (100) is taken as the independent variable "LbrProd" in the AnyLogic model.

Port connectivity
The port connectivity attribute is measured by the liner shipping connectivity index, computed from factors such as **containership deployment, container capacity, number of liners, liner services and vessels per liner, and average and maximum vessel size.** Following Bartholdi et al. (2016), we use the CPCI to measure the trade connectivity of ports within the network of container shipping, with separate scores for inbound and outbound container movements. A port with strong trade connections possesses a high CPCI. We take the inbound and outbound connectivity indices of Singapore as 0.2456 and 0.3420 respectively.

Services
The contribution of port services towards Singapore's GDP is accounted by coding the port tariff obtained from the MPA (http://www.mpa.gov.sg/web/wcm/connect/www/812448e8-eb35-40b6-ab26-78dbceb2baad/pn13-47.pdf?MOD=AJPERES).The services considered here are bunkering, ship supplies, changing crew, and ship repairs. The functions similar to the MPA port dues calculator (http://www.mpa.gov.sg/web/portal/home/e-services-forms/e-finance/fees-charges/port-dues/port-dues-calculator) are modeled and the income from the services is obtained.

Figure 1 shows the causal diagram. For the ease of understanding, the material flow is shown by the brown links. Other causal relations are shown as blue links. The relations between the other parameters and the variables are shown as grey links. Table 1 provides the notations used in the AnyLogic model.

Notation	Variable/Parameter	Unit	Description
GDP_t	Gross Domestic Product at time t	SGD	
UC	Unit cost	SGD/TEU	Notwithstanding cost of individual items shipped, the cost per TEU is SGD 450.
FGImpSplit	Finished goods imports	-	Constant 1

	split (Constant 1)		
Connec_ibound	Connectivity inbound	-	
ImpTx	Import tax	-	Ratio of taxes was considered as explained in model design
ToDomGdExp	Total domestic goods exported	TEU	
FGImpDom	Finished goods imported for domestic use	TEU	
FGImpTrans	Finished goods imported and transshipped	TEU	
FGImp	Finished goods import	TEU	
ToImp	Total imports	TEU	
ImpDd	Import demand	TEU	
RMImp	Raw material import	TEU	
RMImpMfg	Raw materials import to be manufactured	TEU	
RMImpTrans	Raw material imported to be transshipped	TEU	
ComGdExp	Completed goods exported	TEU	
ComGdDom	Completed goods for domestic use	TEU	
DerivedK3	Constant 2	-	Constant 2
FrSplit_ToImp	Constant 3	-	Constant 3
DomGdExp	Domestic goods exported	TEU	
ExpDd	Export demand	TEU	
ExTx	Export tax	-	
Connec_obound	Connectivity outbound	-	
ToExp	Total goods exports	TEU	
LbrProd	Labour productivity	-	Ratio of obtained index point and baseline index point
SCallImp	Ship calls for imports	TEU	
SCallExp	Ship calls for exports	TEU	
CTraffic	Container traffic	TEU	
TSCallFY	Total ship calls in a year	-	
PDue	Port dues	SGD	
PDueInc	Port dues income	SGD	
Load_UnPPS	Loading and unloading profit per ship	SGD	
ARprPPS	Average repair profit per ship	SGD	
BunkerPPS	Bunkering profit per ship	SGD	

Table 1: Notations used in AnyLogic model

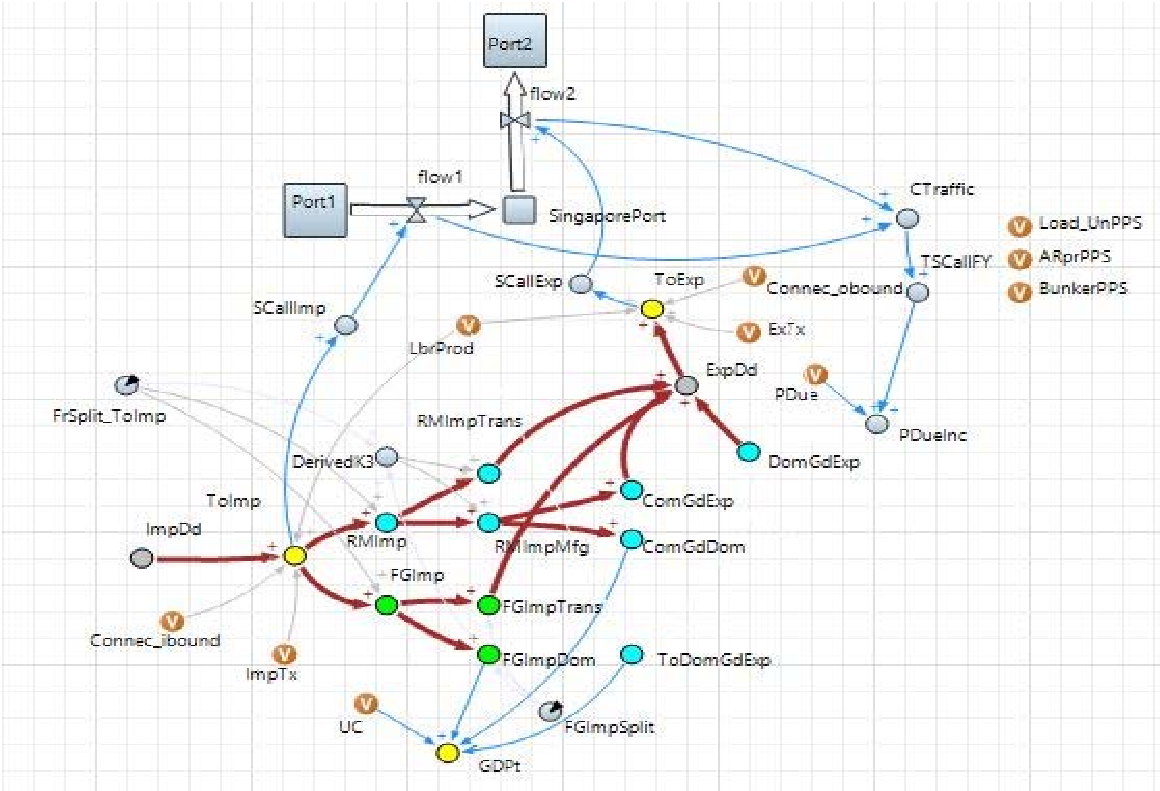

Figure 1: Systems dynamics model

Results and Discussion

Table 2 shows the GDP (SGD/year) change with the outbound connectivity index. Clearly, the connectivity index increases with an increase in annual GDP. Also, the results are influenced by the assumptions made, and hence variations in the numerical value of the assumptions made affects the values in Table 2, which suggests that maritime connectivity affects economic development.

Outbound connectivity index	GDP($/year) (in billions)	Economic growth (%)
0.3	6.99	
0.31	7.40	5.86
0.32	7.82	5.67
0.33	8.23	5.24
0.34	8.64	4.98
0.35	9.05	4.75
0.36	9.46	4.53
0.37	9.87	4.33
0.38	10.28	4.15
0.39	10.69	3.99
0.40	11.10	3.84

Table 2: Effect of outbound connectivity index on rate of change of GDP

Figure 2 shows that the increase in the GDP for 2015 with the increase in the outbound connectivity index changes as a step function.

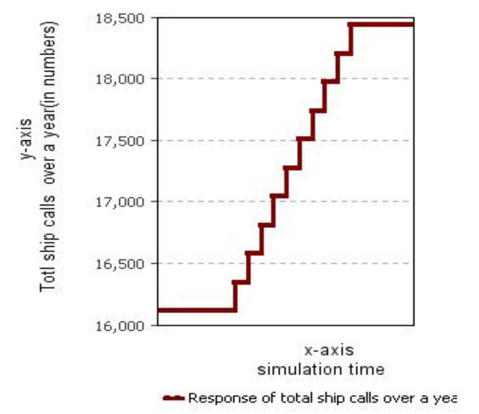

Figure 2: Response of GDP (SGD/year)

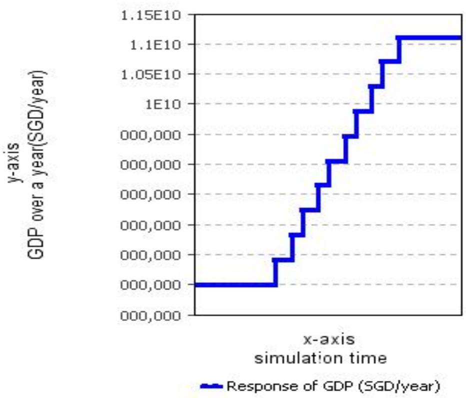

Figure 3: Response of total ship calls over a year

Table 3 gives the response of the total number of ship calls per year to the change in the outbound connectivity index. Figure3 shows the increase in the total number of ship calls per year with the increase in the outbound connectivity index. From Figure 3, we infer that enhanced port connectivity allows for more transactions of goods and services, leading to the increase of ship calls. Moreover, the increase in ship calls may also provide a benefit of contribution towards Singapore's GDP by income from port services.

Outbound connectivity index	Total number of ship calls / year	Percentage variation in total number of ship calls (%)
0.3	16111	
0.31	16343	1.44
0.32	16575	1.42
0.33	16807	1.40
0.34	17039	1.38
0.35	17271	1.36
0.36	17503	1.34
0.37	17735	1.32
0.38	17967	1.31
0.39	18200	1.30
0.40	18432	1.27

Table 3: Impact of outbound connectivity index on total ship calls

Conclusion

In this paper, the system dynamics model involving the causal effects influencing economic development through industry growth, multiplier effects and maritime connectivity, over a period of one year is simulated. Our results show that as maritime connectivity improves, economic growth proxy-ed by more GDP per year follows. This work can therefore serve to inform policy makers, and business strategists on how to string maritime connectivity into greater trade impact and hence the economic development of a country. Moving forward, we can investigate other forms of maritime connectivity such as bulk carriers, tankers, and so on. Further, though the system dynamics model investigates the various sub systems' behavior (such as causal effect caused by domestic goods exports); the model may become more complex when the exact detailed scenario is replicated as it increases the number of variables. As a result of this limitation, the SD model is not able to study the specific sub-system behavior. We can only run independent versions of a scenario singly by altering the values of the dynamic variables separately each time. To overcome this limitation, we can consider in future combining the systems dynamic approach with other models such as agent based modeling.

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IMPACT OF TRADE FACILITATION ON BILATERAL TRADE FLOWS BETWEEN VIETNAM AND ASEAN COUNTRIES

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ABSTRACT
Purpose: This paper focuses on examining the relationship between bilateral trade flows and trade facilitation and estimating the gains in trade derived from improvements in trade facilitation for ASEAN members.

Methodology/design/approach: The relationship between trade facilitation and bilateral trade flows is estimated using a gravity model that includes other standard variables. The paper uses panel data obtained from Vietnam and 8 ASEAN members over the period 2004 – 2015. Trade facilitation is measuring through UNCATD's Liner Shipping Connectivity Index.

Findings and originality: Based on the research results, the paper provides evidence that the marginal effect of the sea transport efficiency improvement on trade flows. The results also suggest that the impact of sea transport efficiency is somehow larger than the traditional variables including GDP per capita, distance and exchange rate. In addition the paper provides recommendations and solutions that encompass a series of policies to enhance ASEAN members' and Vietnam's capacity.

Research limitations: Limitation is related to the availability of the required assessment data. Choosing the impact of trade facilitation on Vietnam-ASEAN bilateral trade flows as a research subject limits us using various indicators in estimating, thus posing restriction on further results.

Keywords: Trade facilitation, Liner shipping connectivity index (LSCI), gravity model, bilateral trade flows, ASEAN, Vietnam.

INTRODUCTION

Over the past 30 years, with the major milestone of the participation of ASEAN Association of Southeast Asian Nations (ASEAN) and the normalization of relations with the United States, Vietnam has experienced the period of sustained economic growth. Beginning as a backward agricultural economy with 90% population living on agriculture, Vietnam has step by step enhanced its infrastructure, adopted science and technology to respond to industrialization modernization. Vietnam has experienced nearly 25 years of impressive growth: 8.2% per year (1991-1995), 7.6% per year (1996 - 2000), 7.34% per year (2001-2005), 6.3% per year (2006-2016). These achievement Vietnam has been obtained is thank to the integration into international economic relations. Vietnam – World trade relations developed rapidly by the actively establish and being come into force of many ambitious free trade agreements (FTAs). Formal trade barriers such as tariffs and non-tariff barriers will be soon abolished due to the effect of bilateral and regional trade agreements, thus enhancing the important of the issues relating to trade facilitation in the field of policy-making process.

The WTO (1998) introduced the definition of trade facilitation as "simplification and harmonization of international trade procedures, including practices, practices and procedures in the collection, presentation and communication and processing data and other information necessary for the transportation of goods in international trade." The importance of trade facilitation has been recognized when the Trade Facilitation Agreement (TFA) has officially become an Agreement under Annex 1A of the GATT 1994. TFA, which entered into force on 22 February 2017, is the first multilateral agreement to be negotiated successfully under the WTO. Trade facilitation has been existed in almost all Vietnam's bilateral trade agreements, in other words, Vietnam is clearly aware of the benefits and essential roles of facilitating activities.

Despite being well-aware of the potential of trade facilitation, Vietnam has not full taken advantage of these benefits. This is reflected into the slow recovery of bilateral trade between Vietnam and ASEAN after the 2009 economic crisis. By 2016, the trade balance between Vietnam and ASEAN still remains deficit. After the formation of the ASEAN Economic Community, the tariffs of commodities almost reached zero, countries lost advantage against each others in terms of bilateral agreements. So, Vietnam trade balance, in the negative side, may be influenced badly and become more deficit.

Therefore, it is necessary to conduct an assessment on the impact of trade facilitation indicators, especially in Vietnam where no previous research has been done on this subject. This is a great opportunity to study this issue in Vietnam in terms of one of the most important factors contribution to promoting international trade.

The main objective of this paper is to quantify the quantitative impact of trade facilitation indicator on the bilateral trade between Vietnam and ASEAN countries through the Liner Shipping Connectivity Index represent shipping capacity. Based on the combined results of quantitative result and the qualitative analysis, the paper provides some recommendations for Vietnam to make use of these effects in the context of globalization.

To achieve the main objectives discussed above, the study seeks to answer the following questions:
(a) What is the current status of bilateral trade between Vietnam and ASEAN countries and their current trade facilitation index?
(b) Whether trade facilitation affects bilateral between Vietnam and ASEAN countries positive or negative, and what are the implications for that?
(c) What should Vietnam pay attention to, in other words, the recommendation for Vietnam?

The paper is structured into four sections. First, overview of Vietnam trade facilitation index is presented. The literature review on trade facilitation and determinants affect bilateral trade is then discussed. In the third part, the methodology section presents the regression method applied and the data collection in this paper. Finally, the findings from the study presents the regression result and explain impact dimension of major variable (LSIC represents for trade facilitation). The recommendations regarding a set of measures for improving Vietnam trade facilitation implementation.

OVERVIEW OF VIETNAM TRADE FACILITATION INDEX

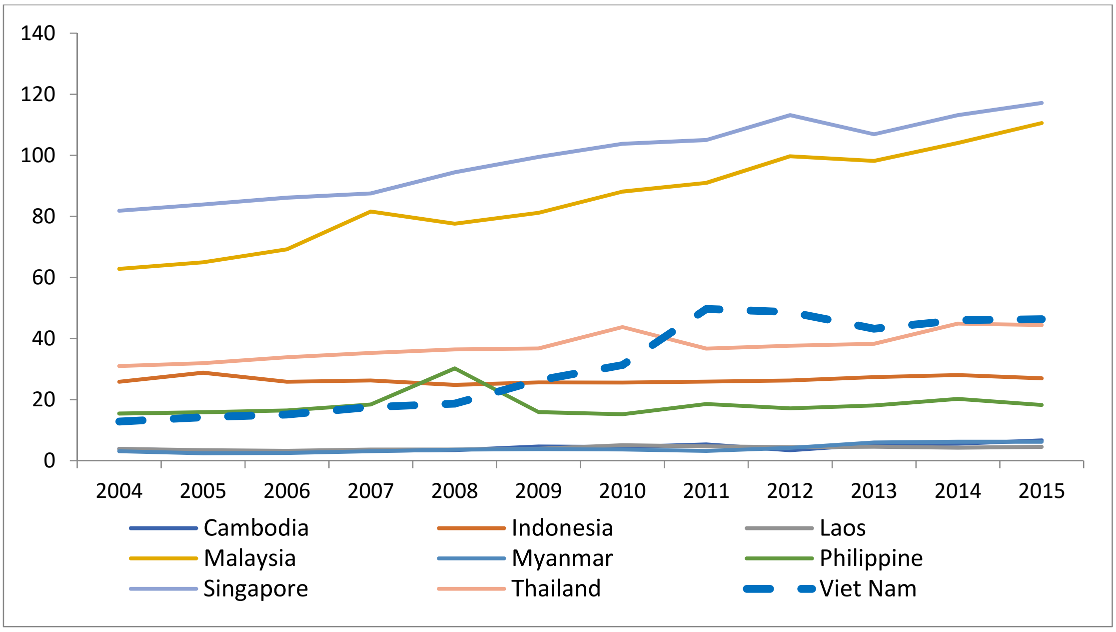

Figure 1: Vietnam and ASEAN Liner Shipping Connectivity Index 2004 – 2015
Source: UNCTAD, http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx

In the period of 2004 - 2008, Vietnam LSCI was relatively low and was considered to be less developed than Thailand, Indonesia, Philippines. But in the coming period of 2009 - 2015, Vietnam has improved its maritime transport capacity and its value is increased gradually with the figure leveling off at the higher level than the above countries. Vietnam has overtaken Thailand and Indonesia as described in Figure 1. However, Vietnam LSCI is far lower than the two top countries in the region such as Malaysia and Singapore. Interestingly, Vietnam has the fastest growth speed in ASEAN.

LITERATURE REVIEW

Gravity models have been extensively used in economic literature dealing with international trade issues. They were first introduced in 1961 by Linder, then used by Tinbergen in 1962 and followed by Linnemann in 1966. Their basic is used to explain that trade among countries is directly affected by their economic size and inversely affected by the distance between the countries, measured as distance between their economic centers. The basic form of the gravity model has been augmented by adding additional factors that influence international trade. Recently, a number of "theoretical" gravity models have been developed and they use various micro-founded theories of international trade to develop gravity-like models (Shepard, 2012). Some of these are based on technological differences – Ricardian model (Ricardo, 1817), factor endowments – Heckscher-Ohlin model (Ohlin, 1933), emphasize the importance of monopolistic competition and increasing returns to scale – Helpman and Krugman model (Helpman and Krugman, 1985) or capture the multilateral resistance relationships – Anderson and van Wincoop model (Anderson and Van Wincoop, 2004).

In this paper, we add a variable to examine the impact of trade facilitation on bilateral trade flows. Recent developments in the literature focus on choosing the right estimation procedure. ESCAP (2013) outlines four sets of potential indicators to become viable variables assessing the impact of trade facilitation on bilateral trade such as the WB Logistics Performance Index (LPI), the WB Ease of Doing Business (EoDB), the OECD Trade Facilitation Indicators (TFIs) and the UNCTAD Liner Shipping Connectivity Index (LSCI).

Using a gravity model approach, Wilson *et al.* (2003) find that enhancing facilitation in the Asia-Pacific Economic Cooperation (APEC) countries will increase intra-APEC trade by as much as $254 billion or a 21% increase. In a follow up paper (Wilson *et al.*, 2005), using global bilateral trade data, the authors show that improving the different components of trade facilitation increases trade flows by $377 billion.

Djankov *et al.* (2006) use data on time taken to export and import from the World Bank's Doing Business Survey to estimate the impact of delays on trade. They show that each additional day taken to move the goods from the firm's warehouse to the ship reduces trade by at least 1%. This is equivalent to increasing the distance of a country from its trade partners by 70 km.

Limão and Venables (2001) show that deterioration in the infrastructure from the median to the 75th percentile reduces trade volumes by 28%, which is equivalent to being 1,627 km away from trading partners. Hertel and Mirza (2009) by using LPI show that trade facilitation reforms in South Asia translate into a 75% increase in intra-regional trade and a 22% increase in trade with the other regions.

OECD (2011, 2013) used the TFI found out that 5 out of 11 factors namely: Information availability, Formalities - procedures, Formalities - automation, Governance and impartiality and Border agency cooperation have a significant impact on trade flows between countries. Further details showcase that the 1% increase in the total TFIs improves the value of the country's trade would by 12%.

ESCAP (2015) used LSCI as the major variable to assess the impact of trade facilitation on trade flows of APEC member economies. The study shows the positive effects on commodity trade. The 10% LSCI improvement will increase 1.4% of trade between these countries. The study also pointed out that the 10% increase in the number of freight services, the number of shipping companies, and the fleet's ability can low trade costs down to 0.8%, 0.7% and 0.5% contributing to promoting APEC's bilateral trade.

In general, past studies on trade facilitation using different measures (either incorporating all the possible dimensions of trade facilitation or by focusing on the specific components) show that there are gains in trade from improving trade facilitation. Djankov *et al.* (2006) use time taken to export and import, from the World Bank's Doing Business Survey, to measure the ease of moving goods from firm's warehouse to the ship. Hertel and Mirza (2009) use the World Bank's LPI (World Bank, 2007a) to capture the quality of trade facilitation. ESCAP (2015), like this paper, use the UNCTAD LSCI to assess the impact of improving transportation (especially marine transportation) capabilities towards bilateral trade.

There are, however, important differences between this study and that of ESCAP (2015). First, we tackle directly the problems arising from zero trade observations by eliminating them. Second, we use 2004 - 2014 data for 9 ASEAN countries (ESCAP (2015) use a sample of 21 APEC countries in 5 years).

METHODOLOGY

The gravity model that we use in this study is as follows:
Export model:

$$\ln(EX_{vjt}) = \beta_0 + \beta_1 \ln(GDPPC_{vt}*GDPPC_{jt}) + \beta_2 \ln(DIST_{vj}) + \beta_3 \ln(ER_{vjt}) + \beta_4 \ln(DIST_{jj}) + \beta_5 \ln(LSCI_{ji}*LSCI_{vt}) + \beta_6 BORDER + \beta_7 LANDLOCKED$$

Import model:

$$\ln(IM_{vjt}) = \beta_0 + \beta_1 \ln(GDPPC_{vt}*GDPPC_{jt}) + \beta_2 \ln(DIST_{vj}) + \beta_3 \ln(ER_{vjt}) + \beta_4 \ln(DIST_{jj}) + \beta_5 \ln(LSCI_{ji}*LSCI_{vt}) + \beta_6 BORDER + \beta_7 LANDLOCKED$$

where *v* denotes the Vietnam and *j* denotes the trading partner. The dependent variable, $ln(EX_{vjt})$ and $ln(IM_{vjt})$ are the export value and import value of Vietnam with ASEAN countries. The variables are defined as follows. D_{ij} is the distance between Vietnam and country *j*. Size is captured by the GDP per capita of Vietnam (and country j). *ERvjt* is the real effective exchange rate in year *t* of Vietnam and country *j*. $DIST_{jj}$ is the internal distance, measureing of average distance between producers and consumers in a country[6]. $LSCI_{vt}$, $LSCI_{jt}$ is the liner shipping connectivity index of Vietnam and country j. We are most interested in the coefficients of LSCI, our measure of trade facilitation. Landlocked is a dummy variable that takes on the value 1 if the country j is landlocked, and 0 otherwise. Border is also a dummy variable that takes on the value 1 if Vietnam and the trading partners share a common border, and 0 otherwise.

With panel data, we can use Pooled OLS, Fixed Effect Estimation (FE), and Random Effect Estimation (FE and RE) for estimation. The choice to use one of three OLS regression models, the fixed-effects model and the random-effects model depends on the existence or non-existence of the individual characteristics of each observation and the correlation between these characteristics with the explanatory variables in the model. The following convention will call these distinct characteristics u_i.

The (pooled) OLS is a pooled linear regression without fixed and/or random effects. The pooled OLS posits no difference in intercept and slopes across airline and time period. When there is no u_i model OLS will produce the best results. A fixed group model examines group differences in intercepts. The model does not evaluate the effect of constant variables over time, so it is inappropriate to estimate the model in the paper using fixed variables over time. A random effect model examines how group and/or time influence error variances (Park, 2011). The random-effects model considers the effect of random change u_i, so it can be used to estimate the model using fixed variables over time. However, it is necessary that all observations must be random.

To find the most suitable model of the three models, Park (2011) proposed two approaches:

1. First, comparing two regression results of OLS and the FEM through F-test. The F-test based on loss of fit is the case. If the result do not reject the H_o hypothesis, the OLS model is the model that yields the best estimate; otherwise, the FEM is the one. Then the Hausman test is performed. If Hausman's hypothesis is not rejected, the REM will be the model yields best estimate; otherwise, the FEM will be the chosen model.
2. Secondly, comparing two regression results of OLS and the REM through the Lagrange Breusch Pagan factor (LM test). If the result do not reject the LM test hypothesis, the OLS model yields the best estimate, otherwise, the REM is the one. Then the Hausman test is performed. If Hausman's hypothesis is not rejected, the REM will be the model yields best estimate; otherwise, the FEM will be the chosen model.

In this paper the regression model 1 and 2 will be approached in the second way.

Data used in this paper comes from a variety of sources. The key data on bilateral trade flows comes from United Nations statistics division of Commodity and Trade (UN COMTRADE) database. Given the data availability for other countries, especially the LSCI, we are left with 8 countries. This results in 96 observations. According to the documentation accompanying the BACI dataset, data does not include trade flows below US$ 1,000. Consequently, after aggregating trade flows, any trade flow less than US$ 1,000 is treated as zero trade, thus eliminating.

We use GDP per capita form 2004 to 2015 and both are measured in PPP terms. They are taken from the World Development Indicators. The geographic distance between Vietnam and the trading partner, the internal distance between producers and consumers and the data for landlocked and border are derived from the CEPII database. In our sample of 8 countries, there are 1 landlocked country and 2 countries sharing land borders with Vietnam. The exchange rate is aggregated from the International Monetary Fund (IMF) database.

The key variable of interest in this paper is the measure of trade facilitation. We use the UNCTAD Liner Shipping Connectivity Index (UNCTAD, 2015). We use the overall LSCI to examine the impact logistic facilitation on bilateral trade. LSCI captures how well countries are connected to global shipping networks by 5 components: number of ships, their container-carrying capacity, maximum vessel size, number of services, and number of companies that deploy container ships in a country's ports.

[6] Head and Mayer (2002), "Illusory Border Effects", CEPII Working Paper No. 2002-01

FINDINGS AND DISCUSSIONS

Independent Variables	OLS_EX (1)	Random_EX (2)	OLS_EX (robust) (3)
$lnGDPPC_{jvt}$	0,739***	0,739***	0,740***
	(0,067)	*(0,067)*	*(0,071)*
$lnDIST_{jv}$	-0,769***	-0,769***	-0,773***
	(0,206)	*(0,206)*	*(0,141)*
$lnER_{jvt}$	0,181***	0,181***	0,181***
	(0,030)	*(0,030)*	*(0,023)*
$lnLSCI_{vjt}$	0,880***	0,880***	0,882***
	(0,099)	*(0,099)*	*(0,089)*
$lnDIST_{jj}$	0,300***	0,300***	0,303***
	(0,070)	*(0,070)*	*(0,062)*
BORDER	2,566***	2,566***	2,567***
	(0,224)	*(0,224)*	*(0,150)*
LANDLOCK	-2,863***	-2,863***	-2,860***
	(0,237)	*(0,237)*	*(0,140)*
Constant	4,333**	4,333**	4,313**
	(2,094)	*(2,094)*	*(1,645)*
Observations (N)	96	96	96
R^2	0,923	0,940	0,924
LM test	1,000		
Ramsey Reset Test	0,000		
VIF test	4,78		
White test	0,000		
Skewness/Kurtosis Test	0,000		

legend: * p<.1; ** p<.05; *** p<.01

Table 1: OLS, Random Effect, OLS Robust Regression result for export flow

Independent Variables	OLS_IM (1)	Random_IM (2)	OLS_IM (robust) (3)
$lnGDPPC_{jvt}$	0,449***	0,449***	0,446***
	(0,070)	*(0,070)*	*(0,065)*
$lnDIST_{jvt}$	-0,998***	-0,998***	-1,008***
	(0,214)	*(0,214)*	*(0,290)*
$lnER_{jvt}$	-0,137***	-0,137***	-0,137***
	(0,031)	*(0,031)*	*(0,047)*
$lnLSCI_{vjt}$	1,146***	1,146***	1,151***
	(0,103)	*(0,103)*	*(0,091)*
$lnDIST_{jj}$	0,121	0,121	0,121
	(0,073)	*(0,073)*	*(0,082)*
BORDER	0,438*	0,438*	0,442
	(0,233)	*(0,233)*	*(0,381)*
LANDLOCK	-0,948***	-0,948***	-0,951***
	(0,247)	*(0,247)*	*(0,264)*
Constant	10,957***	10,957***	11,049***
	(2,176)	*(2,176)*	*(2,545)*
Observations (N)	96	96	96
R^2	0,9160	0,9788	0,916
LM test	1,000		
Ramsey Reset Test	0,000		
VIF test	4,78		

White test	0,000		
Skewness/Kurtosis Test	0,000		

legend: * p<.1; ** p<.05; *** p<.01

Table 2: OLS, Random Effect, OLS Robust Regression result for import flow

Based on the regression results in tables 1 and 2, the author provides an export and import model to assess the impact of trade facilitation on commodity trade between Vietnam and ASEAN.

Export model

$$\ln(EX_{vjt}) = 4{,}313 + 0{,}740\ \ln(GDPPC_{vt}*GDPPC_{jt}) - 0{,}773\ \ln(DIST_{vj}) + 0{,}181\ \ln(ER_{vjt}) + 0{,}303\ \ln(DIST_{jj}) + 0{,}882\ \ln(LSCI_{jt}*LSCI_{vt}) + 2{,}567\ BORDER - 2{,}860\ LANDLOCKED$$

Import model

$$\ln(IM_{vjt}) = 11{,}049 + 0{,}446\ \ln(GDPPC_{vt}*GDPPC_{jt}) - 1{,}008\ \ln(DIST_{vj}) - 0{,}137\ \ln(ER_{vjt}) + 0{,}121\ \ln(DIST_{jj}) + 1{,}151\ \ln(LSCI_{jt}*LSCI_{vt}) + 0{,}442\ BORDER - 0{,}951\ LANDLOCKED$$

Table 1 and table 2 show the regression results. The first two columns of the two tables both show the OLS estimates, and the fix random model in logarithms. Column 3 presents the results from Robust regression, which…. The result of LM test, with p-value is 0,000, show that the OLS model yields the best estimate.

Column 3 presents the main results of the paper and the beta coefficients (to allow for direct comparison of the importance of different variables) are shown in the formula 1 and 2. Our results are in line with the results found previously in the literature. Specifically, decrease in distance by 1% increases export by 0.79% and import by 0.99%. The size of the trading partners positively and a statistically significant impact on trade flows. Landlocked exporters (importers) trade less than coastal exporters (importers). Countries with a common border trade more than countries that do not share a common border. Distance between producers and customer has a positive and a statistically significant impact on exports flows; whereas it does not have any impact on import.

As expected, our key variable of interest is LSCI. The variable represents the combined effect of maritime transport capacity of Vietnam and its partner on the bilateral trade flow. LSCI has a positive coefficient and is statistically significant, for both export and import flow. The 1% LSCI increase will improve 0.881% of Vietnam's export turnover, and 1.151% of Vietnam's import turnover. It is clear that maritime transport ability has more impact on imports than exports, in case of Vietnam. This may mean that Vietnam tends to import more from countries with higher LSCI scores. The fact remains that Singapore and Malaysia are the two countries with the highest LSCI among ASEAN countries and also is the two largest partners of Vietnam.

Interestingly, the impact of trade facilitation (represented by LSCI) in both export model (0.881) and import model (1.151) are greater than the two traditional factors: the GDP per capita (0.739) (0.446) and the geographical distance (0.773) (1,008), and also the exchange rate (0.181) (0.137). This may mean that improving the LSCI score (which represents the maritime transport capacity) will also bring a greater impact on trade flows than the other variables. Therefore, in this fast-changing world, Vietnam should pay more attention to enhance maritime transport capacity to promote bilateral trade not only with ASEAN countries but with the others also.

RECOMMENDATIONS AND CONCLUSIONS

The LSCI can be considered a proxy of the accessibility to global trade and is used by UNCTAD as an indicator to assess the impact of trade facilitation on bilateral trade. The higher indicator is, the higher trading value is, by facilitating the export and import process of one country. Specifically in the case of Vietnam, because of the characteristics of exported commodity such as low value, large volume so that marine transport is the most popular one. Beside, almost ASEAN countries are bordering on the sea, especially for four island countries: Malaysia, Indonesia, Philippines and Singapore; thus marine shipping is considered to be the best choice. The ability of shipping may either directly influence the demand for goods, or it may impact on the costs and/or levels of service of one or more freight transport modes. Therefore, improving maritime transport capacity, in particular by reducing time and costs, develop the national fleet, will boost the export turnover, reduce trade deficit.

The authors arrive to draw some conclusions:

Firstly, based on the regression results, the trade facilitation factor represented by the LSCI has a positive and statistically significant impact on trade flow and its value is greater than the two traditional factors: GDP per capita (represented to the size of the economy) and geographical distance. Secondly, the results also showcase of the trade facilitation status of Vietnam and some key markets in the ASEAN region, indicating that Vietnam are facing more difficulties in implementing trade facilitation compared to other countries.

To sum up, trade facilitation is turning to become a key factor that needs to be addressed to improve Vietnam – ASEAN trade deficit. In order to successfully implement trade facilitation, Vietnam needs to focus on improving transportation infrastructure and information technology infrastructure, national transport connectivity, and institutional framework for trade facilitation.

However, the paper has some limitations. The chosen study space ASEAN create a limited sample research. It is possible to provide a quantitative assessment by several indicators as well as to analyze the impact of the sub-indexes. For further study, the authors wish to develop in two directions: (1) approach with VAR estimate; and (2) expand the study space to ASEAN +3, APEC, the EU or WTO members, thus combining several sets of indicators or using sub-indexes of the indicators. As space expands, the LPI, TFIs, EoDB, ETI, will meet the sample requirements.

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IMPLEMENTING SUCCESSFUL LOGISTICS OUTSOURCING CONTRACTS: THE CASE OF 3PL PROVIDERS AND USERS IN SINGAPORE

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ABSTRACT

Purpose: This paper examines how a logistics outsourcing contract can be successfully implemented from the perspectives of both 3PL providers and users in the context of Singapore.

Design/methodology/approach: The case study design is adopted to empirically examine logistics outsourcing practices. D**ata** are collected through in-depth interviews with senior logistics and supply chain managers **from t**hree 3PL service providers (logistics outsourcing firms) and one 3PL user (logistics outsourcer). These companies are engaged comprehensively in logistics outsourcing activities, and encompass both international firms that have their operations in Singapore and those local firms whose operations expand internationally.

Findings: Results suggest that although there are some differences between the 3PL user and 3PL providers, and among the 3PL providers themselves, most of the eight critical aspects of successful logistics outsourcing contracts are common between them and are in line with the relevant literature. What seems unclear in the literature however, is how cultural differences can make or break a logistics outsourcing contract. This research also confirms that these differences **can** be countered by using the "think globa**lly**, act loca**lly**" business strategy.

Research limitations/implications (if applicable): The major limitation of this research is the use of small number of cases. Future research needs to employ more cases from both 3PL provider's and user's perspectives.

Practical implications (if applicable): This research confirms the **significance** of **investigating the** key success factors **of** logistics outsourcing **contract implementation** from both 3PL provider'**s** and user's perspectives, as well as the need for "cultural intelligent" through cultural training.

Originality/value: This is one of the few research on logistics outsourcing that employs case study design from both 3PL provider's and user's perspectives.

Keywords: logistics outsourcing, 3PL, critical success factors, Singapore

Introduction

This paper examines how a logistics outsourcing contract can be successfully implemented from the perspectives of both 3PL providers and users employing case examples in Singapore. Given the widespread trend of logistics outsourcing in today's business world, it is important that the logistics outsourcing contract is implemented successfully. Therefore, the identification and validation of critical factors for the successful implementation of logistics outsourcing contracts play a pivotal role. The remainder of the paper is organised as follows. First, a literature view to identify critical success factors for logistics outsourcing is given in section2. Then a brief introduction to the development of the logistics and supply chain industry is provided in section 3. The research methodology detailing sampling and data collection methods is given in section 4. Findings from the empirical validation are presented in section 5 and the paper is concluded with a brief discussion on academic and empirical implications in section 6.

Literature review

As an organisation decides to outsource one or several of their operational functions or activities to an outsourcing provider, various critical factors are required to be considered for the successful implementation of outsourcing contracts. These factors have been identified and validated quite extensively in the contemporary literature. To name a few, the study by Leahy, Murphy and Poist (1995) is perhaps one of the earliest research in this area in which 25 factors were viewed by third-party logistics providers in the US as important in the success of business relationship with their customers. Among these, customer orientation, dependability, timeliness, control and performance appraisal, etc. are found to be the most important factors leading to successful business relationship perceived by the respondents. Specifically, performance measurement and appraisal has been consistently identified as critically important to the success of outsourcing in various sectors (Weimer and Seuring, 2009), and is also found to be one of the critical success factors (CSFs) contributing to successful IT outsourcing in many large multinational companies (Hodosi and Rusu, 2013). Among other factors include maintaining good communication between organisations, selecting the supplier that is compatible in business culture and size, and outsourcing only when it makes good business sense. Meanwhile, through empirical validation, Reddy, Jigeesh and Kumar (2013) confirmed that timely delivery, cost efficiency, project management capability, communication, transparency, and ability to manage the scope creep are critical factors for the successful delivery of pharmaceutical outsourcing projects in India. Whereas, a study by Min (2013) in the context of the US logistics outsourcing environment found that consistent/reliable services, 3PL's reputation, focused/niche capability are among the most important determinants when an organisation selects their 3PL service provider.

Throughout the literature on critical factors for the success of outsourcing contracts, relationship quality between the organisation and its outsourcing supplier has been constantly identified as an essential factor which plays a critical role for the successful outsourcing venture. To successfully manage this relationship, several key managerial practices are required, including the reliance on internal knowledge capabilities to evaluate the potential cost and process improvements proposed by the supplier, monitoring of supplier performance and their responsibilities, as well as the continual organisational control of the outsourcing process (Boyson, Corsi, Dresner and Rabinovich, 1999). From the industrial perspective, Webb and Laborde (2005) affirmed that successful relationships would lead to successful outsourcing arrangements and the more successful outsourcing relationships are those in which the outsourcing firm has become "like family" to the client. Hence, while the outsourcing firm should allow flexibility and change as their relationship with the supplier matures over time, the supplier must also take the customised approach to the relationship with their client so as to become their consultant and trusted advisor. This closer, longer-term relationship or "partnership" has since been acknowledged in various studies (for example, see Golicic and Mentzer, 2006; Hofer, Knemeyer and Dresner, 2009).

Consistently throughout the literature about outsourcing relationship, trust is identified as the key determinant which facilitates others. In this respect, the outsourcing firm's prior satisfaction with the supplier, the supplier's relationship-specific investment, information sharing and their reputation are key determinants of the outsourcer's level of trust toward the supplier (Tian, Lai and Daniel, 2007). Adding further, Swar, Moon, Oh and Rhee (2012) argued that the determinants of outsourcing success in the public sector should be treated separately from those of the private sector. By examining 93 IS/IT outsourcing projects in South Korea, the authors found that relationship quality, which is determined by cooperation, trust and mutual understanding between parties in the outsourcing contract, explains a significant amount of variance in IS/IT outsourcing success. Meanwhile, it was also found that trust is one of the main common factors leading to logistics outsourcing success, among others such as joint vision and objectives, clear role, top management commitment and support, and communication (Srabotic and Ruzzier, 2012). At the more specific level, Qi and Chau (2013) found that interpersonal trust plays a more dominant role than does interorganisational trust in making IT outsourcing successful, hence building a strong interpersonal trust with the key contact person in the service provider is essential to sustain a long-term relationship, and to achieve the final IT outsourcing success. In a recent study about logistics outsourcing in the US, it was found that trust plays a key role in the relationship between a government agency and its third-party logistics provider as it affects the level of information sharing and, without it, their relationship is purely transactional (Hooks, 2015). Table 1 provides a summary of key determinants of successful outsourcing contracts.

Key determinants	**Sector**	**References**
Customer orientation	3PL	Leahy, Murphy and Poist (1995)
Timeliness	3PL, Pharmaceutical	Leahy, Murphy and Poist (1995); Reddy, Jigeesh and Kumar (2013)
Dependability/reputation	3PL	Leahy, Murphy and Poist (1995); Min (2013)
Control and performance appraisal	3PL, manufacturing, IS/IT	Leahy, Murphy and Poist (1995); Weimer and Seuring (2009); Hodosi and Rusu (2013); Boyson, Corsi, Dresner and Rabinovich (1999)
Communication	IS/IT, Pharmaceutical, 3PL	Hodosi and Rusu (2013); Reddy, Jigeesh and Kumar (2013); Srabotic and Ruzzier (2012)
Compatible in business culture and size	IS/IT, 3PL	Hodosi and Rusu (2013); Srabotic and Ruzzier (2012)
Cost efficiency	Pharmaceutical	Reddy, Jigeesh and Kumar (2013)
Project management capability	Pharmaceutical	Reddy, Jigeesh and Kumar (2013)
Transparency	Pharmaceutical	Reddy, Jigeesh and Kumar (2013)
Consistency/reliability	3PL	Min (2013)
Focused/niche capability	3PL	Min (2013)
Capabilities to evaluate potential cost and process improvements	3PL	Boyson, Corsi, Dresner and Rabinovich (1999)
Continual organisational control	3PL	Boyson, Corsi, Dresner and Rabinovich (1999)
Personalised approach to client relationship	3PL	Golicic and Mentzer (2006); Hofer, Knemeyer and Dresner (2009)
Trust, interpersonal trust	3PL, IS/IT	Tian, Lai and Daniel (2007); Swar, Moon, Oh and Rhee (2012); Srabotic and Ruzzier (2012); Qi and Chau (2013); Hooks (2015)
Top management commitment and support	3PL	Srabotic and Ruzzier (2012)

Table 1. Selected key determinants of successful outsourcing contracts

Although the determinants of successful outsourcing are consistently found and/or validated in the contemporary literature, most existing studies were conducted either from the perspective of the outsourcing firm or that of their supplier but not both at the same time. It is believed that the concurrent examination of outsourcing practices from both players' perspectives would reveal significant insights about critical determinants of outsourcing success which in turn possess implications for both academics and practitioners.

Setting the context: Singapore

Despite being only a “red dot” in the world map, Singapore is well known for having a pro-business environment, which the government of Singapore has been promoting over the years. The transparent government’s policies and efficient government’s services, together with numerous favourable fiscal and other business policies have encouraged foreign investors to invest in Singapore. For many years, Singapore has been known to have the most conducive environment for business as compared to the rest of its neighbours – and the world. According to the Economist Intelligence Unit, Country Forecasts Report in 2014, Singapore was ranked the most attractive investment location, both regionally and globally (The Economist - Economist Intelligence Unit, 2014).

In terms of logistics and supply chain management, Singapore has also been ranked highly. The World Bank ranked Singapore as the number 1 logistics hub in Asia and 5th in the world in their 2016 Logistics Performance Index (World Bank, 2017). With an international seaport and airport that are consistently ranked as one of the busiest and best performing in the world, Singapore has continually been in the forefront as the preferred location for logistics and supply chain related operations. Indeed, Singapore today is a prime location for major logistics firms, with 20 of the top 25 global logistics players conducting operations here. Many 3PLs such as DHL, Kuehne + Nagel, Sankyu, Schenker, Toll, UPS and Yusen Logistics, have set up regional or global headquarter functions in Singapore. It is noteworthy to mention that Singapore is also the preferred logistics and supply chain management hub for leading manufacturers across industries, such as Avaya, Diageo, Dell, Hewlett Packard, Infineon, LVMH, Novartis, ON Semiconductor, Panasonic, and Siemens Medical Instruments (Economic Development Board EDB, 2015).

Given this business setting of Singapore, an examination of logistics outsourcing practices from the perspectives of both the outsourcer (the organisation) and their 3PL service providers in the context of Singapore would be significant to draw meaningful lessons for both academics and practitioners whose interest is in the area of logistics outsourcing theories and practices.

Methodology

The case study design

The case study design is adopted to empirically examine logistics outsourcing practices in Singapore. A case study is an empirical enquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2003). Case studies are widely used in various contexts such as in sociology, organizational psychology, employment relations, political science and business operations. While most existing research about logistics outsourcing in the contemporary literature employs survey method to generalise findings to the population, a case study design is used in this paper to gain further insights on the practices of logistics outsourcing in Singapore in various aspects, from the process followed to other determinants of successful outsourcing such as performance indicators, supplier relationship management, etc.

Sampling

This paper examines how a logistics outsourcing contract can be successfully implemented from the perspectives of both 3PL providers and users. For this purpose, the firms that are to be examined as case studies must engage comprehensively in logistics outsourcing activities. In addition, given the setting of Singapore being a global logistics hub, we aim to examine both international firms that have their operations in Singapore and those local firms whose operations expand internationally.

Consequently, three 3PL service providers and one 3PL user were selected. Among the three 3PL service providers, the first one is a leading company in the parcel delivery service originally in the US but has now become a true global logistics and supply chain service provider. The second 3PL service provider has its origin traced back to Germany as a famous land transport (rail) solution provider, however, over the past years has transformed into a global total logistics solutions provider. The third 3PL service providing firm has developed from a warehouse operator in in the Middle East to become one of the world’s largest integrated logistics service providers. Although these logistics firms are today acknowledged among the world’s top 3PL service providers, they have developed from different origins and thus an examination of their logistics outsourcing practices would render critical insights from the 3PL service provider's perspective. Meanwhile, the 3PL user is one of the largest local Singaporean distributors of the world's leading manufacturers of fragrance, cosmetics and skin care products.

Interestingly, the 3PL user has been using the logistics outsourcing service provided by the three aforesaid 3PL service providers. These firms were selected as case studies as they met the criteria for the research to be conducted, and because the management of these firms were willing to elaborate various aspects of their logistics outsourcing practices. The descriptions about these firms are further elaborated in the below paragraphs.

Case 1: A local 3PL service user with headquarter in Singapore but operations expanded internationally.

This firm is a Singapore-based local distributor of more than 130 world's first class fragrance, cosmetics and skin care brands. Their business is expanded across the Asia Pacific region, including China, Hong Kong, Taiwan, India, Philippines, Vietnam, Indonesia, Thailand, Malaysia and Singapore. In the Singapore headquarter, the supply chain manager takes charge of the distribution not only in the local market, but also the foreign markets. Their suppliers are mainly located in Europe and the United States. All cargoes are shipped from the manufacturers to Singapore for consolidation in Full Container Loads (FCL). After cross-docking, shipments in small sizes are shipped to various countries according to the demand of each region.

This firm has its in-house logistics team in Singapore. They are in charge of in-bound and out-bound logistics and cross-docking. In recent years, as a result of the expansion, the workload of Singapore office increased dramatically. As a distributor, it was important to be competitive in terms of cost. As a leading distributor for fast moving consumer goods and fashion products in Asia Pacific, the required level of control over the whole supply chain is high for the case of this firm. Therefore, they rely largely on the in-house logistics arm and only three out of ten countries' logistics functions are outsourced, mainly because of the lack of resources. Firstly, in China and Vietnam, the language barrier prevented the in-house logistics team to execute logistics functions directly from Singapore. Moreover, the unsystematic logistics operations process and the complicated import policies further burdened the logistics department of the firm. More importantly, due to the small lot size of each shipment, the overhead transportation cost and warehousing cost is high, and thus it is more economically viable to employ a 3PL service provider to perform logistics functions in non-strategic and newly entered market such as Vietnam.

Case 2: A global 3PL service provider originally from the US

This firm is currently one of the world's leaders in the fields of logistics and supply chain solutions. Originally from the US market in the parcel delivery service, the firm has grown to become a giant with presence in nearly every corner of the globe, making it virtually the most international company in the world. The firm is now providing solutions for nearly every single logistics need including parcel delivery, express, forwarding, supply chain, e-commerce, etc. the company's service portfolio includes a widespread spectrum, from freight transportation (air freight, sea freight, road and rail freight, multimodal transport, industrial projects transportation, etc.), to Lead Logistics, warehousing and distribution, temperature controlled logistics, green logistics, supply chain solutions and industry sector solutions (for example in the sectors of aerospace, automotive, chemical, fashion, etc.). In Singapore, this 3PL service provider has an extensive coverage built up over 30 years in the region. The current facility for supply chain solutions occupies 1.2 million square feet of space in the island.

Case 3: A global 3PL service provider originally from Germany

This 3PL service provider is a global logistics expertise with a strong original foundation in land transport operations, especially in rail freight. In terms of revenue and performance, the firm is ranked in the top two transportation and logistics service providers worldwide. The company is also placed as one of the top providers of air and sea freight globally, while its land transport network is one of the most comprehensive in Europe. The firm is currently providing integrated logistics services in more than 140 countries across various modes and carriers seamlessly together with other additional logistics services. They are also the partner of specialised industries such as automotive, consumer goods and high-tech industries. In Singapore, the firm has developed over 44 years from being the first airfreight forwarder to become a market leader for integrated logistics services with about 2.1 million square feet of modern warehousing space island-wide.

Case 4: A global 3PL service provider originally from the Middle East
From a humble start as a warehousing service provider in a country in the Middle East, this 3PL service provider has grown to become one of the world's largest integrated logistics service providers with more than 20,000 employees and operations in 100 countries. Being the largest logistics company in the Middle East, this firm has now had its footprints internationally especially in emerging markets. This 3PL service provider offers supply chain solutions including air, ocean and road freight forwarding, warehousing, distribution, and specialized services in project logistics, chemical logistics, etc. The firm is currently ranked in the top 15 logistics service providers worldwide. In Singapore, this 3PL service provider offer customers a wide range of products and solutions across the automotive, hi-tech, fashion and retail , FMCG, food and beverages, life sciences, industrial and chemical sectors with close to 50,000 square meters of warehouse space.

Data collection
The main method of data collection in the case study design for this research is in-depth interviews conducted with senior logistics and supply chain managers of the case companies. Overall, four face-to-face semi-structured in-depth interviews were conducted, followed by a couple of follow-ups via emails. On average each interview lasted for about 90 minutes. The semi-structured interview allows the interviewees to express their views and ideas and also the researcher to collect in-depth information on buyer's and supplier's perceptions of various aspects of logistics outsourcing practices. Before the face-to-face sessions, a cover letter detailing the project's objectives, research questions, etc. was sent to the interviewees so as to obtain their consent to participate in the research project.

Although the questions for 3PL service providers and users were worded a little differently to reflect their positions in the logistics outsourcing, they cover the same aspects of logistics outsourcing practices: *the process of logistics outsourcing*, *determinants of successful logistics outsourcing contracts*, *3PL evaluation criteria*, *key aspects of a logistics outsourcing contract*, *partner engagement*, *contract performance measurement*, *common hindrances to the successful outsourcing contracts and solutions*, and *the importance of culture as a determinant of a successful logistics outsourcing contract*. This is important to ensure the same basis for cross-case analysis and discussion of findings. The investigation on the role of culture is essential given the global nature of logistics outsourcing contracts nowadays and the context of Singapore as a global logistics hub. The following sections present findings from analyses of cases.

Findings - Determinants of successful logistics outsourcing contracts
The cross-case analysis compares views, perceptions and shared experiences derived from cases toward the same eights aspects of logistics outsourcing practices as elaborated in the earlier section. 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 and users, and among the 3PL service providers themselves, for various aspects of the logistics outsourcing venture.

According to the 3PL user (Case 1), a successful logistics outsourcing contract requires a *well-defined Service Level Agreement (SLA)*, *clearly stated KPIs for the 3PL provider*, and *clearly stated SOW in the outsourcing contract*. Meanwhile, for the first 3PL provider (Case 2), logistics at the end of the day is still very much a service industry, and thus *having the right people* is a key to success. Successful outsourcing venture requires staff from both 3PL provider and user company being involved actively from the start. A steering committee is normally put in place to actively steer the direction of collaboration and resolve any disputes. In addition, as the length of contract is typically three to five years, the 3PL provider will need *ample time to understand and integrate into the client's business processes*. For the second 3PL provider (Case 3), the key determinants of logistics outsourcing success also include *having the right people to work with the client* and also both parties need to understand what are required in the Scope of Work *(SOW*) as well as the *KPIs* which are used to measure performance.

Meanwhile, for the third 3PL provider (Case 4), any successful outsourcing attempt must first be traced back to the SOW developed by the 3PL user. Specifically, it all depends on *who is in charge and how the SOW is crafted*. The person crafting the SOW must be familiar with the scope at hand. In most instances, the person preparing the RFQ may be from the procurement department and they may not be familiar with the entire scope that is at hand. Secondly, even if the procurement person ropes in the Subject Matter Expert (SME), the SME may keep certain part of the scope out of the document for fear that inclusion may increase the final pricing or deemed unattractive to potential bidders. Thus, what is in and what is out of the SOW has to be clearly identified. During negotiation and implementation, a common challenge is scope creep i.e. doing more than what was asked for, and that will create lots of unexpected hiccups during the process. In any outsourcing program, the more comprehensive the SOW is, the more time is needed to respond and chances are, the higher the cost elements. If the SOW is not thorough enough, there is a high chance of missing out the critical components and having challenges implementing the contract. Hence, it is critical that the SOW is clearly stated and the person who is in charge of drafting it understands the implications of not having the properly stated SOW. Secondly, *performance measures* (KPIs) must be clearly understood by both parties to ensure a smooth cooperation during the outsourcing process.

Table 2 provides a summary of determinants of successful logistics outsourcing contracts. It can be seen that while most of these determinants are in line with those in the contemporary literature such as teamwork between parties, performance measures, etc., it is worth noticing the importance of having a clearly stated SOW and its implications, which is currently not recorded in the literature.

Determinants	**3PL user**	**3PL provider 1**	**3PL provider 2**	**3PL provider 3**
Well defined Service Level Agreement (SLA)	√			
Clearly stated Scope of Work	√		√	√
Clearly stated key performance indicators (KPI)	√		√	√
Having the right people		√	√	
Ample time to understand and integrate into the client's business processes		√		

Table 2: Determinants of successful logistics outsourcing contracts

Conclusion

This paper discusses critical factors of successful logistics outsourcing with cases from both 3PL user and providers in Singapore. By reviewing the contemporary literature on the outsourcing process and determinants of successful outsourcing contracts, this paper examines how logistics outsourcing is conducted from the perspectives of both 3PL user and provider and whether critical factors for a successful logistics outsourcing contract appreciated by 3PL practitioners are in line with those reported in the literature. For this purpose, four cases were examined, one is a 3PL user and three others are 3PL service providers. Interestingly, it was found that, although there are some differences between the 3PL user and 3PL providers, and among the 3PL providers themselves, most of critical aspects of successful logistics outsourcing are the same between them and are also in line with those recorded in the literature. For example, all of them emphasised the importance of having the right SOW, performance measurement using widely accepted KPIs such as lead time, cost saving, etc. and those factors and aspects are also in line with those in the literature.

What seems unclear in the literature, however, is how cultural differences can make or break a logistics outsourcing contract. Although the literature reports that firms tend to select a 3PL partner which is compatible in terms of business culture, what remains unanswered is how to overcome cultural differences so as to secure business opportunities. It has been confirmed through the analysis of case studies that these differences may be countered by using the "think global, act local" business strategy. Furthermore, those involved in the outsourcing venture in each firm needs to be "cultural intelligent" through cultural training sessions. Of course, strong commitment in change management from the top management is always an important prerequisite. These are additional critical factors to make logistics outsourcing a success in the context that 3PL users and providers in outsourcing contracts are today from different cultural regions of the world.

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IMPROVING RISK MANAGEMENT BY USING SMART CONTAINERS FOR REAL-TIME TRACEABILITY

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Abstract
This research proposes implications of application functions by using the chain traceability data acquired from the *Smart Object attached with Extended Real-time Data* (*SO-ERD*: e.g. smart container, smart pallet, etc.) to improve risk management at the level of the logistics chain. Recent applications using traceability data and major issues in traceability systems have been explored by an academic literature. Information is classified by the usage of current traceability data for supporting risk detection and decisions in operational, tactical, and strategical levels. It is found that real-time data has been a significant impact on the usage for the transportation activity in all decision levels such the function of food quality control and collaborative planning among partners. However, there are some uncertainties in the aggregation of event-based traceability data captured by various partners which are preventing the adoption of data usage for the chain. Under the environment of Industry 4.0 and the Internet of Things (IoT), the SO-ERD enables independent data tracing through the chain in real-time. Its data has potential to overcome current issues and improve the supply chain risk management. Therefore, Implications of risk management are proposed with the usage of SO-ERD data based on the literature review which reveals current concerns of decision functions in the supply chain. The implications can be an impact to the domain needs.

Keywords: Risk Management, Chain Traceability, Internet of Things (IoT), Smart Container, Real-time Traceability

Introduction
Traceability is considered as an essential part of quality requirements to fulfil the quality improvement for organizations including in the supply chain. Traceability data collected during operations in the field is integrated for risk management in various contexts: manufacturing, food, pharmaceutical, etc. [2,3]. However, current traceability practice is limited by information visibility within the chain which consequently impacts the supply chain risk management (SCRM).

To track and trace products among stakeholders along the supply chain, Electronic Product Code Information Services (EPCIS), is the only global standard which uses barcode and/or RFID technologies to perform four major activities for the traceability: (1) to identify traceable items, (2) to capture events (date-time, location, event-type e.g. arrival, transfer, etc.) separately by each partner using their own barcode or RFID reader, (3) to share business-critical information with involved partners and (4) to trace the product flow among trading partners [4]. However, the frequency of event capturing limits the visibility of event-based traceability. The tracing status in between reading points during logistics is invisible (as shown in Figure 1) which further restricts the risk awareness and risk handling. Moreover, due to the scattering of data storage owned by different stakeholders, it requires extra efforts to qualify chain data. The additional technical implementation at least the data crawling to fulfil requirements of the chain collaboration [5].

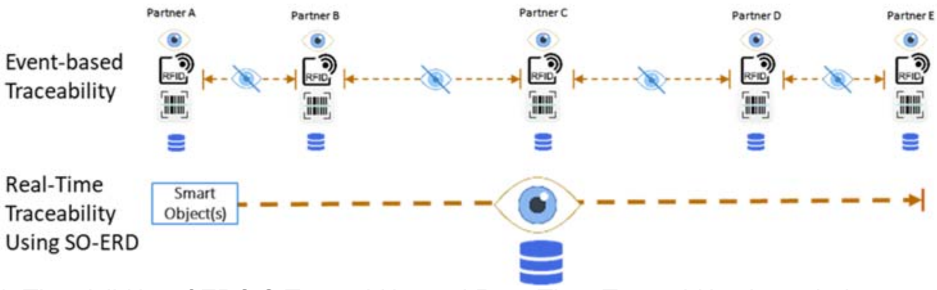

Figure 4: The visibility of EPCIS Traceability and Real-Time Traceability through the supply chain.

Soon within the Industry 4.0 environment, the visibility is extending through the chain during transportation in real-time by technologies of the Internet of Things (IoT). For example, Traxens proposes a smart container solution which can sense the actual status of the tracing object (e.g. temperature, container's status, location, etc.) and collect these data to one global data storage in near real-time, not limited to the event-based. Traxens also offers data service platform for clients to monitor smart container and related data in real-time [6]. These data collected by the *Smart Object attached with Extended Real-time Data* (SO-ERD) has potential to extend the use for SCRM but current studies are limited.

Therefore, this paper proposes the use of SO-ERD data to improve SCRM as compared to the conventional methods in the literature review. Besides, the SO-ERD traceability data can be used to handle risks at the supply chain level and overcome difficulties of the current traceability system. The rest of the paper is organized as follows. Section 2 presents the theoretical background of the risk management and definitions of traceability. Section 3 describes the methodology of the academic literature review. Section 4 reveals results of the usage of traceability data to support decisions on the supply chain. Section 5 introduces implications of the chain traceability data captured by SO-ERD. Finally, Section 6 concludes the paper.

Theoretical background

Risk Management

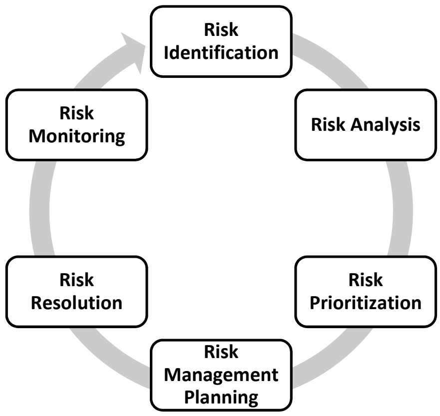

Figure 5: Risk Management Cycle [7]

Figure 2 introduces a typical Risk Management cycle [7], (1) identifying risk items which tends to be success's obstacles, (2) assessing loss probability and loss magnitude of each risks e.g. techniques of performance models, (3) prioritizing the order of risk items, (4) planning of risk management to prepare risk handling, (5) performing resolution to the risk and finally (6) monitoring to progress after resolving and continuously managing risks. To perform risk management activities, it is necessary to have the available data for the monitoring process. Especially, risk identification and analysis depend on data captured during operations in the field and are captured by traceability tools.

Definitions of Traceability

ISO 9000:2015 defines traceability as "ability to trace the history, application, or location of an object" while "object" means "anything perceivable or conceivable" such as product, process, service, person, system, organization, or resource. Traceability of a product or a service can also include the processing record, the distribution and location after delivery [1]. Traceability is also classified in terms of partnership by Moe [8] as follows:

- *Internal Traceability*: tracing within an organizational internally, e.g. batch processing.
- *Chain Traceability*: tracing the continuous production along with several partners which go from materials or resources, productions, distributors and/or others. It can be conducted in two different approaches for chain data collection as illustrated in Figure 3.

- Approach 1: Distributed - Only the identity of the product is passed through the chain, information can be acquired by collaborating with internal traceability.
- Approach 2: Accumulated - All information is attached to the product along with all stages of the chain.

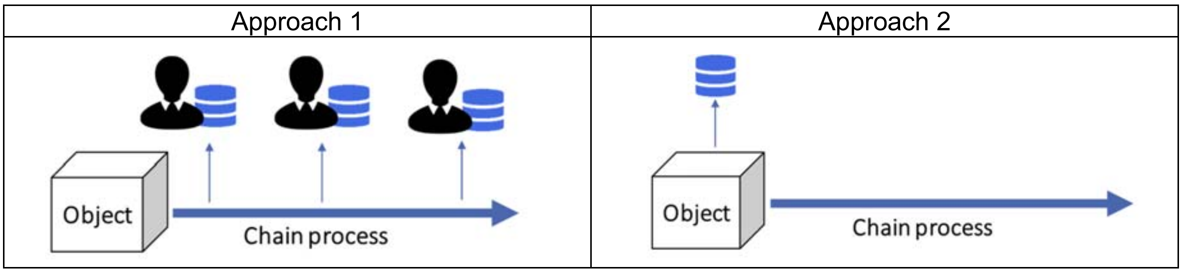

Figure 3: Chain Traceability approaches

Currently, the common approach for chain traceability is Approach 1 as such the practice of EPCIS standard. For this approach, as an example, in the case of a container traceability, this later travels through several logistics service providers. When passing on each provider, internal operations can collect information via RFID or barcode. Tracing of the container through the whole chain requires collaborations among these partners to aggregate all data. While Approach 2 is scarce to be adopt using technology due to it is difficult to attach data to an object during the travel. However, the availability of IoT which facilitates objects to extract data anywhere can overcome this difficulty. The adopting of Approach 2 becomes possible for the case of smart container. It can collect data by itself when it travels through service providers of the chain. The collaboration to collect the internal traceability of logistics data from partners is not mandatory. Therefore, the approach of chain traceability for the SO-ERD turns to the Approach 2, as well as tasks affected by traceability data such as the risk management.

Methodology

In order to identify opportunities for the adoption of risk management, decision-making is a significant activity to identify and to analyse risk. Therefore, this study focuses to make use of the traceability data to support decisions of the supply chain. A literature review is conducted within main bibliography sources; Scopus, Web of Science and IEEE. First, major related keywords are searched, “traceability” and “data”, and “supply chain” or “logistics”, and “decision” or “performance”. After merging results from all databases to remove duplicated papers, there are 142 publications from the year 1996 to 2017. Then, papers are reviewed to exclude studies which have no usage of traceability data or the usage is only for tracking and tracing or high-level usage concept without data parameters, for example, studies of methods for tracing resource originality, studies of stakeholder’s perspective based on survey, studies that adopt technologies such as RFID for traceability, conceptual papers and etc. The remained 31 publications [10-40] are reviewed again in detail and information is structured using mind mapping.
The classifications on mind map are structured in three major axes.

1. *Traceability Data* – containing a list of data parameter and type of the data (e.g. master data, transport condition, business transaction), the frequency of traceability data acquisition: real-time/ event based/ batch/ offline and the acquisition tools.
2. *Usage of Traceability Data* for *Decision Support* – the use of traceability data is classified into three levels: operational, tactical and strategical. The impact of the decision is also classified into activities of the supply chain process with supported data attributes.
3. *Issues* – presenting issues of technical and business perspectives caused by implementing current traceability system.

Result

Regarding 31 publications researching in the use of traceability data are in the context of perishable products, manufacturing, transportation service providers and others in the ratio of 54.8%, 25.8%, 9.7% and 9.7%, respectively. Details of studies are classified into three axes as follows:

Traceability data

Traceability data is classified into three types by its characteristics: Master, Transactional and Condition Status. Master data is containing permanent or not subject to frequent change data such as identifications, product information, location information, etc. Transactional data is containing events captured during the flow of tracing object e.g. shipment information (date of dispatch/arrival, to/from, delivery operator). Condition Status captures parameters related to the tracing object. This last data type can be the status of surrounding environment, e.g. temperature, humidity, position, etc or the status of tracing object's component, e.g. nutrients of food product occurring during the production in the field.

In terms of data acquisition, the visibility of the physical activities occurring in the process flow depends on the availability of data and information. A data acquisition is conducted by different tools e.g. RFID, sensor, GPS, Laboratory or Manual. Data is captured in different frequency: real-time, batch or event-based. For the real-time capturing, data is detected and transmitted immediately and continuously to the information system. For the batch capturing, data is collected once in a time interval or once in a production lot. For an event-based, data is collected by an event action such as product arrival/depart time, recall, etc. The classification of data acquisition of traceability data is as presented in Table 1.
In a traceability system, it uses a combination set of data types. Master data is statically defined in the information system and is available before productions in the field is launched. From the review studies, 67.7% of applications uses the Transactional data and 71.0% of applications uses the Condition Status data. The number of studies in Conditional Status data is a little higher even there is no traceability standard supporting. Especially the use of data attributes in temperature, position and humidity are in 38.7%, 29.0%, 16.1% of total research respectively.

Data Acquisition	**Transactional**	**Conditional Status**					
		Temperature	**Humidity**	**Position**	**Gas**	**Object's component**	**Others**
Classification by Acquisition tool							
RFID/barcode	[11,12,15,18,19,21,22,25,27,28,29,30,31,36,37,39]			[15,19,21,27,28]			
Sensor		[10,11,12,13,16,23,24,25,26,29,32]	[10,12,24,26,29]		[10]		[13]
GPS				[18,22,30]			
Manual/Laboratory	[17,34,40]	[20]				[20,13,35]	[20,40]
Classification by Acquisition frequency							
Real-time		[10,11,12,16,23,24,26]	[10,12,24,26]	[14,22,30]	[10]		
Batch of production or time interval	[25]	[13,20,25,32]				[13,20,35]	[13,20]
Event-based	[11,12,14,15,17,18,19,21,22,27,28,29,30,31,33,34,36,37,38,39,40]	[29]	[29]	[15,18,19,21,27,28]			[40]

Table 1: The classification of data acquisition of traceability data in tools and frequencies

Usage of traceability data

Once the traceability data is acquired, it is prompt to support activities of the supply chain process. This study classifies the use of traceability data supporting on each decision level: in operational – decisions during the flow of tracing object, in tactical – decisions before the operation activity e.g. planning, scheduling etc., and in strategical – decisions in a process or business change. Furthermore, to identify the impact of traceability data, the usage of decisions is mapped to the 9 activities of supply chain process defined by Grant et al. [9]. The classification result of traceability data usage is as shown in Table 2.

Usage of data	Decision Support Level		
	Operational	**Tactical**	**Strategical**
Classification by frequency of data analysis			
Real-time	[10,11,12,16,22,23,24,26,30,32]	[14,22,30]	
Event-based	[12,19,25,27,28,29,31,40]	[15,18,28]	[12,37]
Batch of production	[13,20,35]	[31]	
End of cycle		[17]	[33,36,38]
Series of process cycle		[21]	[34,39]
Classification by Impacted activities			
1. Customer service and support	[11]	[14]	[33,34,36,37,38,39]
2. Demand forecasting and planning		[14,21]	[33,34,36,37,38,39]
3. Purchasing and procurement		[14]	[34]
4. Inventory management		[14,31]	[34]
5. Order processing and logistics communications	[10,12,13,20,23,28,31,35,40]	[15,18,21,28]	[12,34]
6. Material handling and packaging	[10,12]		[12,39]
7. Transportation	[10,11,12,13,16,22,23,24,25,26,27,29,30,32]	[14,17,18,22,30]	[12,39]
8. Facilities site selection, warehousing and storage	[10,12,13,16,19,20,23,24,29,32]		[12,39]
9. Return goods handling and reverse logistics	[29,35]		

Table 2: Usages of traceability data for decision support and performance measurement in the supply chain

The total 31 studies in decisions: 20 studies in operational, 9 studies in tactical and 7 studies in strategical. The most usage of data is in the transportation activity for 54.8% of the total. Results are as follows:

Decisions in Operational
The highest number of traceability data usages are in the activities of processing, transportation, and storage. Functions of this decision level are generally concerning in the awareness of risks before they occur such as anomaly prediction, pre-warning prediction food shelf-life prediction and fault diagnosis. Therefore, real-time analysis is significant. From the top mentioned activities, about half of the applications use real-time data for decisions. Furthermore, every application of real-time decisions in operational and tactical (Table 2) need to use the traceability data captured in real-time (Table 1) to support their real-time analysis.

Decisions in Tactical
In this decision level, the '*position'* parameter plays an important role to support planning and scheduling of the manufacturing [15,21,28] and to improve collaboration among partners [14,18,22,30]. The '*position'* can be used for acknowledging the position of a shared object or can be mining for the knowledge of object trajectory to support plan optimization.

Decisions in Strategical
Traceability data is used as secondary information to support the strategical decision. Production data is modelled to illustrate the big picture of the process. The first usage is to measure the performance of the operation process. A method is by integrating the Business Process Management Notation (BPMN) to the process interaction model. KPIs are measured and analysed for each activity performance along the chain process [12]. In the case of environmental performance, traceability graph is mapped to environmental KPIs e.g. CO_2, CH_4, N_2O etc. [33,36,38]. The second usage is to model process from historical data for simulating the process re-engineering. The process model is constructed for the experiment of process change before the actual implementation [34,39].

Issues of chain traceability implementation
Regarding the implementation of traceability data usage, there are challenges to the current solutions which may prevent the adoption of the risk management system are described:

1. *Traceability data sharing*

Regarding that global traceability of event-based approach, only the relevant data captured by each partner should be shared while respecting confidentialities of all partners [18]. Only necessary interfaces among partners are limited. However, partners are still lack of willingness to share due to concerning in data security and reliability [12,14] and some partner can choose not to share access code of EPC on their sites [18].
Moreover, in addition to the selected 31 papers studying the use of traceability data, it is interesting that there are 14 papers which propose data models to aggregate data of the chain. These models tend to improve visibility and consistency for real-time tracing, collaboration, and decision-making. By the number of these studies, it is about half compared to selected studies. It is assumed that currently there are requirements to improve the linkage of data and information for sharing in the chain level.

2. *Changes in business*

There can be changes in business which cause uncertainty to practice, process model [14] and decision-making procedure [22]. A dynamic information system which is flexible to changes and enables real-time feedback for precise adaptive decision is required [22].

<u>Implications</u>
Based on the capability of the SO-ERD, the theoretical background, and the literature review result, this study proposes implications toward the implementation of traceability data of SO-ERD for the risk management of supply chain.

1. *SO-ERD offers the change of chain traceability approach.*

Current chain traceability is performed by collecting event-based distributed data among the chain partners. SO-ERD offers opportunity in collecting data by itself through the logistics chain. Therefore, the chain traceability approach can be changed to the accumulated collection.

2. *SO-ERD can overcome the data aggregation issue of distributed data collection.*

As a result of the accumulated approach of the chain traceability, concerning in aggregating scattered data from the chain partners can be declined. The chain traceability data is also available in real-time.

3. *SO-ERD is matched to the current research focus in the traceability data usages for the supply chain.*

Once the availability of chain data is enabled, the extension of the data value is possible. Through the interest of reviewed researches, activity during the transportation has the highest usage of traceability data especially the decision functions which use real-time data. The SO-ERD such as smart container also has the capability to collect real-time data during the transportation. Therefore, the potential of using SO-ERD to serve the domain needs can be an impact. The implementation of usage functions based on SO-ERD data should be also matched to current requirements as stated by the literature review.

4. *SO-ERD offers real-time traceability data to support real-time analysis of all decision levels under the environment of Industry 4.0.*

As the SO-ERD independently collects data of itself at anytime and anywhere it goes in real-time but data is not limited just only to itself status. Under the environment of Industry 4.0, the integration of traceability data with external data sources such as weather, route condition, business information system, etc can extend information and enable the awareness of the situation. This information can support the decision analysis for transportation activity in real-time such the case of a smart container as follows:

- <u>*Operational decisions*</u>: *Robust Tracking* – smart container offers various data parameters such as position, temperature, humidity, etc. so not only the common function as the goods position tracking but the goods quality tracking can also be functioned. By these parameters, the analysis for problem detection such as the probability of container lost, accident or goods quality prediction can be conducted, notified and handled in real-time.

- *Tactical decision: Efficient Planning* – due to the availability of chain data in real-time, knowledge of the travelling route can be constructed in several dimensions by integrating the container data such as '*position*' and '*time*' with the external related data such as weather, traffic congestion, operator performance etc. Then, the prediction or optimization decision functions of the route plan or route collaboration can be more informative. In addition, as the data of the chain available to all parties, the internal analysis can also benefit the chain data such as the prediction of incoming loads for the port preparation based on the real-time situation.
- *Strategical decision: Process Performance* – the handling of containers by each operator are different. The measuring of time, position, vibration in the container, etc can be used to evaluate the performance of each operator and can be conducted anytime. This information can support the chain for further process improvement analysis.

5. *The recursive monitoring of risk management for the logistics chain is possible by SO-ERD.*

Since the SO-ERD data is available in real-time, the risk management of the chain according to the risk management cycle can be performed at all decision levels recursively in real-time. During the transportation, risks are monitored, notified and analysed continuously for real-time handling. For tactical and strategical, the route plan can be decided based on the analysis of risk prevention or to achieve the optimized solution. Once the action is taken as planned, results of the plan or a process change can be feedbacked immediately throughout the chain.

6. *The recursive monitoring of risk management in real-time can improve robustness to the business or process change.*

Data acquired by SO-ERD is robust to changes in a process due to the data collection is independent of the process. Even there are changes in intentionally or unintentionally to business strategy, process or production, traceability data is monitored in real-time and can be notified in an early time.

Conclusions and Future Research

The major challenges for the chain traceability are the scattering of data collection and aggregation, and the uncertainty of the business process. These have influenced on the SCRM due to the limitation of data availability. This paper proposes implications of the SO-ERD traceability data to extend the risk management of the logistics chain. The proposed decision functions are also based on the literature review presenting current requirements dealing with concerns of the supply chain. This might improve the chance of impact to the domain once these functions of SO-ERD data usage are implemented. In near future, we will propose a design of the proposed decision functions for further improvement of the SO-ERD traceability.

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INFLUENCE OF INTERPERSONAL RELATIONSHIPS ON SOFTWARE SUPPLY CHAIN INTEGRATION: A RESOURCE ORCHESTRATION PERSPECTIVE

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Abstract

Purpose – The purpose of this study is to explore the role of the interpersonal relationships (IPRs) on software supply chain integration (SSCI). In particular, our study investigates the role of the three dimensions of inter-personal relationships (IPR) on strategic alliances, information sharing, and process coordination.

Methodology/approach – The research employs an exploratory/investigational approach to multiple case studies and empirically investigates the effects of IPRs in software supply chain integration in New Zealand. The data were mainly collected through semi-structured interviews with management staff (strategy/sales/service managers) from relevant software suppliers (developers) and their customers. Archival data from the Internet and company documentations were also applied.

Findings – We determine that in SCI, the Internet environment facilitates personal communication while simultaneously alienating personal affection, and plays a neutral role in personal credibility. More importantly, these three dimensions of IPRs influence SCI in different ways, even though the effect of IPRs on SCI is indirect: personal affection acts as an initiator, and personal credibility works as a "gate-keeper" and strengthens the confidence of interactive partners, while personal communication, a facilitator, plays a more important role in SCI than personal affection and credibility.

Originality/value – This research contributes to a better understanding of the relationships between IPR and SSCI. Advocating the resource orchestration theory in SCI, the external resources of the Internet and internal, tacit IRRs resources need to be concerted to achieve capabilities of IPRs in order to capture efficient and effective SCI. Our study develops the individual level research in SCI to a further depth.

Managerial implications – Our research provides managers in supply chain relationships awareness of the importance of IPRs in software chains, as well as the characteristics of IPRs, in order to best utilize the available resources. In the age of the Internet, managers should synergize all three dimensions of IPRs' resources: (1) make efforts to cultivate personal affection to avoid the instinctive isolation the Internet brings; (2) attempt to accumulate positive personal credibility profiles; (3) focus more on the role of personal communication and retain physical contact in the SCI process in spite of, or even because of, the Internet.

Keywords Interpersonal relationships, supply chain integration, software supply chain, case study

Paper type Research paper

Introduction

Nowadays more and more products (e.g. smartphones, automobiles, and computers) and services (e.g. billing, banking, information systems) are increasingly software-based rather than exclusively reliant on traditional physical devices or humans (Fricker, 2012). The main reason is that the Internet has grown exceptionally quickly over the last two decades and spread into nearly all areas of business, including supply chain management (SCM) (Lancioni et al., 2000). The Internet has dramatically influenced SCM by providing an unprecedented web-based platform for the development of relationships (Graham & Hardaker, 2000), speeding up communication between trading partners, improving service levels, and thereby reducing costs (Bruque-Cámara et al., 2015; Lancioni et al., 2000; Yao, 2015). Supply chain integration (SCI) is regarded as an efficient and effective approach to improving the performance of SCs (Huo, 2012). Most extant SCI studies, however, focus on physical products at the firm level, to examine various supply chain relationships (IORs) at the organizational level, such as trust, power, leadership, commitment, justice, and reciprocity (Huo, 2012; Yeung et al., 2009). This research tendency is understandable and logical, given that SCI is nominally the integration between companies of suppliers and customers (Flynn et al., 2010). However, these firm-level studies tend to overlook those critical SCI enablers at the individual-level (Gligor and Holcomb, 2013), because in practice, organizational integration is planned, implemented, and controlled by individuals themselves (Wang et al., 2016). Limited research has been conducted to investigate the role of interpersonal relationships (IPRs) in SCI, especially in software supply chain integration (SSCI), with the exception of a few studies that focused on human resource management, general staff training and awareness of SCM (Fawcett et al., 2014), and the roles of salespeople (Jia et al., 2014).

More recently, Gligor and Holcomb (2013) highlight roles and benefits of personal relationships in buyer-supplier interactions, and call for more research to develop a deeper understanding of behavioral complexities. Barnes et al (2015) have gone deeper into IPRs' conceptualization and suggested that IPR have three primary dimensions, which are personal affection, personal credibility, and personal communication. Further on, Wang et al (2016) have applied IPR concept into the field of supply chain integration (SCI) and conceptualized the relationship between IPRs, IORs and SCI. Following this framework, the role of personal level attributes can be applied to underpin SCI through a mediating effect from organizational level relationships. Although valuable literature has explored the role of the Internet in supply chain management (SCM) (Bruque-Cámara et al., 2015; Lancioni et al., 2000; Yao, 2015), there is still limited empirical evidence on how IPRs are developed to improve SSCI which is closely related to the Internet. An in-depth study of IPRs in SCI needs to consider different characteristics of three dimensions of IPRs affected by the Internet and Internet-related technology and applications. For instance, when personal communication becomes more and more convenient, efficient, and effective with hand-held devices (Negron & Hayes, 2016), the Internet affects personal affection immensely, by isolating personal physical interaction (Mahmoudi et al., 2014). Meanwhile, personal credibility can be easily perceived from the profiles of both companies and personal blogs publically available in the virtual world (Greenberg, 2013). Both the positive and negative influences of personal credibility cannot be ignored in the SCI process. Therefore, it is necessary to study the synthesising effect of the Internet on IPRs in SCI.

Resource orchestration theory suggests that companies can structure and bundle resources to build capabilities, then leverage those capabilities to gain on the competition and to achieve superior performance (Sirmon et al., 2007; Sirmon et al., 2011), instead of simply combining the resources together (Liu et al., 2016). Inter-personal and inter-organizational relationships are both resources, because they are valuable, rare, inimitable, and non-substitutable (Barney, 1991). The Internet can also be regarded as a kind of resource (Ochkov et al., 2015) from the perspective of resource orchestration theory while the Internet, as part of a firm's resource portfolio, may not necessarily meet the resource-based view criteria when acting alone (Wu et al., 2006). However, only limited contemporary SCM literature focuses on the orchestration and synergy of all these resources in SCI. Instead, most studies focus on examining the independent effects of the individual resources (Bruque-Cámara et al., 2015; Lancioni et al., 2000; Wu et al., 2006). There is a need to empirically explore how to interrelate resources of IPRs between suppliers and customers to achieve a superior SCI (Liu et al., 2016). Resource orchestration theory explores breadth (across the scope of the firm), life cycle (at various stages of firm maturity), and depth (across levels of the firm) (Sirmon et al., 2011). Our study mainly focuses on the domain of depth to develop our research framework.

This study aims to explore the role of IPRs on SSCI. In particular, it focuses on the following two research questions. Firstly, what are the characteristics of IPRs in software SCI? Secondly, how do three dimensions of IPR influence SCI? This study contributes to SCI literature and practices.

Theoretical background

Software supply chain integration (SSCI)

SCI can be defined as: "*the alignment, linkage and coordination of people, processes, information, knowledge, and strategies across the supply chain between all points of contact and influence to facilitate* *the efficient and effective flows of material, money, information, and knowledge in response to customer needs*" (Stevens and Johnson, 2016, p. 22).

Since SCI explores firm-level integration, SCI would involve integration of all partners across the supply chain (Stevens and Johnson, 2016). But in real practice, the integration of the *entire* supply chain is extremely difficult and very rare (Childerhouse et al., 2011). More often, SCI mainly explores internal integration (Horn et al., 2014; Williams et al., 2013) or external integration. Internal integration refers to "the degree to which a firm can structure its organizational practices, procedures and behaviors into collaborative, synchronized and manageable processes in order to fulfil customer requirements" (Zhao et al., 2011, p19). External integration includes integration with supplier and integration with customer (Flynn et al., 2010; Huo, 2012). However, complete SCI is required to achieve the ultimate goal of SCM: to create maximum value through services and products provided to end-customers (Wisner et al., 2016).

This popular classification clarifies the scope of SCI and focuses on improving the performance of the supply chain, including internal units of a focal firm and its suppliers and customers (Stevens and Johnson, 2016). It emphasizes the "*importance of conceptualizing SCI as a multidimensional construct to examine its effects on firm performance*" (Liu et al, 2016, p15). However, more weight is placed on the SCI contents regardless of whether the integration is internal or external. Liu et al (2016) conclude that SCI includes four key components: information integration, synchronized planning, operational coordination, and strategic partnership. Prajogo and Olhager (2012) address information integration and logistics integration while emphasizing long-term effects. Our study addresses strategic alliances, information *integration*, and process *integration* as three key SCI dimensions corresponding to strategic flow, information flow and process flow, respectively (Min, 2015; Zhao et al., 2011). Strategic alliances are characterized by conjoined thinking and decision-making (Pagell, 2004) as well as synchronized planning (Liu et al., 2016) focusing on long-term symbiotic effect (Prajogo and Olhager, 2012). Information integration refers to the sharing of key information in the course of supply chain processes to achieve real-time transmission and processing of information vital for supply chain decision making (Prajogo and Olhager, 2012). Process integration refers to the extent to which supply chain partners streamline and smooth the supply chain processes (Liu et al., 2016).

A supply chain can be a product chain or a service chain (Selviaridis and Norrman, 2014; Wang et al., 2015). Nowadays, more and more products and services are becoming software-based (Fricker, 2012). However, there is limited research on supply chains in the software industry. Unlike physical products, software can be easily copied, shared, resold, or rented (Variant 2000), reproduced and distributed quickly at negligible cost, thus potentially achieving fantastic profit margins (Cusumano 2008). Furthermore, software suppliers can provide exclusive service for locked customers (Fricker, 2012). Software supply chains focus more on the direct dyadic relationships between supplier-developers and their customers (Keil and Carmel, 1995). On the other hand, in comparison with the traditional physical product business, software business has a feature of a high uncertainty both for its software products and business market: short product life cycles (Weng and McClurg, 2003), in addition to highly unpredictable and risky product-development processes (Xu and Brinkkemper, 2007). Thus, in order to attain competitive advantages for companies (Naranjo-Valencia et al., 2011), software supply chains must respond quickly to changing environments with great flexibility and sensitivity regarding the market (Basu & Wright, 2008). As a result, companies are more like to follow a strategy of agility to achieve SSCI. Therefore, software supply chains provide a more meaningful setting to explore SCI between software suppliers (developers) and customers in terms of strategic alliances, information sharing and process coordination.

Inter-personal relationships (IPRs)

SCI is examined primarily as an organizational level construct (Stevens and Johnson, 2016) with various studies empirically testing the influence of a range of inter-organizational relationship (IOR) factors, such as trust, power, leadership, communication, reciprocity, and commitment (Huo, 2012; Cao et al., 2015). However, SCI practices are planned, implemented, and controlled by individuals, especially those with key boundary-spanning responsibilities, such as purchasing officers, sales people, customer service staff, invoice and receipt clerks, as well as relationship managers (Jia et al., 2014). The alignment, linkage and coordination of these individuals between suppliers and customers are emphasized in SCI (Stevens and

Johnson, 2016), highlighting the importance of IPRs in SCI. Thus, SCI is regarded as the state-of-the-art of this field (Pagell, 2004).

Barnes et al (2015) propose that IPRs have three main dimensions, namely, personal affection, personal credibility, and personal communication. Among them, personal affection, as an internal and relational aspect of IPRs, is a reflection of individual's feelings and sentiments. As personal affection is human feelings or likings relating to an enduring and emotional commitment to other individuals (Lee and Dawes, 2005), an individual's personal affection can affect and be affected by the personality, character, knowledge, lifestyle, and likings of the other individual during SCI interactions. After developing personal affection, individuals in a business interaction can have a mutually empathetic understanding of and affection for each other (Leung et al., 2008), providing the flexibility needed to handle changing circumstances as well as creating a strong tie (Leung et al., 2005). Thus, personal affection can affect the attitude and behavior of the representatives of suppliers or customers, consequently being conducive to the progression of a more comprehensive strategic alliance, greater information sharing, and profound process coordination, especially at the formative stage of SCI. After the formative stage, the function of informal IPRs may be gradually replaced by more formal IORs (Ekanayake et al., 2015).

Personal credibility is also an intrinsic element of IPRs, but contains further meaningful information. Personal credibility is the trust and confidence an individual can inspire in the business over time, based on a strong performance and achievement record, responsibility, and loyalty in the business (Barnes et al., 2015; Wang et al., 2016). It is gradual and long process for the building-up of personal credibility. Because trust can be character-based and reliability-based (Bowersox et al., 2010), personal credibility too can correspondingly be character-based (e.g. related to personal honesty and philosophy), or reliability-based (e.g. willing to perform). Therefore, it can give confidence to the counter-partner's representatives, who are then open to investing time and efforts, to prepare for the alignment of strategies in both firms, to share if not volunteering information, and to coordinate the formative processes. This is because personal credibility can generate strong desires to continue the relationship (Luo, 2007). Compared to the more subjective personal affection, which is hard to pin down and is based on heuristics and instincts (Diener et al., 2003), personal credibility is more objective as it is based more on facts and data.

Personal communication is the main vehicle to exchange information and ideas with business partners, in order to achieve familiarity and mutual understanding (Pearce and Robinson, 2000). In comparison with personal affection and personal credibility, personal communication has more of the external attribute of IPRs (Wang et al., 2016). Personal communication enhances the feeling that promises and obligations can be delivered as agreed, thus achieving harmony in IPRs and IORs (Ring and Van de Ven, 1994). When communication is more open and personal, the richness of the communication would increase, resulting in enhancement of the inter-organizational relationship (Cousins *et al.*, 2006). As a result, a higher level of personal communication will lead to greater longevity of IORs (Barnes et al., 2015), because personal communication can encourage business partners to understand the intentions, plans and potentially even the strategies of the other business partners, to share the right information of the process, and to facilitate the process by reducing risks and conflicts in the process.

Resource orchestration theory

We now draw upon resource orchestration theory, an extension of resource-based view, to provide a theoretical lens for our research. Following a resource-based view, the valuable, rare, inimitable, and non-substitutable assets and possessions can be regarded as strategic resources (Barney, 1991). The heterogeneously distributed "sticky" resources can "be stuck with" other resources and capabilities among companies, creating competition (Teece et al., 1997). These resources can be tangible (e.g. equipment, employees) or intangible (e.g. services, knowledge) (Liu et al., 2016). Compared with other types of resources, IPRs – the intangible relationships between suppliers and customers at a personal level – are dearer because IPRs are more difficult to obtain and are more inimitable than more physically tangible resources. Moreover, as a type of resource, IPRs are full of dynamic, as they are assembled within different time horizons (Ketchen et al., 2014).

However, possession of abundant resources by itself does not "indicate how resources can be deployed to generate synergistic effects" (Liu et al., 2016, p. 14). Resource orchestration theory states that a company's resources need to be structured and bundled to build capabilities, then be leveraged to achieve superior performance (Sirmon et al., 2007; Sirmon et al., 2011) rather than to be merely combined together (Liu et al., 2016). How to manage the resources to make full use of their potential may be just as important as which resources a company possesses (Ketchen et al., 2014). More importantly, the fit or alignment of interdependent resources should be considered (Liu et al., 2016). For instance, the Internet and related IT is widely regarded as a type of resource (Ochkov et al., 2015). However, the Internet, as part of a firm's resource portfolio, may not meet the resource-based view criteria for creating competitive advantage when acting alone (Wu et al., 2006), because of the relatively low barriers to imitation and acquisition by others.

This weakness can be effectively addressed by taking an analytic lens of the resource orchestration theory, as this theory is particularly useful for understanding the fit and deployment of resources and capabilities, such as IPRs, IORs, the Internet, and SCI. Based on this theory, when the Internet is structured, bundled with other resources such as company-based information technology and management systems, the Internet can be leveraged to gain competitiveness for the company. Because the supplier-customer boundary individuals have dual identities at both the personal and firm levels, the relationships between them are more complex when affected by the Internet. Thus, our study focuses on how companies leverage and orchestrate their resources in the forms of Internet and IPRs in order to achieve SCI at organizational level. More specifically, following the conceptualization of three dimensional IPRs as personal affection, personal credibility, and personal communication (Barnes et al., 2015), our study examines how these three dimensions of IPRs have played the role of SCI enablers. As a type of resources, IPRs include three dimensions which are rare, valuable, and very difficult to be imitated and substituted when employed in a firm (Barney, 1991) and can be regarded as resources of both firms and individuals. Each dimension has its own characteristics and functions in different ways, but the three dimensions are inherently related to each other and cannot be separated (Barnes et al., 2015). As a result, the three sub-resources of IPRs can be inherently orchestrated in different manners controlled by the relevant individuals. The resource orchestration theory can be applied in various research settings, such as breadth (across the scope of the firm), life cycle (at various stages of firm maturity), and depth (on different levels of the firm) (Sirmon et al., 2011). This study mainly focuses on the domain of depth, in terms of three dimensions of IPRs affected by the Internet, to extend resource orchestration theory and develop our research framework (Figure 1).

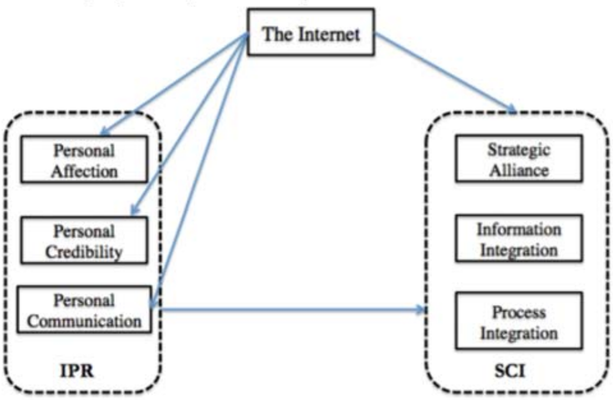

Figure 1. Research Framework

Research methodology

Through an exploratory case study, our research aims to explore the role by IPRs in enabling SCI in the Internet environment. Most prior research of SCI focuses on the firm level (Gligor and Holcomb, 2013) and studies different resources (for instance, the relationships, the Internet) in SCI independently (Bruque-Cámara et al., 2015; Lancioni et al., 2000; Wu et al., 2006). Methodologically, most prior research in SCI applies quantitative oriented method, such as questionnaire survey (e.g. Flynn et al., 2010; Huo, 2012), resulting in a lack of in-depth understanding regarding the dynamic nature of the development and IPRs and their influence on SCI (Barnes et al., 2015; Gligor and Holcomb, 2013; Wang et al., 2016). Moreover, there is limited research on the synthesized influence of three dimensions of IPRs in SCI affected by the Internet. To address these research gaps in terms of research topic and methods, we employed an exploratory qualitative case study approach (Eisenhardt, 1989) in order to develop an in-depth understanding of the concerted effect of the three dimensions of IPRs and the Internet in SCI by observing actual practices (Voss et al., 2002). The in-depth case studies explore the linkages between IPRs changed by the Internet and SCI in real-world software supply chains.

Case selection
Case selection is a critical issue for a case-based study. As this study focuses on the role of IPRs in SCI in software chains affected by the Internet environment, we selected two case companies of software developers and focused on their supply chains. One is the supply chain of a case company named NIS, consisting of NIS (a leading local software developer in New Zealand and based in Wellington) and its foreign supplier, USM (a US-based world leading software and platform provider). NIS provides business and government clients with web-based solutions and services such as financial and client relationship management; custom software development and systems integration; web and digital strategy. It is a leading software developer and service provider in Australasian, employing 380 people in New Zealand, Australia, and North America. It can be a representative of large software company. NIS started to collaborate with USM as supply chain partner in 2001, and its supply chain strategy focuses more on supplier integration.

Another one is AKS supply chain, consisting of AKS (an Auckland-based software developer) and its customers. AKS focuses on providing its customers with IT solutions and services in the functional area of human resource management (HRM). It has 8 staff only and can be regarded as a small and medium enterprise (SME), just like 97% of business in New Zealand (Joyce, 2014). AKS strives for collaboration with its customers, so AKS chain focuses more on customer integration. Both NIS and AKS supply chains are embedding in the Internet environment: all their operations and processing, including software product development, service delivery, database maintenance and stock keeping, have been mainly conducted or involved in the Internet environment. The two companies have over five year’s successful integration exposure with their suppliers or customers.

Data collection
Research instruments in this study include face-to-face and Skype semi-structured interviews lasting 60-90 minutes per interview and archival data from the Internet and company documents. The multiple sources of evidence strengthened the analysis by allowing triangulation on important issues to cross-verify insights and findings (Yin, 2003). Fieldwork of this research spanned for about eight months (from April to December 2016). To conduct the interviews, we used a three-part interview protocol (Appendix 1): (1) company and IPRs people profile; (2) SCI in the Internet; (3) Role of IPRs in SCI in the Internet. During the interviews we provided interviewees a list of three main aspects of SCI and nine roles and activities of IPRs in SCI in the Internet environment, drawn from literature review, and asked them to discuss each aspect and role from their experience, knowledge and understanding. We also asked them to identify aspects or roles not listed. Each interview started with a brief introduction about the research purpose. Then the interviewees were asked about their company background, main business, and their strategic supplier-customer relationships in terms of strategic alliance, information sharing, and process coordination. In regard to individual dyadic relationships, the respondents were asked how and why personal affection, personal credibility, and personal communication affect the organizational level relationship factors during different stages of their relationships. The interviews also explored the attitude and opinions if IPRs should be encouraged or not. We apply multiple respondents for each case to enhance validity (Yin, 2003) and reliability of the collected data (Voss et al., 2002). We purposely selected top, middle, and operational level staff such as managing directors, product managers, marketing managers, and sales representatives. Thus we acquired a range of hierarchical levels and greater depth and multiple perspectives: the top management have more comprehensive viewpoints about the role of IPRs in SCI while the middle level managers have more directly interaction experience and skills with supply chain network partners. The interviews were audio-recorded with the prior permission of the interviewees and subsequently transcribed. Unclear answers were clarified and supplemented through emails or follow-up telephone calls. The draft reports were reviewed by two researchers. We validated the

results by performing tests of validity and reliability. In terms of construct validity, we apply the multiple sources of evidence (interviews, archival data), multiple-level interviewees to complement each other. Internal validity has been enhanced according to the following suggestions (Merriam, 1998): (1) triangulating to confirm the emerging findings; (2) discussing the findings with research peers; (3) exchanging and communicating with interviewees on the data and interpretations; and (4) refining the theoretical orientation with our study. Meanwhile, comparing across the two case studies increases the external validity to examine the commonalities and differences. Reliability is less applicable to qualitative research (Merriam, 1998) as we concern more on the results' consistency with the data collected (i.e. interview notes, recording, transcripts, and interview questions).

The measures used for ensuring validity and reliability of the research throughout the case study are summarized in Table 1 (Gibbert et al., 2008; Yin, 2003).

Validity and reliability criteria	Case study tactics
Construct validity	Applying multiple sources of evidence to triangulate data (e.g. face-to-face and/or Skype interviews, information from the Internet, company documents) (Section 3.2) Establishing chain of evidence (e.g. the interview details, indication of data collection circumstances and clarification of data analysis approach (Section 3.2, and Section 4.2) The draft report was reviewed by three researchers (Section 3.2)
Internal validity	The case study was guided by a clear research framework (Figure 1) Applying pattern matching logic to compare the empirically identified patterns with the predicated patterns (Section 4.2)
External validity	Rationale for the case selection (Section 3.1) Details of the case study context (Section 4.1) The case study was guided by resource orchestration theory (Section 2.3)
Reliability	The interviews were guided by a semi-structured protocol (Appendix 1) We developed a case study database, including interview transcripts, notes, the Internet information, and companies documents (Section 3.2)

Table 1. Validity and reliability tests

Analysis and discussion

Case description

Since establishing in Wellington in 2001, NIS has been relying heavily on its supplier, USM, and has closely integrated with USM to develop, distribute web-based technologies and software products, IT solutions, and associated consulting services. NIS also works on projects from USM. It has been regarded as "Gold" member of USM Partner Network. NIS has been among the longest and largest dedicated providers of Microsoft-based solutions in the southern hemisphere and its Microsoft-related activity accounting for around 90% of its revenue. AKS, a typical SME in the IT industry, has developed a range of innovative workforce management systems since 2010, serving the New Zealand and Australian market. As a software developer, AKS specializes in providing solutions for time and attendance, employee and team scheduling, and payroll needs, as well as mobile solutions. AKS specializes in clouding-based time and attendance data management systems and operating in the business area with leading edge of technology innovation. It employed only 8 people but thanks to the successful achievement of integration with its customers and customer's network, AKS has attracted more than 100 customers in Australia and New Zealand.

Case analysis

All the interviewees quickly grasped the concepts in our research framework, such as IPRs, and SCI, at least in terms of practitioner comprehension. The two cases will now be explored in an attempt to set up a conceptual model.

The Internet, IPRs, and SSCI

Both NIS and AKS are embedded in the Internet environment to provide software products and service. NIS was located in the southern hemisphere while USM was located in the northern hemisphere with 19 hours' time differences between them. AKS and its customers doesn't have so much spatial and temporal discrepancy but AKS needs to collaborate with its tens of customers in Australasian area. It is the Internet rather than traditional physical and information flow technologies and approaches that make SCI possible. From inception, NIS contributes the integration achievement to strategic alliance and through joint actions

"We work closely with USM – both locally and globally – on the latest technologies, often well before these are unveiled to the wider world." (NIS)
"One thing above all has remained constant over our time in operations: our unwavering commitment to USM. Technology may have evolved radically over the years, but our core USM foundations have not (and will not)."
The partnership between NIS and USM is so successful that
"…*USM operates, a lot of the products that are being developed, that we help them develop", "we probably know more about what's coming out of USM in the next five years than USM New Zealand does…"*
AKS has similar experience*:*

"We work with our customers to understand their real needs…then we design the right solutions for them."

In terms of information sharing and integration of process, the Internet works as a timely and effective facilitator. To achieve integration with USM, NIS maintains high standards of information sharing/ security and process coordination with USM. *"It could be information control, confidentiality, keep a tight rein on things, because we have very heavy non disclosure agreements with Microsoft HQ."* Both case companies of software chain developers/suppliers transfer and exchange real time information and knowledge to their customers, such as company data, strategic plan, updated requirements, questions and answers, and solutions by using online communication applications (e.g. emails, Skype, video conference).

In both cases, the focal companies have been greatly benefitted from the modern information and communication technologies (ICT) to achieve SCI with their supply chain partners. However, our empirical data suggests that IPRs have played even more significant role to enable achievement of SCI. There are at least two reasons. One is that IPRs built up in the supply chains by the focal companies have facilitated their access to the latest technology and pace together with software partners (which will be explained in 4.2.2). The other reason is the side effects of the Internet and ICT on IPRs. For example, although emails improve communication efficiency, all the participants of interviews indicated that emails are "*too formal*" and "*too frosty*" and that over reliance on email could affect their "*friendships*" compared with traditional telephone calls. The online chatting makes more convenient "*communication with voice and expression*" but "*if you want to drink with them, you may be frustrated because they are far away*". Also, "*the Internet makes your personal and business information available, so, it will be good if you have good reputation, good experience, successful cases, of course, otherwise, it may make your case worse.*"

IPRs and SSCI
Both case studies attribute their SCI success to their people, especially IPRs. NIS addresses *"… the personal connection of our directors to USM has been the main basis of the relationship".* "*… we started off relatively small through a personal association with our director (of Strategy and Innovation), and over time it's expanded to be a large software business."* The director is recognized internationally as a leader in his area of web technology, and his role is to provide a link between USM and NIS. NIS has developed and maintained good IPRs with USM not only at the top management but also at the lower levels. *"We've now got two people on the ground over there in the US, whereas in the past we were doing the work out of New Zealand." "By working closely with USM personnel on a daily basis, we stay connected".* The main reason is "to make sure we're bringing the most up-to-date in thinking of USM, a global market leader" and to get "the earliest possible access to new technologies", also to "avoid the technical and financial risks associated with depending on a hot today, gone tomorrow technology"(NIS official website). *"…the guys that run that part of the business, they say it's not so much doing work for USM, it's doing work for about ten businesses within USM and a lot of it is based on personal relationships. For example, now we do the majority of their key note demonstrations at their large conferences … the ones that we've done work for over the years."* Because of the good IPRs "built on numerous years of trust and mutual

cooperation", the relationship between NIS with USM "is more than just a nice-to-have credential". Furthermore, NIS extends the unique philosophy to other supply chain partners, for example, the business in Australia: "by staying personnel connected, we keep you connected". As a result, NIS states that "(our) *culture is based on our people: they are the key to our business. We employ people who are genuine, honest, seriously committed to what they do and, above all, talented."*

The AKS case also provides a clear demonstration for the importance of IPRs in integration with customers. AKS has neither the time nor budget to invest into marketing. *"…all we have is our personal connections with potential customers. All our current customers are introduced by our friends, or friends' friends. It is very common and important for us to develop our market in New Zealand as it is a very small country and its culture is a little special."* The IPRs were critical for AKS to develop its business, especially in the initial stages. "…*with the established personal relationships, our customers come to know our products and services in the beginning. Then, we can have a chance to learn the customers' time and attendance system; and most of their systems are time-consuming and laboring-intensive."* AKS develops new customers through personal connections; then gains an appreciation of customers' requirements through information sharing before offering a customized solution; leading to the delivery of tailored products and associated service coordination "*according to pre-set company rules*". Through personal connection and network, AKS understand customers' situation and real needs, then convinces customers to collaborate to design customized solutions. Because each customer has its own requirements with different background, personal relationships become necessary and complementary during complex and sensitive data or information exchange process. Customers can save data in AKS cloud-based database to ensure information security. Also, customers can retrieve their data from anywhere at any time via the Internet. As a result, AKS' product and service has changed the customer's management approach and improved the overall efficiency. AKS has attracted over 100 customers across Australia and New Zealand.

There were also some interesting differences between the two cases. While NIS has committed its efforts to invest in IPRs throughout the whole process of supplier integration, the AKS case suggests that the role of IPRs is more important in the initial stage of SCI. As for the ongoing relationship, an executive of AKS stated that "*our products and service will do the job". "Of course, we will keep a regular personal touch with them to understand customers' new requirements, or to solve the problems from iTimer system application*".

Findings from the NIS and AKS cases also suggest that different dimensions of IPRs have different roles in facilitating SCI. In terms of strategic alliance, the role of personal affection is important, because *"Lots of customers start from talking and good feeling, especially for small companies."* As for information sharing, personal affection seems to fall short. "*Personal affection is not significant, but it certainly makes for having the discussion about what information will be shared easier*." (NIS). AKS disagreed with the role of personal affection in information sharing and simply said "*No*". Personal affection works a little better on process coordination as "*process coordination implies more ongoing personal interaction.*" (NIS). The interviewees indicated that personal affection is "*just kind of gatekeeper*" in regard to information exchange.

Personal credibility was seen more important than personal affection regarding to information sharing. Findings from the two case companies also demonstrated importance of personal communication. Compared with personal affection and personal credibility, personal communication is the more external attribute. Personal communication is the main approach to exchange the opinion and share the information to directly interact with business partners. In this way, personal communication can help in understanding the intention, plan and even strategy of the business partners, in obtaining the right information of the process, and in facilitating the SCI process by reducing risks and solving conflicts.

Evidence from our case interviews suggests that communications are more efficient and convenient with the help of web-based communication tools, such as Skype meetings and email in the Internet environment. On the other hand, our informants emphasized that traditional face-to-face contacts still works more effective and are preferred in quite some occasions.

Table 2 quotes the influence of personal affection, personal credibility, and personal communication on strategic alliance, information sharing, and process coordination.

	Strategic alliances	Information Integration	Process Integration
Personal affection	"We typically collaborate better with parties we have some liking of." (AKS). "We have shared many personal experiences and in doing so have reached a better mutual understanding of each other. We are now developing our ideas for the benefits of both businesses." (NIS).	"Personal affection is not significant, but it certainly makes for having the discussion about what information will be shared easier." (NIS). "No". (AKS)	"process coordination implies more ongoing personal interaction." (NIS). "just kind of gatekeeper" (AKS)
Personal credibility	"We are proud of and stand by our reputation. We employ some of the greatest Microsoft experts around." "Our experience reduces the risk to you, and helps increase the return on your technology investment". "We are not the cheapest but they (USM) must think they get good value for money, and we produce quality... We've never let them down." (NIS) "Definitely we like to do business with someone who we believe are credible". "Good personal credibility, means, the quality of trustworthy; for example, if you always keep your promise, I will trust you, then I would like to discuss the business." "For long term relationship, the personal credibility is the most important." (AKS)	"(our) exceptional technical community leaders share their high quality, real world expertise in offline and online technical communities around the world"; "more information will be forthcoming if a partner is seen as credible and capable for a long-term relationship." (NIS) "the role of personal credibility is limited – information sharing is something we agree between parties – we seldom associate or think about an individual's personal credibility in arranging or facilitating information sharing". (AKS)	"(our) experts are internationally recognised for our knowledge and experience in designing, creating, implementing and supporting Microsoft-based solutions." "We more readily will work with people we find personally credible to find solutions and supplier -customer process coordination is an example of needing to work together to find solutions".
Personal communication	"strategic alliance needs to be fed, and to feel that regularly meetings/chats/catch-ups are necessary." (NIS) "personal communication will strengthen the relationship and likely result in a mutually improved outcome." (AKS)	"impact of personal communication on information sharing seems even more significant"	"is helpful for a more harmonious integration of process between two parties."

Table 2. Observed significance of IPRs in SCI

Figure 2 shows the observed influence level of IPRs in SCI.

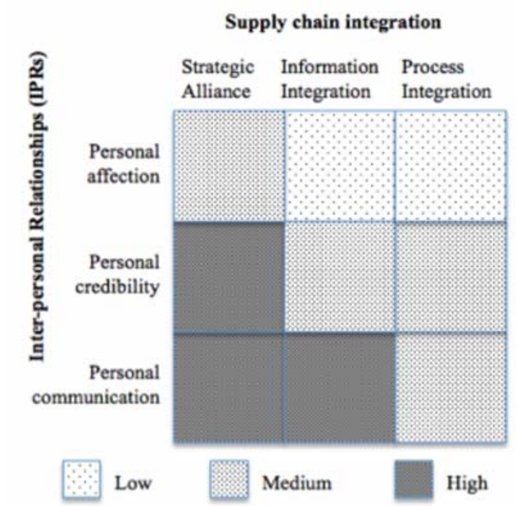

Figure 2. Observed influence of IPRs on SCI

Research proposition
The analysis indicates that IPRs can influence software supply chain integration (SSCI), although its influence on SCI is more likely to be indirect because IPRs must work through inter-organizational relationships (Wang et al., 2016). In software industry, every business customer needs a unique software solution because of differences in production procedure, organizational structure, and also available budget (Fricker, 2012). Thus, software developers or suppliers would need to provide tailor-made service for the locked customers. Our data also suggest that three dimensions of IPRs would influence SSCI differently in the dyadic integration between the direct supplier/developer and customer relationships (Keil and Carmel, 1995).

SSCI starts from strategic alliances to joined-up thinking, decision-making, and synchronized planning between a supplier and its customer (Liu et al., 2016; Pagell, 2004). It offers fast and flexible means of achieving market access, scale economies, and competence development (Larsson et al., 1998) and captures cross-business synergies to secure competitive advantage through collaboration (Narasimhan and Nair, 2005). However, the long-term collaboration strategic alliances between the supplier and customer (Prajogo and Olhager, 2012) starts from the interactions of relevant individuals. Personal affection, the intangible subjective resource, can affect the individuals' willingness and attitude (Leung et al., 2005) of whether or not to start the interaction after selecting and contacting a potential business partner's representative. Moreover, personal affection can provide the flexibility to manage changing market conditions and create strong tie between personnel of the supply chain partner (Leung et al., 2005). This flexibility is highly important for managing software supply chain activities. Because of high unpredictable and risky process as well as short life cycle of software product/system development (Weng and McClurg, 2003; Xu and Brinkkemper, 2007), software supply chain integration also has high uncertainty, which increases the uncertainty of subjective personal affection. Thus, software supply chain must response quickly with great flexibility to adapt to the changing market (Ron Basu and Wright, 2008). Because of the inner enduring and emotional commitment to others (Lee and Dawes, 2005), personal affection, the invisible human feelings or likings, can affect the willingness and attitude to further influence information sharing level, contents, frequency, and accuracy, as well as the knowledge transfer and exchange, software product development, delivery, and services during the process integration. Therefore, based on the above discussion, we propose that in the software supply chain:

P1a. Personal affection influences SCI as an initiator

Personal credibility refers to a person's quality to be trusted in the business (Barnes et al., 2015). It can be intrinsically character-based credibility or reliability-based credibility, corresponding to the classification of character-based trust or reliability-based trust (Bowersox et al., 2010). Because software products are technology-intensive and knowledge-based (Lytras & de Pablos, 2011), only suppliers with professional and skilled experts can develop the requisite product and service systems. As a result, reliability-based personal credibility is the fundamental requirement in strategic alliance, information sharing, and process integration. Furthermore, it is highly unpredictable and risky to develop software products or systems in a high competitive market (Xu and Brinkkemper, 2007) and it needs long-term investment and effort. Therefore, without reliability-based personal credibility, the representatives of business partners would be difficult to develop trust and confidence during the SCI process (Luo, 2007). That is the reason our two software chain members convince customers or are convinced by suppliers by showing their successful experiences. Thus, personal credibility influences SCIs in two ways: good historical credibility resources in this industry can open the door for further interactions, while inferior credibility resources can instead hinder SCI. Therefore, we propose that in the software supply chain:

P1b. Personal credibility influences SCI as a gatekeeper

Because supplier-customer boundary individuals have dual identities at both personal and firm levels, open and frequent personal communication can lead to familiarity, mutual understanding (Pearce and Robinson, 2000), and harmony (Ring and Van de Ven, 1994) between individuals as well as supply chain partners. The dual identities of individuals can make the two level relationships to interact with each other, leading to greater longevity of inter-organizational relationships (Barnes et al., 2015). Personal communication, as a tool resource, can exchange information resources between suppliers and customers during integration process (Pearce and Robinson, 2000). Since software supply chain integration is undertaken in a highly risky, competitive, and costly environment (Ron Basu and Wright, 2008; Xu and Brinkkemper, 2007), personal communication can improve strategic alliances by investigating industry trends, understanding of developing strategy, selecting management information system, production and marketing plan. In terms of information integration, personal communication can exchange supplier's capability, customer's requirements, and software solutions proceeding. Regarding to process integration, personal communication can track the process, discuss questions, adjust developing schedules, and solve problems. Inter-organizational communication can promote strategic collaboration between firms (Paulraj et al., 2008). Compared with formal, bureaucratic, complex, time-consuming, and working time-confined organizational communication (Ashcraft, 2006; Diesner et al., 2005), personal communication can be more efficient and effective to facilitate SCI because it is more flexible, direct, and simple without strict time-confined. Thus we propose in software supply chain:

P1c. Personal communication influences SCI as a facilitator

Our case analysis indicates that the role of IPRs in SCI has been affected in the Internet environment. Personal affection is regarded as an important part of social tie (Merrilees and Miller, 1999) and closely related to the personal interactions (Vaquera and Kao, 2005). The Internet, however, has extended informational and interactive capabilities, and served as functional alternative to the face-to-face interactions (Papacharissi and Rubin, 2000), thus the Internet has contributed to the increasing interpersonal isolation (Hampton et al, 2011) which affects the maintenance of personal affection. Personal affection accompanying with physical contact becomes luxury when individuals are alienated from each other (Hampton et al, 2011) when they rely on the Internet and related handset applications to achieve efficient and effective communication (Want et al., 2015). Meanwhile, the Internet provides abound personal profile information including personal background, position, responsibilities, and other historical experience and achievements and the related source credibility in the companies (Park et al., 2014). Because the personal profile information can be self-disclosed or disclosed in the Internet by the companies or supply chain network partners (e.g. customers) or even people themselves, the assessment of full personal credibility may take longer term (Greenberg et al, 2013). Furthermore, the disclosed personal credibility in the Internet can be both beneficial and risky: if a given entity's reputation is found to be excellent, a fruitful relationship is more likely to be formed than if that entity's reputation is found to be lacking. On the other hand, the Internet has provided new digital communication tools such as email, audio, and video software application in both computers and smartphones to facilitate the personal communication more efficiently and effectively (Want et al., 2015).

Therefore, we propose that in the software supply chain

P2a. The Internet has a negative influence on personal affection in SCI.
P2b. The Internet increases the visibility of personal credibility in SCI.
P2c. The Internet has a positive influence on personal communication in SCI.

Theoretical and practical implications

This research contributes to literature in two ways. First, prior research of supply chain integration mainly focuses on firm level relationship in terms of strategic alliance, information integration, and process integration, resulting in an overlook of SCI enablers at the individual level relationships (Gligor and Holcomb, 2013) and application-oriented research is rare. In addition, prior SCI research has mainly emphasized the popular physical supply chains, resulting in inadequate attention to software supply chains (Huo, 2012). Findings from our study contribute to the SCI literature by extending SCI from physical supply chains to software supply chains and investigating the mechanism of individual level relationships in SCI. Because software chains focus more on the direct dyadic supplier (developer) and locked customer linkages (Fricker, 2012), the individual level relationships play more significant roles in terms of strategic alliance, information sharing and process coordination. Also, our study compares the different roles of three dimensions of individual level's relationships, which complements the role of software product and service in SCI (Fricker, 2012).

Secondly, this study applies resource orchestration theory into SCI literatures in a deeper individual level. Most researchers apply resource-based view to study "what resources" a firm can use rather than "how" to deployed available resources to generate synergistic effects (Liu et al., 2016). Our study explores the characteristics of individual level relationship resources and the Internet resource embedded in software supply chains. We find that personal affection, personal credibility, and personal communication are inherently related to each other, but can be orchestrated purposely. In addition, the Internet resource also affects personal affection, credibility, and communication in different ways. Therefore, all these resources can be structured, bundled, and leveraged (Sirmon et al., 2007; Sirmon et al., 2011) to achieve superior performance in SSCI. Our study, thus, contributes resource orchestration theory in SCI in depth.

Our research also provides guidelines for managers in software supply chains to devise and apply inter-personal relationships practices to improve SCI with customers or/and suppliers. In particular, we suggest managers seriously aware the significance and characteristics of IPRs in software chains rather than rely on advanced technology and software products only. In this Internet times managers should understand the interactions and orchestration of all available resources then to make full of resources. Managers need to provide regular training in both technology and influence of new information and communication technology on people. More attention, efforts and time should be invested into developing and nurturing these relationships. Focus should be placed on individuals that enable these relationships, boundary spanners, rather than simply focusing on aggregate organizational level relationships. Also, managers should encourage more physical contact rather than online contact only with suppliers or customer, hence; we can cultivate personal affection to avoid the isolation effect from the Internet. Because of the gatekeeper role of personal credibility, managers should purposely select staff with good character-based personal credibility, also train staff to improve their reliability-based personal credibility based on their successful working experiences or cases, and carefully prepare and cumulate positive personal credibility profiles online. Considering the critical role of personal communication in SCI, personal communication skills should be cultivated based on training in order to keep frequent, direct, close personal communication in the SCI management process.

Furthermore, our findings also suggest that information and communication technology (ICT) tools are able to create more responsive business approaches in the Internet and mobile environment, but these ICT tools are secondary to personal contacts from a relationship perspective. Views from management executives and boundary spanners regarding the roles of ICT tools differ, depending on their positions within a company.

Conclusions, implications and future research

We have highlighted the role of IPRs on SSCI. The findings reveal that SCI facilitates personal communication, simultaneously alienates personal affection, and plays a neutral role on personal credibility in the Internet environment. More importantly, although IPRs indirectly affect SCI, three dimensions of IPRs influence SCI differently: personal affection acts as an initiator, and personal credibility works as a "gate-keeper" to strengthen the confidence of interactive partners, while personal communication, a facilitator in SCI, plays more important role in SCI than personal affection and credibility.

Although this research makes significant theoretical and practical contributions, it has limitations that wait for future studies. First, this study uses exploratory case study approach and data were collected from two software supply chains in New Zealand. This cannot reflect the full picture of the role of IPRs in SSCI in New Zealand, or even other part of the world. On the other hand, the software industry has its special characteristics and backgrounds and cannot reflect the general SCI situation. In addition, the analysis is mainly based on qualitative data. In fact, the relationship between IPRs and SSCI is complex so large scale surveys are needed to quantify the research results. Second, IPRs indirectly influence SCI mediated by inter-organizational level relationships (Wang et al., 2016), therefore, the interaction between IPRs and inter-organizational relationships in SCI has to be investigated. Meanwhile, resource orchestration theory studies the breadth (across the scope of the firm), depth (across levels of the firm), and life cycle (at various stages of firm maturity) (Sirmon et al., 2011), thus, it is necessary to explore the interaction between the two level relationships across the scope and levels of the supply chain during both formative stage and operational stage of SCI. Future studies may apply resource orchestration theory to quantitatively examine the model in more general companies in a variety of industries.

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INFLUENCES OF INFORMATION SHARING ON AIRPORT SUSTAINABILTIY DEVELOPMENT

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ABSTRACT

Purpose: This paper aims to explore contributions of information and knowledge sharing to establish long-term collaboration between airport stakeholders and ultimately to develop an airport in a sustainable way.

Design/methodology/approach: exploratory research is considered as the fundamental research method for this study as there are insufficient study discovering an importance of knowledge sharing and stakeholder engaging on balancing economic, social and environment benefits of airports. Focus group and questionnaire are used for collecting data from perspectives of stakeholders and airport operators. The data collected are then analysed on the basis of descriptive statistical analysis.

Findings: there are wide varieties of stakeholders involved in running an airport. Sharing information owned by each party is important for operating aircrafts and handling passenger and cargo in timely and safely manner. This shared information is crucial for the airport operator in designing the development plan of airside and landside infrastructures with less impacts on environment and communities surrounded the airport. It will also enable the airport to successfully cooperate the stakeholders in the daily operations and also to develop long-term collaboration. It is crucial for the airport to monitor this sustainable development in the three aspects of economic, environment and social. However, the study find that economic benefits seems to be the prime performance dimension of airports in Thailand.

Research limitations/implications (if applicable**):** the findings of research shows that a sustainable quality system is considered as a critical success factor for an airport to sustain its economic development with less impacts on environment and communities around the airport.

Originality/value: Although there are numbers of research focusing on airport planning and developing, there are gaps in integrating environmental and social considerations into the airport development plan. Moreover, contributing factors especially for airports in Thailand in effectively carrying out these three combinations seems to be insufficient.

Keywords: Airport, Sustainability development, Information and knowledge sharing

Introduction

There are many stakeholder group with divergent goals that contribute a success of airport development. They also required the airport to provide daily services in a timely and safely manner. It is vital for the airport to initially understand the stakeholders' needs and then to align those with the airport strategic directions. The airport has a strong intention to engage the stakeholders from operations to corporate level. It always encounters with challenging: identifying who the right stakeholders are, planning how to encourage those to get involve and sustaining the level of stakeholder involvement. Sharing and exchanging information is considered as a key factor to develop the win-win collaboration with trustworthiness of between the airport and stakeholders. However, they usually are reluctant in doing so as the information shared might be treated unconfidential which will affect their competitive advantage {Klievink, 2012 #34}.

This study aims to exploring a relationship of information sharing and stakeholder engaging form the perspective of airports. It also examines performance measurement for monitoring the progress of stakeholder engagement. This result in an improvement of operations and economic benefits of the airport with deliberately protecting environmental surroundings and promoting community advantages.

Airport sustainability.

Sustainability is currently recognized as one of the key research themes especially related to contemporary transport problems not only in Western world but also in Eastern world. In the context of Thailand, sustainability is one of the national development target clearly identified in the 12th National Economic and Social Development Plan {Office of the National Economic and Social Development Board, 2017 #35}. Sustainable development is defined as the maintenance of important environmental functions for present and future generations {Ekins, 1998 #36}. It also refers to the development that meets the three fundamental needs which are environmental, social and economic {Transportation Research Board, 2011 #37}. However, in practice, these needs may not be mutually supporting and their integration may involve trade-off.

The air transport sector has been increasingly emphasizing on the environmental agendas as a result of the growing air traffic. As one of the key steering members, airports contributes to economics of the nation they serve. Under complex and dynamic situations, the airports focus on how they efficiently provided services on a daily basis and also on how they sustainably expand their business without compromising safety and environmental impacts. Moreover, they provide services to various groups of customers and also interacts with numbers of stakeholders which all have varying performance requirements.

According to Airport Cooperative Research Program (ACRP), airport sustainability is defined as "practices that ensure: protection of the environment, including conservation of natural resources" {Berry, 2008 #38}. It also ensures the high and stable levels of economic growth and involves the social progress which include not only airport itself but also the public. {Knudsen, 2004 #39@@author-year} illustrates that airport sustainability aims to minimizing input of resources and output of impacts while maximizing social and economic benefits. As a result, it is a challenge for the airport to determine how to balance its business needs, stakeholder concerns and environmental impacts.

An integration of stakeholder needs into the airport development plan, also known as airport master plan, is required as inputs to design and prioritise sustainable measures. Informing, consulting and engaging with wide range of stakeholders is considered as key success factors in designing the airport master plan. The planning document is also used for facilitating communication and participation of the stakeholders {Department for Transport, 2004 #40}.

Once the mutual collaboration with the stakeholders is established, the airport seeks the way to keep the relationship continue as it is. Sustainability assessment is seen as one method to indicate the progress of airport sustainability. It requires the airport to measure inputs required for operating airports and also outputs as a result or the airport operations {Upham, 2005 #41}. These sustainable measurement is developed on the perspectives of economic, social and environmental concerns.

Airport stakeholders

{Burger, 2006 #43@@author-year} defines stakeholders as a group or individual who have either an interest in the issues surrounding an organization or an ability to influence those issues. From a perspective of airport, stakeholders involve those who concerns about the impact of air transport business upon the local and global environments, particularly with regard to local air quality, noise abatement and waste treatment {Rawaon, 2012 #42}.

In addition, the influence of stakeholders on airport operation and development is continually increasing. Therefore, the airport recognizes the impact of stakeholder engagement is vital for its future development. Figure 6 displays a framework of stakeholder engagement particularly for the air transport sector {Amaeshi, 2006 #44}.

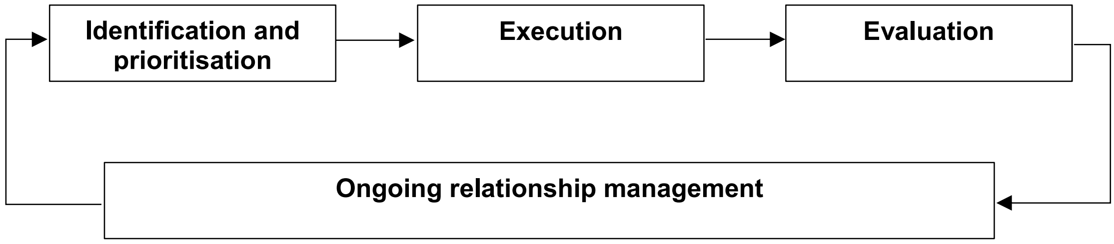

Figure 6: Stakeholder engagement framework {Amaeshi, 2006 #44}

For effective engagement, it is important to be clear who should be engaged, why, and how, before starting the activities. The first step of stakeholder engagement is to identify who the project stakeholders are. The airport design how to develop a collaboration with each group of stakeholders identified. This include a determination of participation and communication activities. To improve the engagement, the airport evaluates the activities carried out regarding to their objectives and goals. This results in a continuity of stakeholder involvement in airport sustainability development.

With the framework above, a variety of communication channels used for sharing information and exchanging information is vital for an airport to establish the mutual relationship with the stakeholders {Rawaon, 2012 #42}. The airport uses a range of participatory methods to communicate with stakeholders, including formal and informal media {Hooper, 2003 #45}. The difference of methods used for a wide range of stakeholder groups result in better willingness of stakeholder in sharing information related.

Research method

This study is designed and conducted based on exploratory research discipline as there are limited research illustrating how information sharing has a crucial impact on engaging stakeholders of airports. It also examines performance measurement suited for the airports in identifying and monitoring the involvement level of stakeholders.

There are two techniques used for collecting data. Firstly, 4 airport case studies were developed and shown in this paper. Focus group meetings were carried out to bring airport operators and stakeholders altogether for a discussion about the first research questions addressed above. The data collected was analyzed on the basis of descriptive data analysis regarding to the stakeholder engagement framework.

In addition, survey was utilized for collecting data relating to sustainable performance measurement of the four case studies from the perspectives of airport management. The data collected was analysed based on the descriptive statistical analysis.

Data sharing :stakeholder identifying and engaging

There are a wide range of stakeholders involving in running airports. They include for example airlines, ground service providers, airport staffs, passengers, public transport operators and concessionaire providers. It is clearly understood that the airports are unable to utilize the same communication approaches to engage with all stakeholders. {Klievink, 2012 #34@@author-year} explained that although information sharing is known as a key factor for engaging stakeholders, it is more important to understand what the right information are to be shared with the right stakeholders at the right time with the right techniques. As a result, the airport stakeholders are categorized into 4 groups regarding to two attributes as shown in the figure below. The first one is expertise which defines as knowledge and experience of the stakeholders in sustainability development. The next attribute is willingness of stakeholders in participating with the airports in optimizing the economic and social benefits with less environmental impacts.

Based on the two attributes, the stakeholders of the four case studies selected are grouped as shown in Figure 7. It shows that 52% of the airport stakeholders are prefer only to receive information from the airports. This implies that they seem not to be ready for exchanging information related to the airport sustainability development. Meanwhile, there is 34% of the stakeholders who have a readiness and willingness in exchanging the information and knowledge important for leading the airports to be greener. The airports recognize that 14% of the stakeholders are in the middle of the first two groups: 6% of them are knowledgeable but not happy to share with others and 8% are full of willingness in sharing but still lack of information useful for sharing.

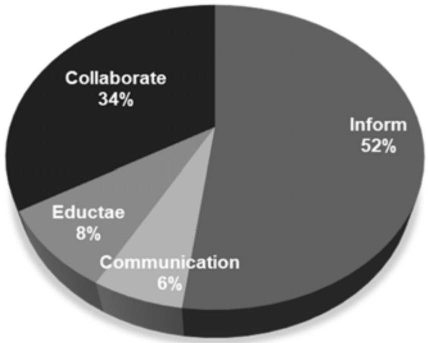

Figure 7: Average percentage of the 4 stakeholder groups of case studies

In addition, there is no relations between airport capability in terms of flight movement and passenger movement and proportion of each stakeholder group. This implies that no matter how big airports are, they can use same techniques for encouraging their stakeholders to share the information.

Table 6 shows how the four airport case studies communicate with each group of stakeholders. They all agreed that data sharing is essential at the first place in establishing the mutual relationship. They also supported that the methods used for sharing data would be the ladder for increasing the participation and influence level {Rawaon, 2012 #42}. The first level aims only for motivating the stakeholders to get involve with the airport development plan. Next, the airports expect the stakeholders to share more data, leading to knowledge sharing. Ultimately, the voice and needs of stakeholders would influence on the airport sustainability development.

Table 6: Objectives and methods of information sharing for each stakeholder groups

Stakeholder groups	**Objectives**	**Data sharing methods**
Inform	To inform stakeholders about the airport development plan to raise their awareness on sustainable development and its benefits.	• Publications • News bulletin • Public Meeting • Exhibition
Communicate	To encourage stakeholders to exchange ideas, express their interest and concerns related to the sustainability development.	• Consultation • Focus group
Educate	To provide knowledge and relevant expertise that will help them to prepare for the sustainability development.	• Consultation • Training
Collaborate	To initiate sustainable projects altogether and integrate their needs into the airport development plan.	• Forming working group • Experimental project • Partnership

Sustainability performance measurement

Figure 8 illustrates an average important score of each sustainability performance dimension from airport managerial views. Service quality is mostly concerned from the managers of four airport cases while environmental impacts is less considered. Nonetheless, service quality performance does not seem to directly relate to societal benefits as it focuses only on services provided to stakeholders who directly involve aircraft operations at the airport. It includes for example aircraft gate departure delay, aircraft taxi departure delay and baggage delivery time. There is no performance measure to indicate benefits and advantages provided to community surrounded the airports. In addition, the airport manager explained that the airports recognize corporate social responsibility (CSR) activities as important method to engaging the community. Nonetheless, there is no performance indicators to show the progress of community engagement level.

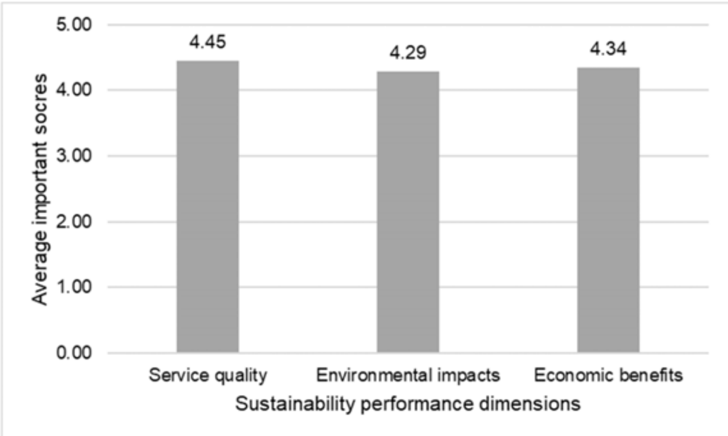

Figure 8: Average important score of sustainability performance dimensions

Moreover, environmental performance has been viewed with less differences from perspectives of the four case studies as shown in Figure 9. This reflects from the fact that the airports tend to comply with relevant statutory requirements. {Upham, 2001 #46@@author-year} stated that UK and European airports emphasise to monitor environmental impacts only to meet the legitimacy. However, from perspectives of sustainability development, airports would put more efforts to deliberately protect environment by reducing wastes as a result of airport operations.

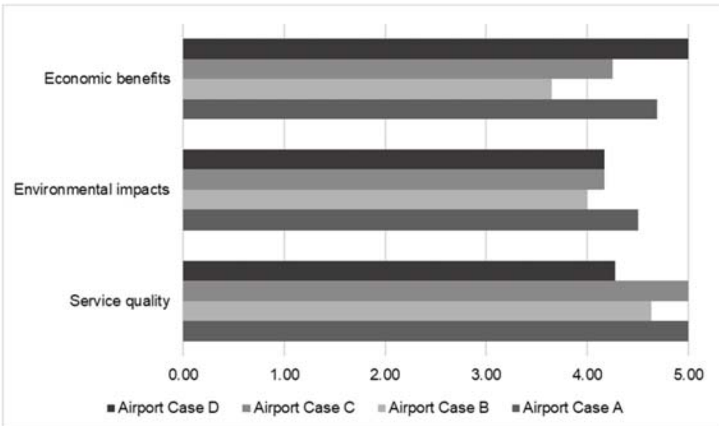

Figure 9: Sustainability performance dimensions from the views of 4 airport case studies

To monitor the participation level of stakeholders, an airport would require not only sustainability performance indictor but also an assessment of engagement activities done regarding to the objectivities. In doing so, data sharing between the airport and stakeholders seems to be a base requirement.

Conclusion

An optimization of economic, social and environmental benefits are the fundamental principles for airport sustainability development, which is similar to other transportation modes. It is clearly shown that the stakeholder needs are important for the airports in constructing the development plan. As such, engagement activities need to be establish for sharing and exchanging relevant information. This is also used for raising the stakeholders' awareness about benefits of sustainability development. In addition, to ensure the mutual collaboration, the airports determine performance measurement in at least three aspects. They are economic, environment and social impacts. From the four case studies, it shows that performance indicators of social impacts might not be sufficient. Corporate social responsibility activities might be used as supplemental methods. In addition, the airports tend to monitor the environmental impacts only to meet relevant statutory requirements.

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INVESTIGATING ENABLERS AND BARRIERS TO GREEN LOGISTICS SERVICE QUALITY

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Introduction

Companies have become increasingly interested in logistics service quality and green issues, and these issues may become trade barriers for developing countries competing with global rivals. The characteristics of companies and other factors may either be enablers or barriers in improving logistics service quality with attendant green credentials. Therefore, it is useful for academia and companies to know what the drivers or/and barriers are for green logistics service quality. The purpose of this paper is to systematically review the literature and present a proposed research agenda to explore these issues. Furthermore, this paper will propose a set of enablers and barriers to green logistics service quality in the context of the logistics industry.

Only one main research question of this paper is what are enablers and barrier to be a green logistics. This paper starts at the literature review by addressing the question of how to have the competitive advantages in the logistics industry and why green logistics service quality appears an importance for having the competitive advantages. This is followed by the methodology, where the systematic literature review (SLR) used for this paper is described. A set of enablers and barriers are presented in the conclusions.

Theoretical Background

Competitive advantages in the logistics industry

Christensen (2010) argued that companies produce the products/goods which are differentiated from other products in response to customers' needs. To create a new product for serving such needs, companies need to know to whom they will sell their products and what their products are including the positioning of the company in the market. Getting the right positioning in the market will help companies have a competitive advantage from their rivals. This is in the line with Potter who stated that companies want to have a competitive advantage compared to their competitors and that their products/goods need to be differentiated from others (Chaisurayakarn, 2015; Christensen, 2010; Shamma and Hassan, 2013). Porter identified three generic competitive strategies as: differentiation, cost leadership, and focus based on the issues of competition and barriers to market entry. Customer needs will be derived from customer pressure, for example firms will focus on environmental issues when customers demand it. Huo et al. (2008) pointed out that the external competitive environment is divided into three dimensions: local competition, international competition, and operational challenges. Moreover, they found that competitive environments force companies to select appropriate operational strategies, either low cost or differentiated products, to gain competitive advantage. Local competition and international competition mean competing in local or international markets whereas operational competition refers to operational difficulties the company faces.

Green logistics service quality

Competitive advantage affects all industries and in particular the logistics industry sector. This sector faces new challenges as customers' needs have changed due to a trend of increasing concerns about environmental issues. Regarding this increased awareness of environmental issues, logistics service providers (LSPs) are willing to make their services more environmentally friendly and to react to customer demands. However, the degree of success with which LSPs will meet these new demands depends on their capabilities, attitude and knowledge about how to develop green services (Lin and Ho, 2008). Environmental performance measurement can be a critical aspect in LSPs' environmental offering (Björklund et al., 2012). However, to be considered as having regards for environmental sustainability, companies need to focus on the triple bottom line of social, economic, and environmental factors

(Elkington, 1998). Chaisurayakarn (2015) found there is abundant research studying logistics service quality and the performance of LSPs but that there is a lack of studies focusing on green issues and logistics service quality. Furthermore, she studied green logistics service quality in Thai logistics based on the perceptions of customers and found that while green issues did not directly affect companies' performance, there were the indirect effects in the form of safety and security. This resultant of this research is founded in the similar way to the other studies published later such as the studies of Chileshe et al. (2015); Islam et al. (2017); and Thomas et al. (2016). These papers describe why the green logistics impacts to the competitive advantages and what are enablers and barriers for implementation. To make sure that the green logistics service quality is still one of the important impacts on the business' performance and what are the enablers and barriers, the systematic literature review is used as the methodology to find the connections of these keywords through the number of papers published.

Methodology

A systematic literature review was conducted by following in order to ensure that there were no bias and valid evaluation (Tranfield et al., 2003; Rousseau et al., 2008; Denyer and Tranfield, 2009). A comprehensive review of the existing bodies of literature on service quality, green logistics, barriers, and enablers was conducted beginning with a search of the ProQuest database. Key search terms (and variations thereof) for each of the areas of interest were used to examine peer reviewed journal articles published from 1997 through 2017. All journals and papers may not be accessible through periodical databases so the authors also tracked citations in identified papers to find additional works. A total of 991 papers were collected and assessed following the above process for the barriers and enablers of green logistics service quality as shown in Figure 1. Each paper was reviewed to identify the barriers and enablers of green logistics service quality.

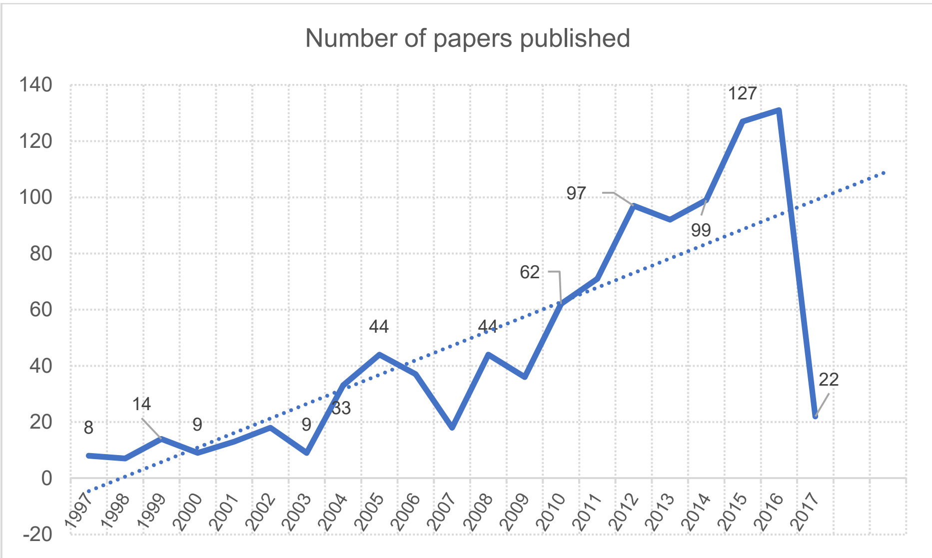

Figure 1: The number of papers with the keywords of research published in 1997-2017

As the number of references accumulated, it was found that some of them were of greater significance than others. From this broad base, a sub-set of papers dealing directly with environmental or green service quality, either from the "supply chain" or "logistics and transportation" perspective were selected. Within this sub-set, a smaller set of articles were identified that focused specifically on environmental or green service quality issues in the field of logistics and transportation activities, and only these were considered for the purposes of the present review.

However, to consider the representative journals which were considered by Melnyk et al. (2012) for assessing the state of research in green logistics service quality. The 15 selected journals were *Supply Chain Management: An International Journal* (61 papers), *International Journal of Operations & Production Management* (42 papers), *International Journal of Physical Distribution & Logistics*

Management (40 papers), *Emerald Management Reviews* (29 papers), *Journal of Economic Literature* (23 papers), *Journal of Supply Chain Management* (19 papers), *International Journal of Logistics Management* (18 papers), *Benchmarking: An International Journal* (17 papers), *Journal of Transport and Supply Chain Management* (10 papers), *Production and Operations Management* (7 papers), *European Business Review* (6 papers), *Asia Pacific Journal of Marketing & Logistics* (5 papers), *International Journal of Retail & Distribution Management* (5 papers), *European Transport Research Review* (3 papers), *International Journal of Productivity and Performance Management* (3 papers). These selected journals had huge impact factor so they were good journals for consideration. Then the papers published in these journal would be considered as one of the SLR criteria.

A total of 288 papers were assessed following the above process for the barriers and enablers of green logistics service quality as shown in Figure 2. It was found that a trend of research studying enablers and/or barriers of green logistics service quality was growing continually, particularly the last five years. This trend could divided into 3 periods as: Years 1997-2007 (the beginning of the Kyoto Protocol), Years 2008-2012 (effects of the 1st Kyoto Protocol), and Years 2013-2020 (the 2nd Kyoto commitment period). As the first period was the beginning, the concept of green logistics often focused on how to reduce costs and the number of academic papers published was rare. The number of papers continued growing from 2008 though the rate of growth was only slightly increased. Although the number of papers published in 2017 has dropped dramatically, it cannot say that the trend of green logistics will drop due to two reasons. Firstly, there are still 4 months left in 2017 so the numbers of selected papers maybe higher than this figure. Secondly, the main keywords for doing the systematic literature reviews (SLR) are barriers, enablers, green logistics, and service quality so all selected papers from the SLR will be selected from the criteria. It does not mean that green logistics service quality is out of the academic interest. On the other hands, we believe that academic attention is rising regarding barriers and enablers to green logistics because of the increase of global customer needs. Therefore, some researchers are looking for how to succeed in implementing green logistics into businesses. For each area of interest for this study, the number of paper citations was the primary criterion considered in evaluating each manuscript's contribution. After reviewing each manuscript, 22 papers were found to specifically address the topic of barriers and enablers of green logistics service quality.

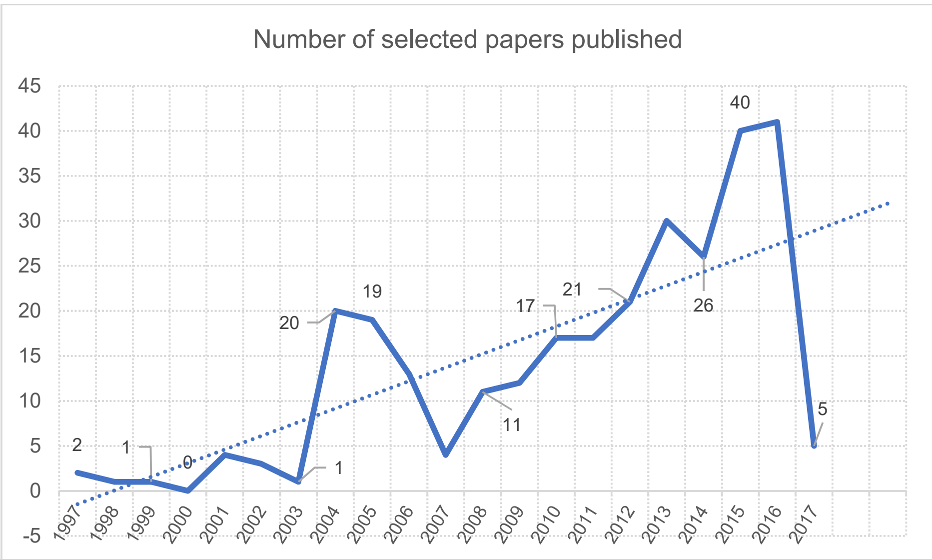

Figure 2: The number of selected papers with the keywords of research published in 1997-2017

Findings
Barriers
A set of barriers of green logistics service quality have been investigated through the reviews as shown in Table 1 below.

Barriers	Authors
Organisational culture	Chileshe et al. (2015), Gorane and Kant (2016)
Lack of companies' awareness	Chileshe et al. (2015), Gorane and Kant (2016), Mejías et al. (2016)
high upfront costs implementation	Chileshe et al. (2015), Gorane and Kant (2016), Thomas et al. (2016)
Environmental standardisation	Chileshe et al. (2015), Mejías et al. (2016), Mollenkopf et al. (2010), Rauer and Kaufmann (2015)

Table 1: Barriers to green logistics service providers

Trend of globalisation on the green issue drives most of multi-nationality companies (MNCs) to concern about the green issue. This includes to all operational functions. Logistics activities as a part of the outbound functions are affected by the green issues particularly in the green service quality. MNCs seem to follow the mission, vision and strategies from the head quarter of the companies, with regarding to the green or sustainability concern which is driven from the end of customers, one of their strategies is to be a green supply chain. To achieve this target strategy, the requirements or needs which MNCs ask LSPs to deliver their goods or products are to reduce CO_2 emission or increase the efficiency of transportation activity. The organisation culture comes from the nationality of companies (Chileshe et al., 2015; Gorane and Kant, 2016). There are differences of the companies' policies between Eastern companies and Western companies. It is seen from a company's awareness on environmental issues as well. It is often seen that the Eastern logistics firms are concerning to green issues less than the Western logistics companies. These different policies and awareness can be a barrier to green logistics service quality (Chileshe et al., 2015; Gorane and Kant, 2016; Mejías et al., 2016).

In term of the barriers to green logistics service quality, it cannot deny that the upfront costs is always pointed at one of the early barriers though it will be cost effectiveness in the long-term. Huo et al. (2008) identified that companies should form an appropriate operational strategic response, either through low cost or differentiation emphasis, to gain competitive advantage and complete to their rivals. Cost and service selection determinants such as transit time, reliability, capability, and security are initially cited as key considerations when choosing LSPs. Although costs is one of important barriers to block the implement of the environmental logistics service quality in LSPs' operations, it seems much less important to decisions when customers require a high environmental service quality (Bardi et al., 1989; Kent and Parker, 1999; Voss et al., 2006; Meixell and Norbis, 2008). The studies of Chileshe et al. (2015), Gorane and Kant (2016) addressed that high upfront costs to implement the green service quality in logistics industry was one of main barriers as same as a study of Thomas et al. (2016).

Last but not least, the environmental standardisation plays the key barriers to green logistics service quality though the standardisation will help company to complete with other rivals. Mollenkopf et al. (2010) found that one of the key common global metrics for environmental initiatives is the International Organisation for Standardisation (ISO) 14000 series. Most of global companies will require the procedures to identify all environmental aspects of the operations, safe handling and disposal procedures for hazardous materials including the compliance with environmental legislation. In the line with a study of Thomas et al. (2016), it was found that service providers who operate in more environmentally services are more likely to be selected and trusted by the partners. Environmental standardisation seems to be a barrier when company does not apply it as well as an enable whether company have an ISO 14000 certification (Chileshe et al., 2015; Mejías et al., 2016; Mollenkopf et al., 2010; Rauer and Kaufmann, 2015).

Enablers
A set of enable initiatives to green logistics service quality was also built from the 22 relevant selected papers. All similarly enable items are grouped and set as one initiative as seen in Table 2 below.

Enablers	**Authors**
Company's nationality & size	Islam et al. (2017), Mejías et al. (2016), Punyapon and Natsapan (2016)
Technology	Islam et al. (2017), Gorane and Kant (2016), Mejías et al. (2016), Punyapon and Natsapan (2016)
Product differentiate or customers' awareness	Chileshe et al. (2015), Chin-Chun et al. (2013), Martinsen and Björklund (2012), Mollenkopf et al. (2010), Rauer and Kaufmann (2015), Thomas et al. (2016)
Government regulations	Chileshe et al. (2015), Gorane and Kant (2016), Mejías et al. (2016)
Cost effectiveness in long-term period	Chileshe et al. (2015), Rauer and Kaufmann (2015)
Competitive pressures	Chin-Chun et al. (2013)

Table 2: Enablers to green logistics service providers

Although it is seen that the organisation culture is one of key barriers for companies to green logistics service quality, the company's nationality and its size seem to play an important role in the implementation of green logistics service quality. To implementing the green service quality, logistics service providers need to have a huge investment capital. This point seems an obstacle of a small and medium companies as they have a lot of improvement projects to do and it may not the first priority to do (Islam et al., 2017; Mejías et al., 2016; Punyapon and Natsapan, 2016). For instance, most SMEs choose to improve their operational processes rather than investing a huge money to do the green services (Chaisurayakarn, 2015).

As noted in the previous section, most Western logistics companies have paid more attention to environmental issues than Eastern logistics companies. This may stem from the trend of globalisation on green issues where most Western customers are concerned about green issues. Some researchers address that service providers have a responsibility to satisfy customer demand, and that providers need to integrate customers' requirements and expectations in the services offering. Lin and Ho (2008) stated that the product and service offering indicated the importance of early customer involvement in the development to understand the customers' demand to help them create a value-added product/service. It is seen that LSPs have begun taking action by offering the different kinds of green services, for example DHL have the promotions of "Go green" and the calculations of environmental impact (Lin and Ho, 2008). In the line with the studies of Mollenkopf et al. (2010) and Rauer and Kaufmann (2015), stakeholders put the pressure to organisation to be more environmentally and to integrate environmental management into the processes and corporate strategies.

Regarding to the previous section on the barriers to green logistics service quality, the upfront costs for the implementation is one of the barriers when companies need to invest or implement the green service. However, it seems much more important for making a long-term decisions when customers require a high environmental service quality (Bardi et al., 1989; Kent and Parker, 1999; Voss et al., 2006; Meixell and Norbis, 2008). Companies' environmental supply chain practices positively affect their competitive advantage and lead to improved market-based, operational based, and accounting-based forms of their performance (Golicic and Smith, 2013). When looking at organisations implementing environmentally sustainable logistics services may be able to achieve long-term competitive advantage, they can gain the competitive advantage from cost effectiveness (Mejías et al., 2016).

In globalisation, companies have to make a decision depending on economic factors as same as other factors such as government regulation, environmental and social impacts or community perceptions (Mejías et al., 2016). However, the upfront costs for the implementation is always the beginning of the barriers to green logistics services for companies. Some companies can start with the environmental services and complete with other international firms because of the government supports and government regulations. It is seen from the past the national policies almost lead the direction of industry in particular the developing countries such as Thailand. To reduce the obstacle of huge upfront costs investment, the government and policymakers should be facilitating incentives to companies in term of building the green logistics (Chileshe et al., 2015; Gorane and Kant, 2016; Mejías et al., 2016). The low environmental standard of small logistics service companies may affect the performance and image of large firms in the same supply chain. Moreover, the increasing pressure, new environmental legislation, and influence of the dominant actors in the value chain, has led to a growing environmental awareness among consumers in many countries (Kim and Choi, 2013). The studies of Rauer and Kaufmann (2015); Lee (2011); and Yang and Rivers (2009) stated that multiple and different environmental rules and government regulations generally create difficulties for developing countries to impose high environmental logistics standards on their processes. However, the demand from customers and the competitive pressures in the market may lead firms to build up their green logistics service quality to complete with the rivals and find a way to survive in the market (Chin-Chun et al., 2013).

Conclusions

The review presented in this paper involved 22 research contributions on the enablers and barriers of environmental or green service quality in logistics and transportation published between 1997 and 2017. The papers were analysed in terms of their main characteristics (e.g. year of publication, journal title, regions addressed, and research method(s) adopted) and content. This review has shown that a number of important areas are under-represented. It was found that there were a small attention research in the drivers and barriers of green service quality in logistics sector. After reviewing each manuscript, a set of drivers and barriers of green logistics service quality has been suggested. A set of enablers composes of company's citizen and size; technology; product differentiate or customers' awareness; government regulations; cost effectiveness in long-term; and competitive pressures whereas a set of barriers comprises of organisational culture; lack of company's awareness; high upfront costs implementation; and environmental standardisation.

The paper investigates the enablers and barriers to green logistics service quality and the resultant proposed research agenda combined with a green logistics service quality framework should help practitioners understand what are the important drivers and obstacles to achieving better performance in these areas. Regarding to Table 1 and 2, it can say that there are 2 types of factors as internal factors and external factors to be either enablers or barriers to green logistics service quality. Internal factors are the factors which companies can manage, change and control by itself such as organisational culture, lack of companies' awareness, cost of implementation, processes effectiveness whereas external factors will be affected by the external aspects and companies cannot control them such as customers' awareness, government regulations, and competitive pressures. These internal factors presents which barriers or enablers that companies should focus whether they want to be green logistics service quality. On another hands, the external factors will show companies on how importance of these factors they have to pay attentions to complete their competitors.

Moreover, we cannot deny that government regulations always play an important role for businesses to implement green logistics or not in particular the developing countries, government can help businesses to implement green logistics by supporting knowledge on how to be a green or give an intensive for businesses which implement a green logistics on their businesses. From the SLR, we present a set of internal factors (barriers and enablers) for businesses what they have to do whether they want to be green logistics. While a set of external factors (barriers and enablers) will present which external pressures will affect to businesses for implementing the green logistics. It cannot deny that customers' awareness and competitive pressures are key aspects to push businesses to implement green logistics. This paper only discusses a systematic literature review and provides a research agenda, and thus does not feature any empirical research. Therefore, to confirm a set of enablers and barriers of green service quality in logistics industry, the empirical research is suggested into the future research.

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LOGISTICS PERFORMANCE OF HANOI: ASSESSMENT AND RECOMMENDATIONS

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ABSTRACT
Purpose: The purpose of this paper is to present and analyse the logistics performance in Hanoi and barriers in improving the current status. This is supported by the assessment of the logistics system of representative firms in major fields and in critical areas. The criteria to evaluate (Grant *et al.*, 2015) are logistics-related dimensions that have profound impacts on logistics performance as well as trade. Furthermore, this paper compares the logistics performance in Hanoi with the country's LPI key dimensions and, whenever possible, provides evidence of determinants that affect to the improvement of logistics system of the city.

Methodology/ design/ approach: The paper bases on theoretical and empirical research, using data obtained from more than 250 firms who responded to the survey in 2017 on measuring logistics performance in Hanoi. The survey was designed with a view to assessing the logistics performance in Vietnam multifaceted, under the perspectives of both logistics service providers and the manufacturing and import-export firms; respondent firms differ in the type of business owner (joint stock companies, private companies, state companies, foreign companies, etc...). There has been a survey conducted by Dang Thi Thuy Hong (2015) about the logistics situation in Hanoi. However, this paper focuses thoroughly on the assessment of logistics service providers of Hanoi, thus being able to give a more precise analysis of the city's logistics performance.

Findings: Based on the research results, the paper defines the logistics performance of Hanoi and its key dimensions, identifies its pros and cons, therefore provides recommendations to effectively improve the logistics system of Hanoi.

Research limitations/ implications: Limitation is related to the availability of the required assessment data. The availability data is a reflection of systematic data collection and storage procedures of the respondent firms. The inadequate understandings in logistics field of firms that lead to the limited number of respondents also imply the research result constraints.

Originality/value: Proposed solutions and recommendations can be considered as reliable practical for both local authorities and enterprises in a common effort to improve logistics system of Hanoi.

Keywords: logistics performance, logistics system, logistics service provider, manufacturing firm, import-export firm, Hanoi, Vietnam.

INTRODUCTION

The global growing wealth of trade has led to rising national and international markets for goods and services. So as to meet the requirements of extended markets and the increase of new products and services, business has developed simultaneously in volume and in complication. In that context, the distribution of products from point-of-origin to point-of-consumption has become a massively vital component of the Gross Domestic Product (GDP). Logistics services have reformed production and distribution process, contributed to further economic integration.

According to the World Bank (2014), logistics costs in Vietnam represent 20.8% of annual GDP significantly higher than in other countries such as US, China, Thailand. Vietnam logistics is evaluated as ineffective due to deficient transport infrastructure and high logistics services costs, which badly affects competition abilities of Vietnam's trade and production sector.

In Vietnam, there are only a few studies assessing the overall logistics performance. Banomyong *et al.* (2014) implemented a study of logistics performance of manufacturing and import-export firms in Vietnam, and Grant *et al.* (2015) completed a study evaluating Vietnamese logistics service quality by exploring Vietnamese Logistics Service Quality in the run-up to AEC 2015. Though having a quite wide range of respondents from the north to the south of Vietnam (53 companies located in the North, 24 in the Middle and 82 in the South of Vietnam), the former researched particularly about manufacturing and import-export firms. The latter studied the logistics service quality, in spite of having diversified genres of respondents, including import-export companies, production and manufacturing companies, privately-owned firms, Vietnamese state-owned firms and four other types, with limited number of samples, 24 respondents. Neither of studies concentrated on logistics performance of Hanoi. Thus, recommendations are proposed in order to improve the logistics performance of manufacturing and export – import firms in Hanoi.

There is a fact that in order to propose recommendations for better logistics sector in Hanoi, what we need initially is the prevailing situation. In other words, there raised a need to implement the evaluation of the all-around logistics performance of Hanoi under a sufficient number of viewpoints from logistics firms as well as manufacturing and import-export firms.

The purpose of this paper is to present and analyse the logistics performance in Hanoi and barriers in improving the current status. Furthermore, the paper compares the logistics performance in Hanoi with the country's LPI key dimensions and, whenever possible, provides evidence of determinants that affect to the improvement of logistics system of the city.

The paper is divided into 4 main sections. First, the literature review is presented. In the second part, the methodology section explains the data collection and the framework for logistics performance assessment. The findings from the study is then discussed. Finally, the recommendations and conclusions are withdrawn.

LITERATURE REVIEW

Based on the comprehensive understanding of the real situation of a geographical area (Mekong Subregion) logistics system, Banomyong (2014) evaluated four logistics related dimensions, namely (1) shippers, traders and consignees; (2) public and private sector logistics service providers; (3) national institutions, policies, and rules; and (4) transport and communications infrastructure. These four logistics-related dimensions are used inter-linked so as that the overall capability of the logistics systems is determined regarding the system performance and capability (Banomyong, 2008). The study has concluded that GMS countries are still at the early development stage in terms of four mentioned logistics dimensions, and they still require extensive infrastructure and corporate development to bolster their competitiveness in the global market.

Banomyong, Huong and Ha (2014) utilised the framework based on 9 key logistics activities proposed by Grant *et al.* (2006) with the usage of three performance dimensions, namely cost, time and reliability to measure enterprises logistics performance. Derived from that, a five-page questionnaire survey was designed. It was discovered that three factors which mainly affect Vietnamese manufacturing and export-import companies are transportation, warehousing, and inventory carrying costs. Limitation regarding the logistics performance assessment research in Vietnam as well as the limitation in the sampling creates the urge to conduct another study with an end of evaluating the logistics performance of Vietnam through a larger number of respondents.

Grant, Huong, and Lalwani (2015) generated a set of fourteen variables containing eight factors or variables derived as Banomyong, Huong and Ha (2014) antecedents and six remaining factors were used in determining LPI (Arvis *et al*., 2014) and carried out the survey to determine which factors are most important to customers as well as service providers in Vietnam regarding factors having profound impact on logistics service quality. The research came to the conclusion that seven logistics service quality variables of costs, the efficiency of customs and border clearance, ease of arranging shipments, quality of logistics services, employee skills, timeliness and reliability are the most important factors to the respondent group. However, the number of responses is 30, 24 logistics “actors” and 6 external stakeholders, which is a limitation of the work. The variables need confirming and validating by a wider sample of logistics actors and external stakeholders. In that scenario, it will be more likely and validate for the observation to be generalized for the population.

Dang Thi Thuy Hong (2015) conducted a survey about the logistics situation in Hanoi and proposed solutions to develop the logistics system in the city in relation to promoting economic development in a stable way for the period from present to 2030. Nevertheless, this research concentrated chiefly on manufacturing and import-export firms, thus was not able to give an adequate view of logistics performance under LSPs’ perspectives.

The World Bank provided another national logistics capability measure, the Logistics Performance Index (LPI). LPI is a weighted average of individual country over more than 150 countries, taking into consideration six dimensions: clearance process efficiency, trade and transport related infrastructure quality, arranging competitively priced shipments capability, logistics services quality and competence, track and trace consignment ease and the timeliness of delivery within an expected shipping schedule. Germany held their top position from 2014 with a score of 4.23/5.0 in 2016. Vietnam was ranked 64th with a score of 2.98, a downhill sign from the 48th in 2014 (World Bank, 2016).

However, these studies did not focus thoroughly on the assessment of logistics providers of Hanoi, therefore, could not provide a precise analysis of the city’s logistics performance.

METHODOLOGY

In order to obtain the research objective, a framework based on Grant, Huong and Lalwani (2015) is developed. A set of criteria for logistics performance assessment are as below:

- -infrastructure: firm infrastructure, commercial infrastructure, transport infrastructure
- -service quality
- -institutional framework: regulations, policies
- -human resource
- -custom
- -shipment issue
- -trucking and tracing
- -capital access
- -cost
- -time
- -reliability

Besides, the survey was designed with a view to assessing the logistics performance in Hanoi, under the perspectives of logistics service providers, manufacturing firms and import-export firms. Respondent firms are all based in Hanoi and differ in the type of business (Private companies, joint stock companies, government companies, foreign invested companies, etc.). 251 responses were received out of 300 questionnaires sent. There were 45.2% of logistics service providers, 39.6% of import – export firms, and 15.2% of manufacturing firms responding to a total response set of 250 respondents. These respondents varied with 53.6% of limited companies, 42.4% of joint stock companies, 1.2% of private-owned firms, 0.08% of state-owned firms, and 0.04% of foreign-owned firms. 24.4% of the total 250 companies had under 20 employees, 40.8% had 21-50 employees, 28.4% had 51-100 employees, 4.8% had 101-300 employees, 0.8% had 301-500 employees, and only 0.04% had more than 500 employees. The average number of year experience for the responding firms was 7.9, ranging from 1 to 26 years.

FINDINGS

Firstly, the result received from research revealed that the level of logistics performance in Hanoi is typically uneven, which have not met the expectations and have not really facilitated the development of enterprises, as well as logistics service providers in the city. In order to visualize more clearly, a comparison of logistics performance evaluation assessed by enterprises is shown on the following factors (5: the best, 1: the worst):

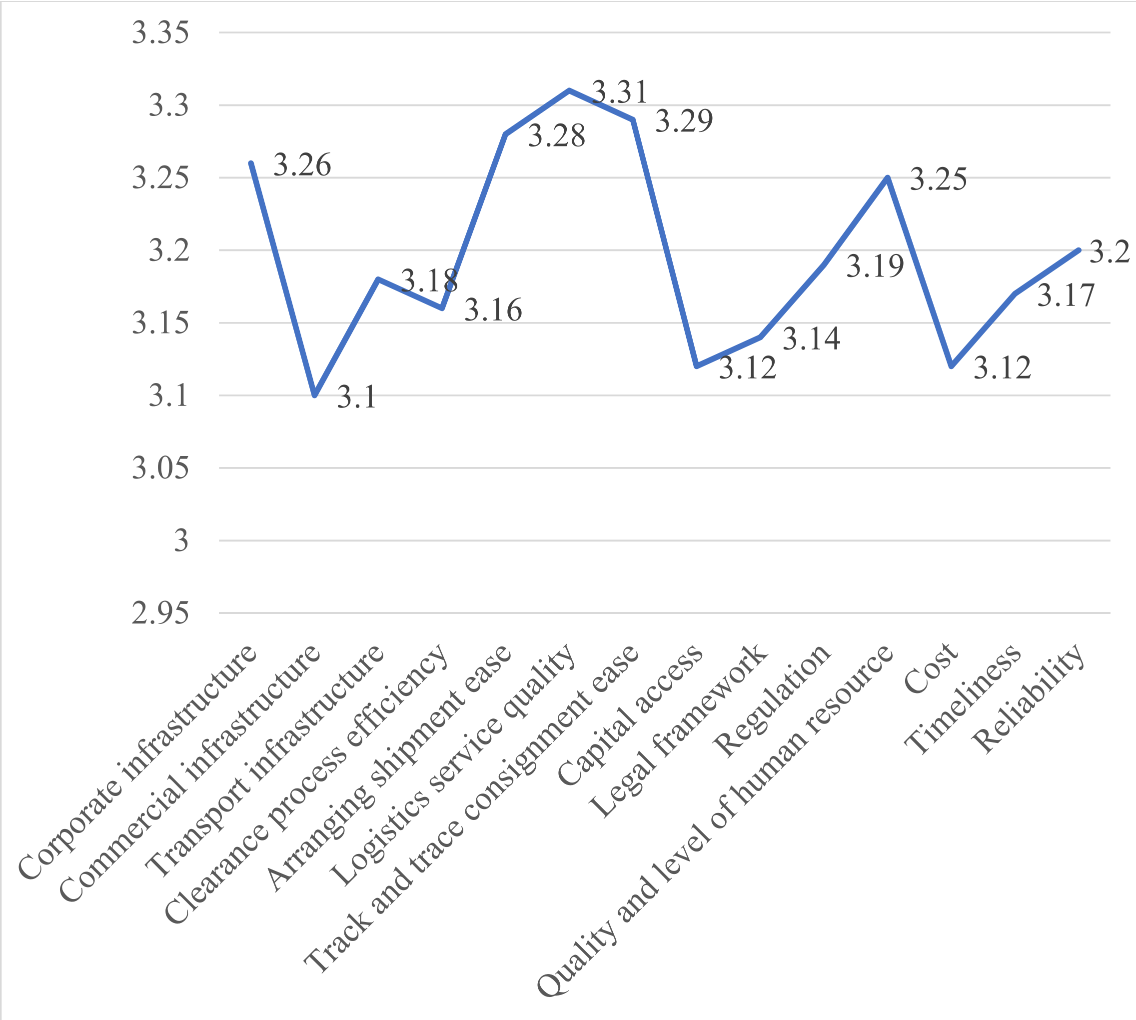

Figure 1: Logistics performance evaluation in Hanoi (Unit: point)
Source: research team

The survey results show that enterprises considered logistics service quality in Hanoi the best factor, reaching 3.31 points. In addition, the ability of tracking and tracing was also highlighted with 3.29 points. Meanwhile, the factors that enterprises in the capital of Vietnam underestimated were commercial infrastructure of Hanoi, with 3.1 points, and access to capital, as well as cost, with 3.12 points equally. The issues of customs and legal framework also need to be improved in the process of developing logistics performance of Hanoi.

The average grade for the inclusive logistics performance in Hanoi over the tenth scale is 7.31/10, which states that the current situation requires a great deal of efforts to make advancement. The good sign is that the point is over medium level, denoting that the current performance is not desperate.
Secondly, in comparison with LPI of World Bank (2016), the result is in the following figure.

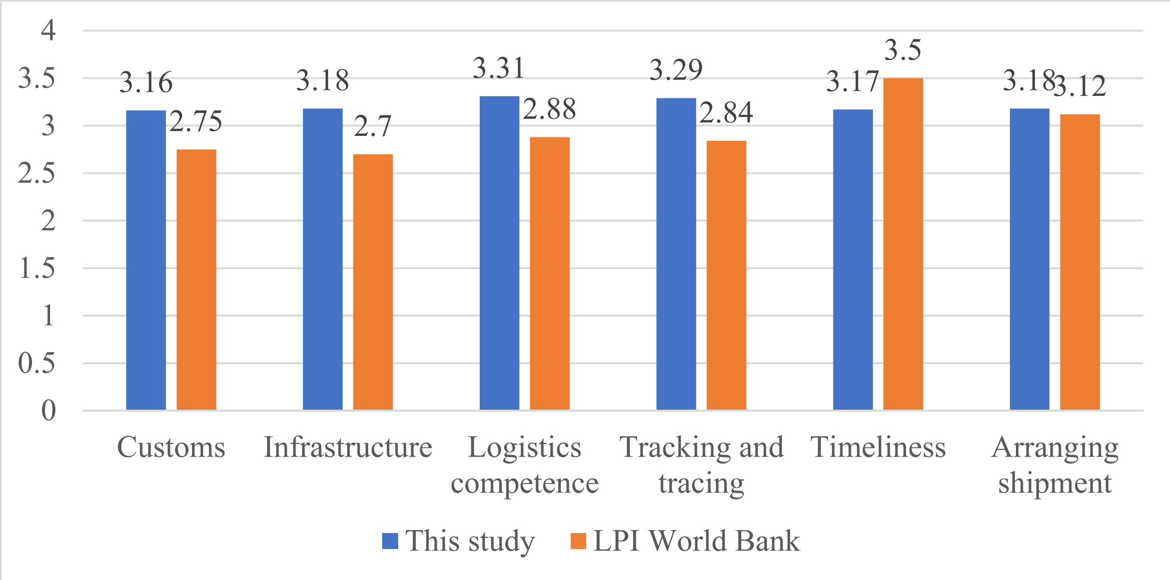

Figure 2: Comparison of survey results with LPI 2016 (Unit: point)
Source: research team

The comparison shows that Hanoi is much higher in logistics performance to whole country, except timeliness was evaluated lower. It is easy to explain the situation as Hanoi is the heart and the second economic and business centre of Vietnam. The survey resulted from the deep insights into the real situation which the city's infrastructure still does not meet the need of punctuality.

Authority role and overall evaluation

In the question asking about the possible authority support, above 70% thought there should have regular business conference and seminars, approximately 62% of the respondents thought that state authorities should have favourable policies for business activities and support commercial activities of the firms by other ways, and 56% indicated that governments could provide courses to train the human resources.

RECOMMENDATIONS AND CONCLUSIONS

Based on the result and analysis, some recommendations and conclusions could be made for government and authorities, as well as firms in order to improve the logistics performance of Hanoi.

Government and local authorities

Government and local authorities take an important role in creating favourable conditions for commercial activities to take place. They also have a vital part in the development of logistics performance of Hanoi.

Firstly, in terms of infrastructure, like other factors, government and authorities need to invest and upgrade three components, namely firm, commercial and transport infrastructure. In addition to the good infrastructure in intra-corporate, transport structure and commercial infrastructure should be invested to make the compatibility in the general infrastructure, creating the best conditions for the improvement of logistics performance.

It is necessary to have the compatibility here. First, the compatibility among the new and the ancient infrastructure is needed. Besides the modern technology used, there still exists infrastructure needed for amending. It is critical to level up the combination of updating and amending the infrastructure, in order to effectively develop the potential and capacity of the country. Second, there is a demand to have the compatibility among geographical areas along Hanoi. The issue of asymmetrical development between industrial areas, in spite of their different competitive advantages, has always been a hard question for the authority to answer for a long time. Finally, the compatibility between infrastructure and human resources is required for the even growth of both components, so that the development is certain and sustainable.

The government should consider investment focusedly and selectively. The investment should be made in projects which have the uniqueness. Besides IT application in the construction investment and operating management, attracting investment from official development assistance, domestic and international investors are worth doing. The government should also create the compatibility among all leading levels in the society so as to maximize the efficiency and minimize the costs.

Investment in IT should be highlighted and taken great attention to by both business and the government because of great advantages it could bring. The use of information, in general, would automate the process, save human and natural resources, so that we could allocate the resources more efficiently.

The authority needs to invest in IT infrastructure, create financial support so that small and medium logistics companies could invest in IT applications. Implementing a long-term IT development strategy along with a strategy for logistics development to 2020 with a 2030 orientation is necessary. The AEC leaders' policy aims “The ASEAN Single Window” to ensure the compatibility of each country's IT network with international standards, thereby linking and integrating all National Single Windows. The ultimate goal is to deliver secure, reliable electronic data, shorten product processing time and create transparency with customs procedures. Therefore, it is extremely urgent to build a comprehensive and transparent IT network linking state management agencies, customs offices, logistics enterprises and shippers.

Secondly, components in service quality need further attention, including clearance process, arranging shipments, service quality and competence, track and trace ease and capital access. The clearance process should be fastened, automated and simplified, ensuring not discouraging the logistics service providers and importer-exporter by decreasing incentives. Service quality and logistics competence should be leveraged up, ensuring the competitiveness of national business with international one by investing in infrastructure and human resources, and professionalizing as well as creating an efficient process. Track and trace ease should be highlighted, using telecommunication technology to guarantee the rights of the customers and the safety of the cargoes. One important factor is the capital access, which is the source for the investment and activity occurrence. The government should create favourable conditions for the capital flows and encourage domestic and international investments, so that domestic logistics and economic development could be beneficial from.

Furthermore, government and local authorities should promote investment in logistics infrastructure; strengthen cooperation with foreign partners to expand logistics infrastructure connection; apply advanced supply chain management model with enterprises located in the area such as garment and textile, footwear, furniture, agricultural food; encourage businesses to take the initiative and take advantage of the outsourcing of logistics services; help commercial enterprises, exporters and importers cut costs, save unnecessary investments and human resources so as to concentrate on their core business. Besides, functional agencies should create conditions on loan capital, allocate land for warehouses and yards, and at the same time, improve the system of legal documents; modernize, simplify customs procedures; listen and answer the problems of the business. The objective is to shorten clearance time, improve the quality of services for logistics enterprises in the area.

Thirdly, legal framework and policies in Vietnam, as well as Hanoi, should be simplified and united by government and authorities so that there is a limited number of documents and easing process. Investors, businesses and other parties are supposed to know which document to follow and where to find a helping hand. Taking into account the current situation of Vietnam legal framework, it will take us a long time to have a desired legal environment. However, things could definitely be achieved through short-run reviews and plans, taking place in turn of each other.

Furthermore, private and government law consultancy companies should be controlled and developed, to better support all the process. Law agencies had better complete their responsibilities to ensure that law companies operate legally and be useful to needed parties.

Last but not least, according to the survey carried out, the cities and provincial authorities should regularly organize seminar and conference to better perceive the difficulties in business, as well as create opportunities for business to have a deeper mutual understanding between partners and competitors, exchange experience and development multifacetedly. In the conferences and seminars, new regulations, international and domestic cases should be given out to discuss so that lessons and experiences would be drawn out and they could learn from each other.

In addition, it is critical for authorities to get rid of complicated administrative procedures. Instead, they could replace it with speedy and appropriated process including really crucial steps. The issuance of new law and policies or their amendment should be focused on one source to considerate, ensuring the speed and compatibility with already existed legal framework.

Recommendations for firms in Hanoi
First, companies need to see the role of IT as one of the factors which create customer satisfaction and contribute to the improvement of logistics services quality. In addition, companies need to focus on developing IT strategies as an important part of their business strategy. Part of the budget for business activities should be used to invest in IT in order to efficiently apply new software needed for logistics operations such as RFID, barcode, logistics cloud, etc. Companies should aim to collaborate with software companies to order specialized applications, thereby maximizing the efficiency of each application.

Companies need to put efforts on the recruitment, training and development of IT professionals. They could consider cooperating with human resource training centres or universities to train IT staff with logistics knowledge. Tailor-made training courses can be used to ensure that IT personnel are trained to meet specific requirements of the job.

Second, it is a matter of urgency that enterprises minimize the cost but still guarantee the quality of the infrastructure and activities proceeded. Costs of the logistics performance are also highlighted because the possibility to control the costs would favour and create competitive advantages for the logistics process. Firms could reduce costs in the long-term by making an initial investment in the equipment, technology and human resources. The increased value created from high-quality products in short-time due to the technology application would make up for the beginning investment.

Third, timeliness and reliability would have a profound impact on the overall logistics performance for the worldwide reputation and its direct impact on the efficiency of the supply chain. In many cases, timeliness and reliability are key determinants affecting the customer's decision of whether to further cooperate with the current partner in the future or not.

The timeliness should be ensured because of its long influence on the later decision of customers and incentives of the consumers. To achieve this, the subprocesses in the supply chain should be well controlled and fastened, for example in the procurement, or partner and suppliers management.
The reliability of the process is decided partially from the timeliness, and also interdependent on the products and services quality perceived each time. Logistics service providers should emphasize on these things to create a reputation for the business.

Fourth, human resource is the factor that needs great attention because of its integral part in controlling the process and creating all the plans carried out. Labour force level should be upgraded to match up with the development and the upgradation of the technology and infrastructure. Courses aiming to upgrade and develop the labour force ability, capacity and skills should be organized to create the compatibility in the country and in the business. Besides, employees ought to be provided opportunities of speaking out their opinion and desires as well as received care in terms of soul.

In a larger scale, the labour force is assumed to be appropriately oriented to efficiently develop, then being able in their desired fields and reaching their desired level of promotions and plan. To be possible to create favourable environment for human resources development, there is an increasing need for authority, educational agencies, business and families to collaborate with each other, so that students –

labour-to-be in the future were able to receive the best nurturing and schooling, in terms of knowledge, soul, health, discipline and practice.

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LONG-HAUL TRUCK AND DRIVER SCHEDULING PROBLEM WITH TRANSFER OPTIONS: A CASE STUDY IN CEMENT DISTRIBUTION

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ABSTRACT
Purpose: This paper discusses a typical practical problem in cement distribution of a leading cement industry in Indonesia. Currently, majority of cement distribution in Java Island have been dominated by trucks. Due to traffic and congestion, the delivery in some cities are delayed because their trucks have not returned from other delivery completion. The company has initiated several logistics improvements including the use of transfer options to minimize the overall driving time. Based on this strategy, this paper proposes a model of simultaneous vehicle routing and truck driver scheduling problem with transfer options. We also consider the Hours of Service (HOS) regulation in developing the schedule. Some numerical experiments based on real cases will be conducted to verified the developed model.

Design/methodology/approach: This research proposes a mixed integer programming followed by heuristics approach for solving this problem. The model contains 4 constraints which are time setting, time windows, HOS regulation, and transfer constraints. Based on this algorithm we develop a decision support system (DSS) based on visual basic application (VBA) which is easy to modify and user friendly.

Findings: This research will find the feasible routes and schedule for driver that still comply the Indonesian driver and traffic regulation and achieve the objective function.

Practical implications: This research solved a case study with real data from one of leading cement distributor in Indonesia. By the result, we can suggest the best possible routes and schedule for drivers, also the best option for transfer shipment strategy.

Originality/value: This research will solve the simultaneously vehicle routing and truck driver scheduling with transfer options that never been studied before. This study will also take into account single shipment and multiple time windows constraints.

Keywords: Vehicle Routing Problem, Truck Driver Scheduling Problem with Transfer Options, Cement Distribution, Hours of Service Regulation

Introduction

Majority of cement distribution in Java island have been dominated by trucks. The high traffic of the trucks increases traffic jam on the road. This congestion will cause delivery time to be longer and less competitive. For example, Jakarta and Surabaya, which has 734 km distances, normally can be reached within 14 hours. But if there is congestion, especially near the holiday, the travel time will increase up to 18-30 hours. As a result from this long journey, the driver fatigue is often contributing in accidents on the roads.

To reduce the number of accident caused by driver fatigue, government issued some rules regarding traffic and road transport. In this regulation, the truck driver should only be able to drive a maximum of 8 hours, and under certain conditions is allowed up to 12 hours including 1-hour rest period. This regulation will certainly increase the total travel time from trucks.

For the companies, this long delivery time led to a shortage of standby fleets at the depot. The distribution companies that operate delivery across cities in Java island should provide a huge amount of capital to invest in buying more trucks. Companies can also choose the second option, by employing a third-party logistics, but this also require additional cost. The shortage fleets at the depot can delay the delivery to other destination. This also can lead to uncompetitive market because the amount of their product in some areas are insufficient.

This research is motivated by the problem faced by a leading cement company in Indonesia. They distribute their product from their plant to their distributors that spread in Java. Cement itself has a distinct characteristic that make it hard to combine with distribution of other products, even as backhaul. This is one of obstacles to reduce the distribution cost. Most of the distributions are done by trucks. Due to the fleet limitation, in some peak season, the delivery in some cities are delayed because their trucks have not returned from other delivery completion. The company want to test a strategy to maintain the number of standby trucks at the depot. This strategy is called “transfer trip”. We aim to make a general model for long-haul distribution and truck driver scheduling with transfer trip. So that this model can be used for general applicability.

The basic of this model is the Vehicle Routing Problem (VRP) combine with Truck Driver Scheduling Problem (TDSP). We adopt the transfer strategy in here as a coverage problem, so that the trucks will allow to serve the route within a maximum driving time. The delivery for distant cities will be transfer to the other trucks that have been assigned to cover destination cities. We also take time windows and government driving regulations into consideration.

Literature Review

Several studies have been conducted to solve TDSP with working hour restriction and routing decision. To optimize maximum shift time limit for drivers, Campbell and Savelsbergh (2004) have developed a modified insertion heuristic. Goel (2009) developed algorithms considering the EU or US regulations. He focused at basic provision of EU regulation and solved a modified Solomon (1987) test instances for the VRPTW using large neighbourhood search algorithm. Prescott-Gagnon et al. (2010) developed alternatives EU provisions that were not considered in Goel (2009). They proposed a large neighbourhood search algorithm based on column generation heuristic. To generate routes (column) and a labelling algorithm for checking the feasibility, they used Tabu Search. Goel (2010) proposed breadth-first search (BFS) approach that always find the feasible solution. These methods still work separately with local search based optimisation methods for combined vehicle routing and truck driver scheduling.

Goel and Rousseau (2011) developed driver scheduling problem under Canadian regulation which is more permissive than US. He proposed two heuristics and an exact approach to solve the problem. Continue with truck driver scheduling problem, Goel et al. (2012) then developed the Australian-TDSP for the standard and Basic Fatigue Management Rules. The exact model and four heuristics approach are proposed to solve the problem during the reasonable computational time. Drexl et al. (2013) modelled the vehicle routing and driver scheduling simultaneously for long-haul trip in Europe. In this research, the drivers are not dedicated to the trucks. This offers greater planning flexibility and allows a better utilization of trucks, but also creates intricate interdependencies between trucks and drivers and requires the synchronization of their routes. Drexl et al. (2013) developed heuristic approach based on a two-stage decomposition. The study for long-haul vehicle routing and scheduling with HOS was also conducted by Rancourt et al. (2013). This research implemented US regulations and some alternative provisions of this regulations. To develop the problem, Rancourt et al. (2013) also took into account multiple time windows and heterogenous fleet constraints. Several scheduling algorithms embedded within a tabu search heuristic have been developed to solve the problem. The solution methods have been tested using modified Solomon instances. Koç et al. (2016) focused in evaluating idling options that often used by drivers. Here, the idling options that will be evaluated are keeping the vehicle engine running while the vehicle is not moving, resting at an Electrified Parking Space (EPS) or using an Auxiliary Power Unit (APU) while idling. To evaluate these three options, a mathematical model with the sum of driving cost, fuel cost, and idling cost as objective function. By looking the literatures of simultaneous vehicle routing and truck driver scheduling problem, there is no literature that discusses the transfer shipment between vehicles to avoid long-haul trip.

Scientific Contribution

The problem considered in this paper differs from the above-mentioned authors. In this research, we considered the following contributions:

a. One truck can only deliver for one destination because the nature of cement shipment that always bigger than truck capacity.
b. Using multiple time windows, we also consider transfer time as a time window. It means the transfer activity can only be done if two vehicles meet at the same point at the same window time.
c. To maintain the number of trucks that standby in depot, we develop several transfer options strategies.
d. The problem is developed to comply with Indonesian regulations that related with commercial vehicles.

The Truck Driver Scheduling Problem with Transfer Option Strategy (TDSPT)

Notations

We develop the model from Goel (2012) by adding the transfer constraints. In this model, a truck driver should deliver product from plant to customer location as scheduled. At each location $i \in n$ some loading or unloading work w_i shall be done. Every location has time windows that denoted by T_i and at each ʋ shall be include the $\left[t_{i,\tau}^{min}, t_{i,\tau}^{max}\right]$ range. The driving time from location I to i+1 denoted by $d_{i,i+1}$. The time horizon, which is 8 days, denoted by $t^{horizon}$.

Objectives

In this research, we want to minimize the total cost that is described by total travel duration. The longer the travel, distribution cost and driver cost will be higher. Let X^{end} be the ending time of a trip and x^{start} be the starting time before the trip begin. The objective function is denoted by this function below.

$$\sum_{i=1}^{n} X_i^{end} - X_i^{start} \tag{1}$$

Constraints

The constraints in this model are divided into 4 categories, which are time setting constraints, time windows constraints, HOS regulation constraints, and transfer constraints.

a. Time Setting Constraints

$$x_i^{arrival} + \sum_{r\in R} t^r z_{i,r} \le x_i^{start} \quad \text{for all } 1 \le i \le n \tag{2}$$

$$x_i^{start} + w_i = x_i^{end} \quad \text{for all } 1 \le i \le n \tag{3}$$

$$x_i^{end} + d_{i,i+1} = x_{i+1}^{arrival} \quad \text{for all } 1 \le i \le n \tag{4}$$

Constraint (2) restricts the work at any location must not start before the arrival plus any rest time. Constraint (3) set the work at any location I end wi time units after it starts. Constraint (4) set the arrival at a location equals the end time of previous location plus the required driving time.

b. Time Windows Constraints

$$y_{i,\tau} t_{i,\tau}^{min} \le x_i^{start} \quad \text{for all } 1 \le i \le n,\ 1 \le \tau \le T_i \tag{5}$$

$$x_i^{start} \le t^{horizon} - y_{i,\tau}(t^{horizon} - t_{i,\tau}^{max}) \quad \text{for all } 1 \le i \le T_i \tag{6}$$

We use different time windows for each city. Constraint (5) and (6) are the time windows constraint, the loading or unloading will start if the trucks arrive at the warehouse during within time windows.

c. HOS Regulation Constraints

In this paper, we consider the HOS regulations for traffic and road transports (Constitution no. 22 year 2009). We use terminologies in Rancourt et al. (2013), that described below:

Driving: Driving time is the total time spent at the driving controls of a commercial vehicle in operation, even when the vehicle is stuck in a traffic jam

On-duty: On-duty time means all the time a driver is performing work for any employer or is required to be available for work.

Off-duty: Drivers have no obligation to perform any work in off-duty time. They can leave the place where the vehicle is parked.

Sleeper berth: The time when driver is in the sleeper berth of a commercial vehicle in conformity with specific requirements.

Indonesia apply almost the same HOS rules as US. These regulations limit the driving and on duty time so that the drivers are not permitted to drive without resting. The regulations that should be conformed in driver scheduling are:

- Driver cannot drive after 70 hours on-duty during a week
- Driver may only drive maximum 8 hours or 12 hours (at certain situation) after 10 consecutive hours off-duty, including 1-hour rest
- A driver should take a break for ½ - 1 hour after 4 hours driving

According to the HOS regulation, we can set the parameters as follows:

h^{total_duty} = 70 hours, the maximum cumulated on-duty hours during a week
h^{rest} = 10 hours, the minimal duration of a rest period to regain driving time
h^{drive} = 12 hours, the maximum cumulated driving hours between two rest periods
h^{on_duty} = 14 hours, the maximum cumulated on-duty hours. After this, the driver is illegal to drive without resting
h^{long_berth} = 8 hours, the minimal duration of a long rest split period when a rest is split in conformity with the sleeper berth provision
h^{short_berth} = 1 hours, the minimal duration of a short rest split period when a rest is split in conformity with the sleeper berth provision

Since it is a direct shipment, the truck drivers are required to drive back to the plant (depot) after delivering product. The trucks will be empty during travel back to the depot. We suppose the driver has been off-duty for a period at least 34 consecutive hours before leaving the depot.

$$x_k^{arrival} - x_i^{start} \le t^c + t^{horizon} \sum_{j=i+1}^{k-1} \sum_{r\in R^c} Z_{j,r} \quad for\ all\ 1 \le i < k \le n; d_{k-1,k} > 0, c \in C1 \tag{7}$$

$$x_k^{end} - x_i^{start} \le t^c + t^{horizon} \sum_{j=i+1}^{k} \sum_{r\in R^c} Z_{j,r} \quad for\ all\ 1 \le i < k \le n; w_k > 0, c \in C2 \tag{8}$$

$$\sum_{j=1}^{k-1} d_{j,j+1} + \delta^c \sum_{j=1}^{k-1} w_j \le t^c + t^{horizon} \sum_{j=i+1}^{k-1} \sum_{r\in R^c} Z_{j,r} \quad for\ all\ 1 \le i < k \le n; d_{k-1,k} > 0, c \in C3 \tag{9}$$

$$\sum_{j=1}^{k-1} d_{j,j+1} + \delta^c \sum_{j=1}^{k} w_j \le t^c + t^{horizon} \sum_{j=i+1}^{k} \sum_{r\in R^c} Z_{j,r} \quad for\ all\ 1 \le i < k \le n; w_k > 0, c \in C4 \tag{10}$$

This the general constraint of the HOS regulations. Constraints (7) and (8) set the time elapsed since the end of the last rest R^C is within the limits imposed by the constraints $c \in C1$ and $c \in C2$. Constraints (9) and (10) set the accumulated amount of driving and working without rest does not exceed the limits $c \in C3$ and $c \in C4$.

d. Transfer Constraints
This constraint keeps the cumulative of x^{end} from the previous visit and driving time of a truck cannot exceed the required arrival time at each i, this will set the long-distance trip will be transfer to another truck.

$$x_{i-1}^{end} + d_{i-1,i} \leq arrival_i^{limit} \quad for\ all\ 1 \leq i \leq n \qquad (11)$$

Numerical Experiment

Here we want to use the developed model to solve small instance of cement distribution case study in Java Island. The company has a plant in Tuban. To optimize the distribution to western Java, company also has a packing plant in Ciwandan that has responsibilities to pack the bulk products and distribute it to several areas located near the packing plant. We will make schedule for 7 days deliveries. Figure 1 describes the distribution network in Java. The distribution to cities can be done both from central plant in Tuban or from packing plant in Ciwandan depend on the cheapest distribution cost and availability of stocks and vehicles. So, this problem can be categorized as multi depot-VRP. Table 1 will present the driving time to each city, exclude the idle and on duty time.

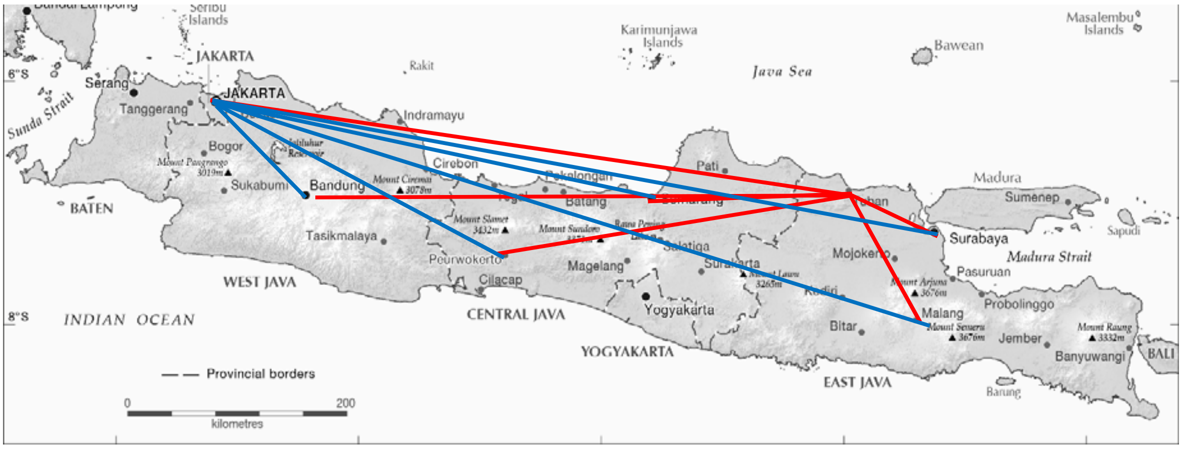

Figure 1. The Distribution Network in Java

From/To	Tuban	Ciwandan	Bandung	Purwokerto	Semarang	Surabaya	Malang
Tuban	0	11.5	11	7	5	3	5
Ciwandan		0	3	6	8	13	15

Table 1. Driving Time (hrs) to each City

Assumed the central plant only has 9 vehicles with 12-ton capacity. The company should make deliveries within a week as described in Table 2. To make deliveries, the company should ensure the number of available trucks as required. If the trucks are not available at the needed time, then on the previous trip there should be transferred shipment, so that the truck back to the factory just in time. The company should make deliveries with minimum total cost, which represent by total driving time.

Cities	Delivery Schedule (ton)						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Ciwandan		60					
Bandung			10			10	10
Purwokerto	20					10	
Semarang		10		30		10	
Surabaya		20	20			20	20
Malang	20				20		

Cities	Delivery Schedule (ton)						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Total truck needed (unit)	4	8	3	3	2	5	3

Table 2. Delivery Schedules to each City

Following the model, we solved the problem by using the developed algorithm. In the above problem, the required transfer doesn't occur because the number of owned trucks are more than required. We can see the schedule of trucks from Tuban plant in Table 3 and from Ciwandan plant in Table 4. For each schedule, the drivers experience several activities, such as driving, on-duty, and off-duty. The duration of each activity is set so that the HOS regulations are fulfilled. Figure 2 and 3 shows the detail activities of each driver. For example, driver 1 in that planning horizon should work 24 hours, including 10 hours off-duty, 10 hours driving, total 12 hours on-duty and 2 hours short rest. At figure 3, the off-duty that should be taken after maximum driving period is fulfilled by applying 8 hours long berth. In this experiment, there is no regulation that has been violated.

From Tuban	**Schedule per Day**							**Total on-duty**
Truck	**Sunday**	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	
Truck 1	24 hrs	8	8					30
Truck 2	24 hrs	8	8					30
Truck 3		37 hrs		24 hrs	24 hrs	24 hrs		71
Truck 4		37 hrs		24 hrs	24 hrs	8	8	73
Truck 5		37 hrs		24 hrs		8	8	59
Truck 6		37 hrs						29
Truck 7		37 hrs						29
Truck 8		24 hrs						14
Truck 9								0

Table 3. Driver Schedules from Tuban Plant

From Ciwandan	**Schedule per Day**							**Total on-duty**
Truck	**Sunday**	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	
Truck 1	26 hrs		8			8	8	40
Truck 2	26 hrs					26 hrs		32

Table 4. Driver Schedules from Ciwandan Plant

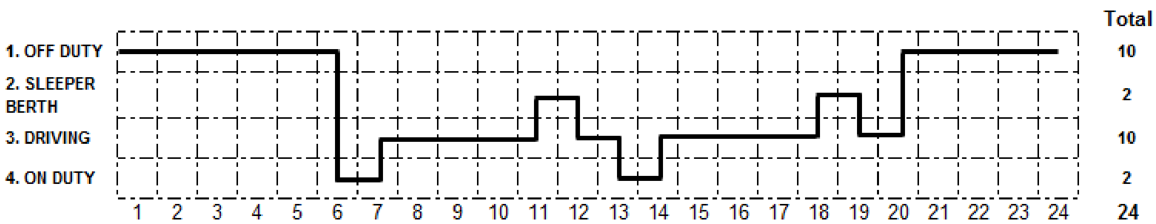

Figure 2. Detailed Schedule of Driver 1 & 2 From Tuban on Sunday

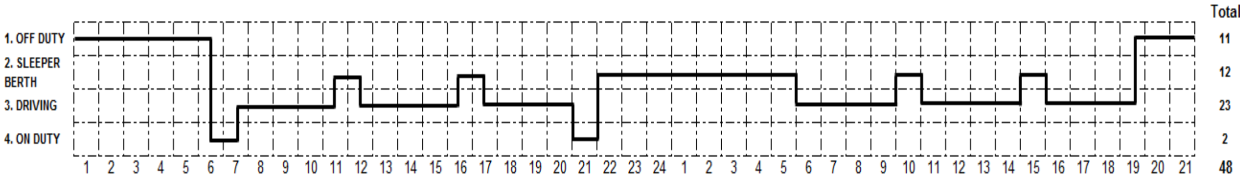

Figure 3. Detailed Schedule of Driver 3-7 From Tuban on Monday

Because the number of trucks in experiment 1 are still bigger than requirement, in the next experiment we will reduce the number of available trucks from 9 to 5. We want to see the effect of transfer constraint to the schedule. First, we change the delivery schedule as shown in Table 5.

Cities	Delivery Schedule (ton)						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Ciwandan		60					
Bandung			10			10	10
Purwokerto	20					10	
Semarang				30		10	
Surabaya			20			20	20
Malang					20		
Total truck needed (unit)	2	5	3	3	2	5	3

Table 5. Delivery Schedule of The Second Experiment

From the delivery schedule above, we generate schedule for drivers in Tuban and Ciwandan Plants. From the schedule that shown in Table 6, Truck 1 and Truck 2 from Tuban plant have to be transferred to trucks from Ciwandan plant. It is because the actual trip requires 2 days long, but unfortunately on the next day Tuban plant needs 2 trucks to deliver products to Surabaya. So the 2 trucks that have departed to Ciwandan have to be back to Tuban before delivery time. The delivery to Ciwandan will be continued by trucks from Ciwandan plant that have been arrived in transfer location before the transfer time. It is known that trucks from Ciwandan plant must travel 3.5 hours to the transfer point.

From Tuban	**Schedule per Day**							**Total on-duty**
Truck	**Sunday**	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	
Truck 1		30 hrs	8	24 hrs	24 hrs	24 hrs		
Truck 2		30 hrs	8	24 hrs	24 hrs	8	8	
Truck 3		37 hrs		24 hrs		8	8	
Truck 4		37 hrs						
Truck 5		37 hrs						

Table 6. Driver Schedules from Tuban Plant

From Ciwandan	**Schedule per Day**							**Total on-duty**
Truck	**Sunday**	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	
Truck 1	26 hrs		9 16 hrs			8	8	40
Truck 2	26 hrs		9			26 hrs		32

Table 7. Driver Schedules from Ciwandan Plant

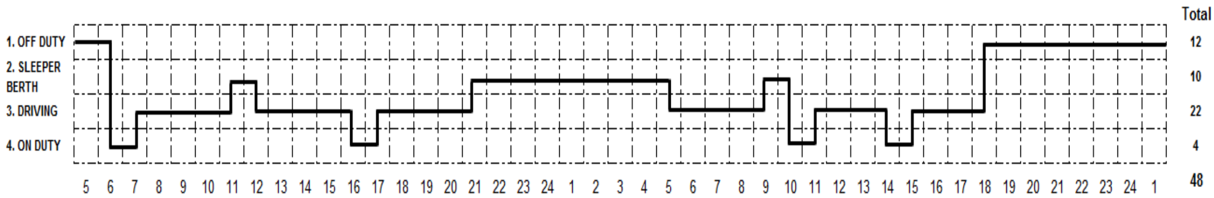

Figure 4. Detailed Schedule of Driver 1 & 2 From Tuban on Monday-Tuesday

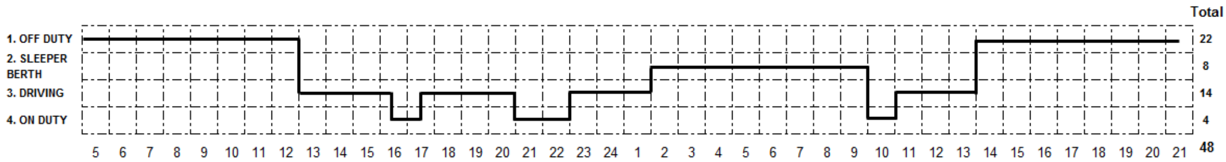

Figure 5. Detailed Schedule of Driver 1 & 2 From Ciwandan on Monday-Tuesday

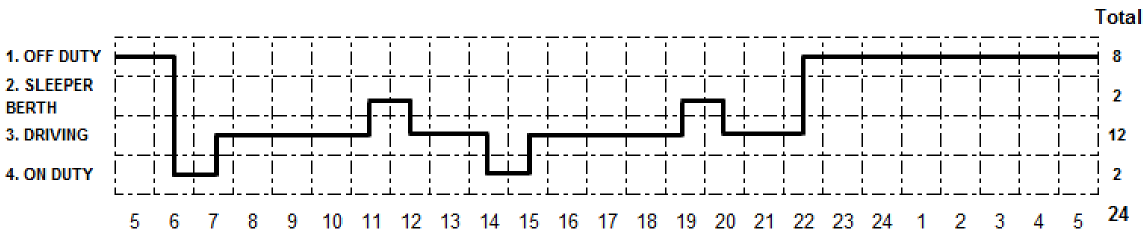

Figure 6. Detailed Schedule of Driver 1 & 2 From Ciwandan on Sunday

Process of transferring shipment from trucks of Tuban plant to the trucks of Ciwandan plant occur at 4 pm in Monday. After that, both trucks travel back to each original location. Trucks from Tuban plant have to take long berth in order to cope with HOS rules. Figure 5 show us that when truck 1 from Ciwandan plant arrive at it's second destination in Bandung, the warehouse has already close (time windows), so the truck should wait until the operational time of warehouse. During the waiting, the truck driver takes a long berth at destination warehouse.

Conclusion

We have developed a new transferring method in simultaneous vehicle routing and truck driver delivery problem. This research implements the HOS rules in Indonesia. Due to the scarcity of the vehicles, the vehicles should be at the plant at required time. So that the delivery to other cities won't be delayed. A mixed integer programming has been developed to solve the experiments. The objective function in the model is minimising the total delivery duration, following with 4 types of constraints. From the conducted experiments, we can conclude that the developed model can achieve the objective function while fulfilling the constraints.

In the future, we want to observe different transfer methods and employed multimode transportation such as train to make distribution more efisien.

Acknowledgement

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MANAGINGTHE AGILITY OF SUPERMARKETS SUPPLY CHAIN USING ICT SYSTEMS APPROACH

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INTRODUCTION

Lately, researchers have been exploring and collaborating with industry practitioners to improving the agility of supply chain. Manufacturers, suppliers, distributors and retailers can contribute significantly to support an efficient distribution of merchandise. Improving distribution agility by responding customers through delivery of goods in full, and on time (DIFOT) is the key to customer satisfaction. Supply chain players therefore can collaborate together in this endeavor to make the chain more agile to support targeted service level.

Retailers play significant role in the retail business. Some of supermarkets uses electronic devices, information and communication technology (ICT) system and excellent collaboration among the supply chain players. However, in traditional market, retailers still use manual ordering and goods distribution with limited ICT resources.They relyon traditional mode of manual operation of their activities with SME suppliers and small store retailers (Gunasekaran & Ngai, 2003). This is where the supply chain agility matters a lot. The supply chain agility (SCA) is defined as responsiveness of the organization to counteract demand variability both in volume and variety (Christopher, 2000).

Quick response by timely distribution is the focus of some select supply chain players in order to get competitive advantage in market. Supply chains have always been at the forefront of retail innovation. Retailers have recognized the need for involvement in the supply chain, got some benefits and achieved intended service levels and cost reduction.Management of logistics isvery imperative for supermarkets. However, logistics elements are costly when it is not managed effectively (Fernie and Sparks, 2009:4).Fernie and Sparks (2009:7) argue for five components of logistics mix that should be applied in the supermarket: storage facilities, inventory, transportation, unitization and packaging and communication.

Supermarket supply chain has inherent operational issues thatrequires its agility to overcome the issues. The agility of supermarket chain is a capability in their operation that responds to an increasing pressure of variability in customer demand in a changing market economy. The question is how quick the supermarkets and their supply chain partners can be in responding to customers needs. Therefore, the paper will examine the agility of supermarkets supply chains to manage the inventory issues in meeting the customer order fulfillment where ICT is perceived as an enabler.

The paper is organized as follows.The next section undertakes a literature review to explore the status quo of supply chain agility studies. The methodology section elaborates on the cross-sectional survey and the data analysis. The paper concludes with discussion and conclusion.

DEFINING SUPPLY CHAIN AGILITY

The agility is associated with uncertainty of market and customer demand. The agile mindset is related to production in manufacturing system and normally used in the supply chain management context (van Hoek et al., 2001).Agile is closely associated with 'quick response' (Stratton & Warburton, 2003) and more pragmatically. The agile supply chain needs to deliver the variety of products to customers quickly. Christopher (2000) identifies the characteristics of agile supply chain as (1) *Market sensitive,* that is the capability of reading and responding to real demand in the market; (2) creating a *virtual* supply chain that relies on shared information among the supply chain players; (3) *process integration* means partnership interrelationship between suppliers and retailers; (4) building *networking* means confederation of supply chain players linked together on networking; and (5) Measurement means quantity of productsfor retailer.

REVIEW OF SELECTED LITERATURE ON SUPPLY CHAIN AGILITY

Supply Chain Agility

Agarwal et al. (2006) have identified some variables that support agility of supply chain. They are: market sensitive (MS), delivery speed (DS), data accuracy (DA), new product introducing (NPI), centralisation and collaboration planning (CCP), process integration (PI), use of IT tools (UIT), lead time reduction (LTR), service level improvement (SLI), cost minimization (COM), customer satisfaction (CS), quality improvement (QI), minimizing uncertainty (MU), trust development (TD), minimising resistant to change (MRTC).

The agility of supply chain is influenced by lead-time reduction, service level improvement, cost minimization and quality improvement (Crhistopher and Towill, 2002; Van Hoek et al., 2001). Theyused ICT tools, collaborative planning, and process integration (Yusuf et al., 2004). Meanwhile, the data accuracy and market sensitiveness will be improved if the variables are achieved. They state that customer satisfaction, quality improvement, cost minimization, delivery speed, new product introduction, service level improvement and lead-time reduction help to get the supply chain agile.

Inventory Management

Candra and Grabis (2006) have observed some variables in inventory management such as ordering frequency, supply source, demand type and lead time. Inventory should be tight and updated regularly and attempt should be made to reduce quantity and accuracyin the data entry.However, Mercier, Sirkin and Bratton (2010) state that inventory management is driven by demand variability, manufacturing and replenishment lead time. It is important to develop an agile of supply chain distribution. Developing trust between suppliersandretailers'can improve material flows through just-in time (JIT) system, making smaller and frequent distribution appropriate of transportation and stock replenishment.

Information Flow

Lee et.al (1997) define that information flow is essential mechanism to communicate with supply chain players as it provides direct impact on production scheduling, inventory control and delivery plan. On the other hand, in the situation of declining consumer demand, they will tend to diminish or stop orders to suppliers. Consequently, this demand can be transformed to expand the variations of stock in every part of the supply chain. There are some common obstacles related to packaging and transportation when retailers want to order frequently (Lee et al. 1997; Chen et al. 2000). As a consequence, the bullwhip effect may occur when retailers suspend their orders until they have a maximum order quantity, and place orders in large size or proportions.

This study observes distortion of demand information backward from small store to supermarket/distributor and retailers to suppliers resulting in customer demand volatility.The consequences of this can be over-production, because the manufactures may double the production of material and finished goods. This gives rise toincreasing bullwhip effect (Lee et al. 1997).

Information and Communication Technology (ICT)

According to Narayanan et al. (2009), application of Electronic Data Interchange (EDI) has some benefit to companies. Application of Radio Frequency Identification (RFID), Vendor Managed Inventory (VMI) and other technology applications will assist companies to achieve real-time, transparent and visible supply chain management. The purpose of the ICT applications, such as EDI, is to reduce inventory levels, improve customer services, increase productivity, data accuracy, reduce paperwork, and response quickly to market trends (Lee et al. 1997; Cachon 1999; Narayaman, Marucheck & Handfield 2009). Non-adoption of these supply chain technologies may restrict the order flow impacting on demand variation, which then may lead to bullwhip effect (Lee et al. 1997; Metters 1997; Ingalls et al. 2005; Chandra & Grabis 2006). Others identified that demand signal processing may impact on order batching which in turn influences the bullwhip effect (Cachon 1999; Chen et al. 2000; Holland & Sodhi 2004; Chandra & Grabis 2005; Potter & Disney 2006; Quyang & Daganzo 2007). This research will identify the absence of supply chain technologies and IT infrastructure that presumably will generate the bullwhip effect in supermarkets.

Knowledge and ICT Application
The extent and efficiency of the following ICT application as below:

1. Electronic funds transfer at Point of Sale (EFTPoS), with cash register device, is a barcodescanning at the checkout and thesold items are removed from the stock in the system.
2. Radio Frequency Identification (RFID) is a system that uses the radio waves toidentify the merchandise.
3. Electronic Data Interchange (EDI)is commonly used to interconnect suppliers with retailers for more efficientoperations.
4. Quick Response Delivery System (QRDS)supports customer services and communicate the information for quick and accurate (point of sale) replenishment.
5. Decision Support System (DSS) is the application program to help decision maker to more easily make right decision.

In this study, we observed four variables such demand management, inventory management, and communication technology systems that significant supports the supply chain agility in supermarkets supply chain.

A FRAMEWORK OF SUPPLY CHAIN AGILITY

Supply chain agility and ICT
Management of materials and related information flows are critical in supermarket operation (Jone and Towill, 1999). Gattona and Walters (1996) argue that agility of supply chain can accommodate the demand uncertainty in the market. So,getting the agility within the supply chain is a rightstrategy. Thisimplies materials and related information flows from factory to customers or vice versa. Retailers are the first supply chain player toface this volatility. So, inventory information (e.g. how many to order and when to order) needs to flow to the suppliers using right ICT infrastructure.

Apply integrated ICT between SC partners is the key to get distribution more agile. Information flow from supplier to retailers can be maintained effectively and efficiently only through collaboration among the partners. Given this considerations this paper begin developing the conceptual framework of retail supply chain agility.

To counteract unpredictable demand in the market, Fisher et al. (1997) suggests that the demand for innovative products have to be “market responsive”. It is the service process response emphasisingmore on speed and flexibility than the cost itself.

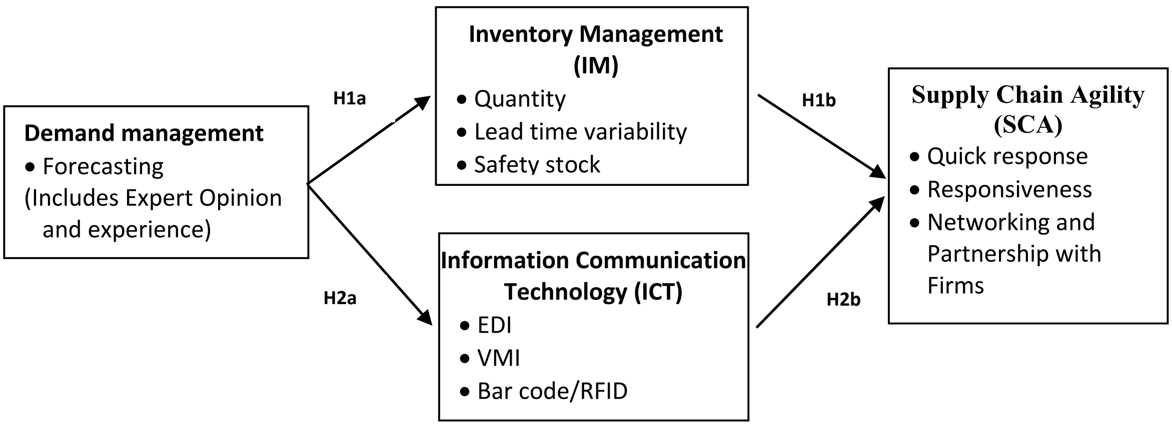

Figure 1: Conceptual framework of Retail Supply Chain Agility

The conceptual framework above comprises of four-part hypothesis: Hypothesis H1a, effective demand management has a positive effect on inventory management in supermarket supply chain. Hypothesis H1b,a well-managed inventory is positively associated with the supermarkets supply chain agility. Hypothesis H2b, effective demand management is positively associated with ICT logistics systems in supermarket supply chain, and Hypothesis H2b,ICT logistics systems is positively associated with supermarkets supply chain agility.

METHODOLOGY

This study used cross sectional survey to explore the agility of supply chain in retail supermarkets in Indonesia involving Carrefour, LotteMart, Gyant supermarket, Matahari, Alfamart and Indomaret supermarket. Supply chain managers of these supermarkets are the key persons to take decision about the demand planning and procurement of goods from suppliers. Investment decision on ICT also comes under their role and responsibility. Other respondents were manufactures/suppliers and small stores as partners of these supermarkets. The questionnaire items addressed demand management, inventory management, ICT systems and supply chain agility. The survey questionnaire was conducted between April – May 2016.

The data was analysed using exploratory factor analysis (EFA) followed by confirmatory factor analysis (CFA) to confirm their reliability and validity. SEM modeling was used to explore the hypothesised relationships among the variables.

RESULTS

The cross-sectional data collected from the surveys were screened for any errors and checked for completeness before being entered into the statistical package PASW. Initial estimation of non-response bias, multicollinearity, and internal consistency (Cronbach alpha) was checked for the data set. Exploratory factor analysis (EFA) wascarried out to check the independent factor loading for all of the constructs. Confirmatory factors analysis (CFA) was then used to provide a confirmatory test of measurement model ensuring that all the fourvariables logically and systematically represent constructs involved in the theoretical model (Hair et al., 2010). In order to figure out the data fit, test the statistical model and hypothesis, SEM modeling was used with AMOS 20 software.

The mean, standard deviation (SD) and correlation coefficients are presented in Table 1. Pearson correlation coefficients suggest a significant relationship between the variables. However, no significant correlation was found between ICT and supply chain agility (SCA). The Cronbach alpha varies from .76 to .86 indicating a good internal consistency.

Variable	Mean	Std. Deviation	DM	IM	ICT	SCA
DM	2.92	.92	*.87*			
IM	4.24	.51	*.165**	.72		
ICT	3.69	.60	.17*	*.30***	*.74*	
SCA	4.59	.48	.35**	.29**	*.60*	*.78*

Table 1: Mean, SD and Correlation coefficient (N=164)

*. p< .05 **. p< .01

Italicised values along diagonal are Cronbach alpha

We evaluated the path model separately for retailsupply chain to check data validity.The results indicate that better demand management (DM) has significant positive influence (.70, p<.001) on inventory policy. The inventory policy isa significant (.49, p<.001) predictor of the Supply Chain Agility (SCA). Similarly, demand management positively and significantly influences ICT system (.72, p<.001), that in turn is a significant predictor of the SCA (.57, p<.001).The results support the hypotheses H1a, b and H2a,b.

The path analysis reports thatthe overall fit of the model is good. The goodness of fit indicesare X^2 = 16.722, df = 14 (0.271), X^2/df = 1.194, RMSEA = 0.035, RMR = 0.021, GFI = 0.974, NFI = 0.965, NNFI/TLI = 0.991, CFI = 0.994. All specified factor loadings for four variables were within the permissible limits.

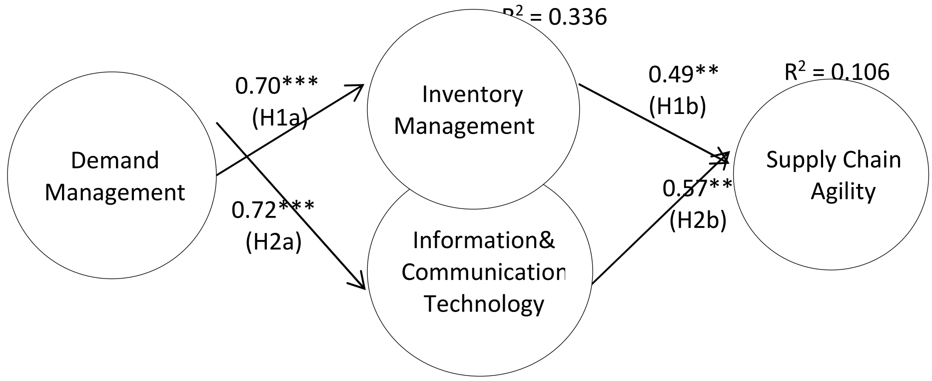

Figure 2: The path model of supermarket supply chain agility

Further, demand management and ICT together explain 10.6 percent variation in improving the supply chain agility in supermarkets.

DISCUSSION AND CONCLUSIONS

The paper examines the supply chain agility in supermarket operations where ICT is seen as an enabler.The results indicate a positive and significant influence of ICT and inventory management on supply chain agility. Though a series of research on supply chain agility is undertaken earlier, the investigation using cross-sectional data collection is novice. This contribution emphasises that effective demand management considers the strategic value of inventory management policy and role of ICT in logistics. On practical side, the study looked at retail practices on order management in Indonesia. While the chains have experienced the existence of the SCA, supermarket managers need to look at their current demand management practices further to make the chain more agile. Demand management needs further improvement atsupermarketlevel as the supermarketsare equally affected by their independent suppliers upstream and convenience stores downstream who need to consider and upgrade their ICT systems to make the whole chain agile.

Given the sample limitations, inclusion of more partners from other regions of Indonesia could help in generalising the result.

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MODELING TEMPORARY LOGISTICS HUB ESTABLISHMENT USING MULTI-CRITERIA DECISION MAKING APPROACH

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Abstract

Purpose

This study develops a new method that determines the location and the order of establishment of temporary logistics hubs (TLHs) taking account of multiple-objectives, multiple-attributes, and multiple-actors during disaster response. The research is motivated by the importance of TLHs and the complexity that surrounds its establishment.

Design/methodology/approach

A multi-period multi-objective mathematical model is developed to determine the location of the TLHs and a fuzzy simple additive weighing under the group decision-making (GDM) condition to determine the order of establishment of TLHs.

Findings

The optimization results provide useful managerial insights for decision-makers by considering the trade-off between two non-commensurable objectives. Determining the order of establishment helps to efficiently allocate mobile storage units when they limited in numbers. Use of fuzzy approach to evaluate subjective attributes eases the overall decision-making process.

Research limitations/implications

In this study, decision-makers are considered to be homogeneous, which might not reflect reality. This study does not consider the stochastic nature of relief demand and thus assumes demand to be known.

Practical implications

The outcomes of this study are valuable to decision-makers for relief distribution planning when there are multiple objectives, numerous decision-makers, and several attributes. The proposed fuzzy simple additive weighing approach under GDM is especially useful during emergency situation because of its ability to take account of vagueness and imprecision inherent in decision-making.

Originality/value

A new method is proposed and implemented to determine the location and the order of establishment of TLHs considering multi-objective, multi-attribute, and multi-actor nature of decision making during disaster response. To the best of the authors' knowledge, the multi-objective, multi-attribute, and multi-actor aspects of the TLH location problem have not thus far been considered simultaneously for one particular problem in humanitarian logistics.

Keywords: temporary logistics hub, multi-objective optimization, weighted-sum method, fuzzy simple additive weighing, group decision-making, facility location problem, humanitarian supply chain, emergency relief

Introduction

Disaster response is a critical task given the uncertainty and suddenness associated with disasters. The location of facilities, particularly distribution centers and warehouses play a significant role in ensuring the success of emergency humanitarian relief operations. While vulnerable countries should ideally prepare designated spaces for these facilities along with safety stockpiles in advance of any disaster occurring, the situation in reality is often different. The lack of advance preparedness in emerging countries necessitates for an appropriate, effective, and efficient response. Additionally, the unpredictability of disasters prevents authorities from determining an exact location for emergency facilities beforehand and given that permanent facilities alone may be insufficient, temporary emergency facilities become especially important in developing countries where disaster preparedness falls short.

Selecting where to locate temporary facilities and how to allocated limited quantities of mobile storage units that are used as temporary logistics hubs (TLHs) is an important task. Additionally, this can be complicated by the growing number of humanitarian actors, prevalence of multiple and often conflicting objectives, and inherent complexity and uncertainty of the situation. Moreover, current guidance suggests that within the humanitarian coordination architecture, decisions should be made by a group rather than by individuals (IASC, 2009, 2015). As the number of actors involved in disaster response operations has continued to grow, a complex network that often struggles to efficiently coordinate efforts has emerged (Balcik et al., 2010; Bharosa et al., 2010; Bealt et al., 2016). Therefore, it is important that the problem of temporary facility location incorporates the conflicting objectives, several attributes, and diverse opinion of multiple decision-makers.

Based on the foregoing, this study presents a comprehensive methodology to determine the number, location, and order of establishment of TLHs. A multi-period multi-objective optimization model is developed to determine the number and location of TLHs in the post-disaster stage and a fuzzy simple additive weighting system under group decision making (GDM) for determining the order of establishment of TLHs. The proposed approach allows us to take account of important factors like multiple conflicting objectives, multiple-attributes, and multiple-actors prevalent in disaster response activities. Furthermore, fuzzy approach is suitable for GDM problems under uncertainty because of the vagueness and imprecision inherent in decision-making during emergencies. With this context, this study proposes a comprehensive approach using multi-objective optimization, fuzzy simple additive weighing under GDM to determine the number, the location, and the order of establishment of TLHs. To our knowledge, this study is the first of its kind to use a multi-objective, multi-attribute, and multi-actor approach to determine the location and the order of establishment of TLHs during disaster response.

The remainder of this paper is organized as follows. In section 2, we review the relevant literature on the temporary facility location models used in humanitarian operations. In section 3, we describe the problem under consideration. Section 4 explains the methodology of the proposed approach. In section 5, we present the results of a numerical experiment based on the April 2015 Nepal earthquake. Finally, section 6 concludes.

Literature review

Recently temporary facility location problem has received growing attention. Afshar and Haghani (2012) model integrated logistics disaster operations by minimizing total weighted unsatisfied demand. Lin et al. (2012) proposed a two-phase heuristic approach to locate temporary depots and allocate covered demand by minimizing logistics and penalty costs. Khayal (2015) develops a network flow model for emergency response planning by minimizing logistics and penalty costs. Cavdur et al. (2016), develop a two-stage stochastic program for allocating temporary disaster response facilities in short-term disaster operations by minimizing the total distance travelled, unmet demand, and the cost of facilities. Finally, Stauffer et al. (2016), developed a model that minimizes total vehicular costs over the planning period to determine the location of temporary hubs for vehicles.

While the humanitarian code of conduct prioritizes minimizing victims' suffering, the budgetary limitations creates a trade-off situation highlighting multiple objectives as a distinguishing feature of humanitarian logistics operations. Kovacs and Spens (2007) states, the typical actors involved in disaster response operations include aid agencies, donors, governments, the military, logistics providers, and other non-governmental organizations which makes presence of multiple actors another distinctive feature of humanitarian logistics operations. Yet studies focusing on temporary facilities have failed to take account of multi-objective and multi-actor nature of temporary facility location and establishment ordering problems.

Moreover, the concept of order of establishment is almost non-existent in the current literature. When dealing with temporary facilities for disaster response, it is essential to consider resource constraint for establishing temporary facilities. A fuzzy multi-attribute approach may best suit the problem of determining the order of establishment of temporary facilities. The fuzzy simple additive weighing system under GDM developed by Chou et al. (2008) for facility location selection is an effective method for dealing with subjective/objective attributes.

Problem description

The problem under consideration is determining the location and the order of establishment of TLHs. Figure 1 shows the structure of a typical humanitarian supply chain and the positioning of TLHs within. In our study, a TLH is defined as a place designated for storing, sorting, consolidating, deconsolidating, and distributing emergency relief materials to disaster-affected areas in the short term. It thus acts as an intermediator between the central warehouse or relief supply points and areas in need and is often established after the disaster.

The supplies from permanent warehouses or entry points typically come in larger vehicles, which might be unable to access affected areas because of partial or complete damage to roads and bridges. In the absence of logistics hubs, the congestion created by larger vehicles using vulnerable road network may cause delivery times to increase significantly. In particular, the temporary nature of hubs is important in developing countries where infrastructure facilities are poor, resources for disaster response are limited and disaster preparedness usually falls short. Resource constraint necessitates effective allocation and utilization of resources during the immediate aftermath of the disaster. Determining the order of establishment of TLHs plays a key role in efficient allocation and thus effective utilization of mobile storage units which are used as the TLHs and are often limited in number immediately after the disaster.

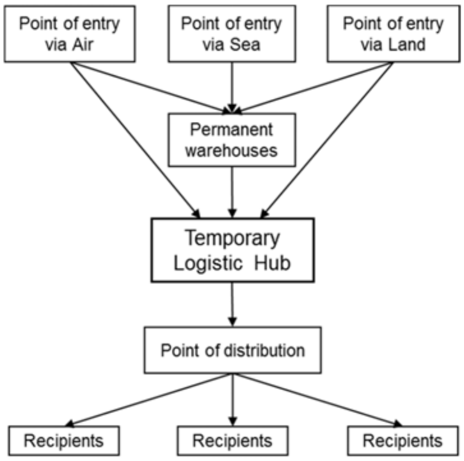

Figure 1: Structure of a humanitarian supply chain

Methodology

In the following section, we explain the methodology to determine the location and the order of establishment of TLHs using the concepts of multi-objective optimization, fuzzy set theory, simple additive weighing, and factor rating system under the group decision making (GDM) condition. The proposed method is modified version of fuzzy multi-attribute decision making approach developed by Chou et al. (2008).

Step 1: Determination of location alternatives

We propose a multi-period multi-objective TLH location model to determine the optimal number and location of TLHs. The proposed method allows us to accurately capture the changing levels of relief demand, supplies, and costs over the planning horizon. Each district or demand point has an associated demand for emergency relief materials. Along the discrete time horizon, demand from the affected zone changes in a known way related to changes in the number of affected people and recovery of affected people, as a result of which demand can either increase or decrease or be stagnant. The establishment of logistics hubs is required to meet the demand of affected people over the entire relief time horizon. The amount of emergency relief materials available in the TLHs can be either less than or equal to the capacity of TLHs but cannot exceed its capacity. The optimization problem minimizes total costs and total unsatisfied demand under dynamic demand, costs, and available units of emergency relief using weighted sum method resulting in the optimal number and location of TLHs.

The notations used in the mathematical model are as follows:
Sets, parameters and variables

T set of time periods
I set of supply points
J set of temporary logistic hubs (TLHs)
K set of affected area demand points
TC_{ijt} transportation cost of shipping one unit of the relief package from supply point *i* to TLH *j* in period *t* [USD per unit]
TC_{jkt} transportation cost of shipping one unit of relief package from TLH *j* to the affected area's demand point *k* in period *t* [USD per unit]
FC_j Fixed cost of opening a TLH in the candidate location [USD]
QS_{it} maximum available quantity of emergency relief materials at supply point *i* ∈ I in period *t* [kg]
QH_{jt} maximum available quantity of emergency relief materials at TLH *j* ∈ J in period *t* [kg]
d_{kt} demand of the affected area's demand point *k* in period *t* [kg]
n_{kt} number of TLHs allocated for demand point k in period *t*
M a very large number
r_{ijt} amount of emergency relief materials shipped from supply point *i* ∈ I to TLH *j* ∈ J in period *t* ∈ T
q_{jkt} amount of emergency relief materials shipped from TLH *j* ∈ J to the affected area's DP *k* ∈ K in period *t* ∈ T
y_j binary variable that equals 1 if the facility at *j* is selected as a TLH and 0 otherwise
y_{jkt} binary variable that equals 1 if TLH j serves demand point k in period *t* and 0 otherwise

The multi-objective optimization problem is formulated as follows:
Minimize,

$$Objective\ 1: O_1 = \sum_j FC_j y_j + \sum_i \sum_j \sum_t TC_{ijt} r_{ijt} + \sum_j \sum_k \sum_t TC_{jkt} q_{jkt} \quad (1)$$

$$Objective\ 2: O_2 = \sum_k \sum_t d_{kt} - \sum_j \sum_k \sum_t q_{jkt} \quad (2)$$

Constraints,

$$\sum_j \sum_k \sum_t q_{jkt} = \sum_i \sum_j \sum_t r_{ijt} \quad (3)$$

$$\sum_i \sum_j \sum_t r_{ijt} \le \sum_i \sum_t QS_{it} \quad (4)$$

$$\sum_i \sum_j \sum_t r_{ijt} \le \sum_j \sum_t QH_{jt} * y_j \quad (5)$$

$$\sum_j \sum_k \sum_t q_{jkt} \le \sum_j \sum_t QH_{jt} * y_j \quad (6)$$

$$\sum_k \sum_t d_{kt} \ge \sum_j \sum_k \sum_t q_{jkt} \quad (7)$$

$$\sum_j \sum_t y_{jkt} \le n_{kt} \quad \forall k \quad (8)$$

$$y_{jkt} \le y_j \qquad \forall j \quad (9)$$

$$\sum_i \sum_j \sum_t r_{ijt} \le M * \sum_j y_j \quad (10)$$

$$\sum_j \sum_k \sum_t q_{jkt} \le M * \sum_j y_j \quad (11)$$

$$r_{ijt} \ge 0 \quad \forall i, j, \mathrm{t} \quad (12)$$

$$q_{jkt} \ge 0 \quad \forall j, k, t \quad (13)$$

$$y_j = \{0,1\} \ \forall j \quad (14)$$

$$y_{jkt} = \{0,1\} \ \forall j \quad (15)$$

The objective function (1) minimizes total costs, which includes the fixed cost of opening a TLH, transportation cost from the supply point to the TLH, and transportation cost from the TLH to the affected area's demand points. Objective function (2) minimizes total unsatisfied demand. Constraint (3) ensures that the flow of emergency relief materials from the supply points to TLHs should be equal to the flow from the TLHs to the affected area's demand points. Constraints (4) – (6) are the availability constraints. Constraint (4) ensures that the quantity of emergency relief materials moved from the supply points to the TLHs should be less than or equal to the maximum available quantity of emergency relief materials in the supply point in each period. Similarly, constraints (5) and (6) ensure that the quantity of emergency relief materials moved from the supply points to the TLHs and from TLHs to affected area's demand points should be less than or equal to the maximum available quantity of emergency relief materials in the TLHs in each period. Constraint (7) ensures that the quantity of emergency relief delivered for each demand point does not exceed its demand. Constraint (8) enforces multi-sourcing, ensuring that each demand point is served by a pre-specified number of TLHs.

Constraint (9) ensures that a demand point is served by TLH only if TLH is open. Constraints (10) and (11) oblige the flow of emergency relief to open "hubs" only. Constraints (12) – (15) express the nature of the decision variables used in the model.

Step 2: Selection of attributes

Several attributes play significant role in determining the order of establishment of TLHs. The term attribute is used to refer to only subjective attributes in this study. The attributes can be selected based on criteria like: socio-economic situation of the country, geo-climatic situation, literature review, and review of lessons learnt reports of past disasters. The selected attributes should be able to ensure sound operability of the established TLHs at the minimum.

Step 3: Selection of decision-makers

Under the GDM scenario, multiple decision-makers can be chosen. The choice of decision-maker also varies case-to-case and country by country. A committee of decision-makers can be formed based on their overall role in the disaster management activity. The nature of these decision-makers and their decision opinions can lead to the generation of four situations: (1) when the decision-makers are homogeneous (1.1) their decision opinions are homogeneous; (1.2) their decision opinions are heterogeneous; (2) when the decision-makers are heterogeneous (2.1) their decision opinions are homogeneous; and (2.2) their decision opinions are heterogeneous.

Step 4*:* Determining the degree of importance of decision makers.
The next step is to determine if decision-makers are homogeneous or heterogeneous. If the degree of the importance of decision-makers is equal, then the group of decision-makers is deemed to be a homogeneous group. Otherwise the group is deemed heterogeneous.

In a committee of *k* decision-makers (D_t, t = 1,2,…, k) responsible for assessing *m* alternatives (A_i, $i=1,2,\ldots, m$), under each of the *n* attributes (C_j, $j=1,2,\ldots, n$), as well as importance of attributes, the degree of the importance of the decision-makers is I_t, $t = 1,2,\ldots, k$, where $I_t \in [0,1]$ and $\sum_{t=1}^{k} I_t = 1$. If $I_1 = I_2 = \ldots = I_k = \frac{1}{k}$, the group of decision-makers is called a homogeneous group; otherwise the group is called heterogeneous group. The importance of each decision-maker can be determined by interviewing the final decision maker.

Step 5: Collecting decision opinions and computing the aggregated fuzzy weight of individual attributes.

Introduce linguistic variables (Table 1) for decision-makers to assess attributes importance. Subsequently, compute the aggregated fuzzy rating of the individual attributes. Let $\widetilde{W}_{jt} = (a_{jt}, b_{jt}, c_{jt}, d_{jt})$, j = 1, 2, …., n; t = 1, 2, ….,k, be the linguistic rating given to attributes $C_1, C_2, \ldots, C_n$ by decision-maker D_t. The aggregated fuzzy rating, $\widetilde{W}_j = (a_j, b_j, c_j, d_j)$, of attribute C_j assessed by the committee of *k* decision-makers is defined as

$$\widetilde{W}_j = (I_1 \otimes \widetilde{W}_{j1}) \oplus (I_2 \otimes \widetilde{W}_{j2}) \oplus \ldots \oplus (I_k \otimes \widetilde{W}_{jk}), \qquad (16)$$

where $a_j = \sum_{t=1}^{k} I_t a_{jt}$, $b_j = \sum_{t=1}^{k} I_t b_{jt}$, $c_j = \sum_{t=1}^{k} I_t c_{jt}$, $d_j = \sum_{t=1}^{k} I_t d_{jt}$.

Linguistic variables	Fuzzy numbers
Very Low (VL)	(0,0,0,3)
Low (L)	(0,3,3,5)
Medium (M)	(2,5,5,8)
High (H)	(5,7,7,10)
Very High (VH)	(7,10,10,10)

Table 1. Linguistic variables and fuzzy numbers

Linguistic variables	Fuzzy numbers			
Very poor	0	0	0	20
Between very poor and poor	0	0	20	40
Poor	0	20	20	40
Between poor and fair	0	20	50	70
Fair	30	50	50	70
Between fair and good	30	50	80	100
Good	60	80	80	100
Between good and very good	60	80	100	100
Very good	80	100	100	100

Table 2. Linguistic variables and fuzzy numbers for ratings

Step 6: Computing the importance weight of attributes.

T
o compute the importance weight of attributes, defuzzify the fuzzy rating of the individual attributes; compute the normalized weights, and construct the weight vector. To defuzzify the rating of the fuzzy attributes, the signed distance is adopted. The defuzzification of $\widetilde{W}_j$, denoted as $d(\widetilde{W}_j)$ is therefore given by $d(\widetilde{W}_j) = \frac{1}{k}(a_j + b_j + c_j + d_j)$ (17)

The crisp value of the normalized weight for attributes C_j, denoted by W_j, is given by

$$W_j = \frac{d(\widetilde{W}_j)}{\sum_{j=1}^{n} d(\widetilde{W}_j)}, \quad (18)$$

where $\sum_{j=1}^{n} W_j = 1$. The weight vector W = $[W_1, W_2, \ldots, W_n]$ is therefore formed.

This crisp values of the normalized weight of the attributes C_j can therefore be used as the importance weight of the attributes.

Step 7: Obtain the decision-opinion of decision-makers using fuzzy ratings to assess each alternative with respect to individual attributes and obtain aggregated fuzzy ratings.

Using the linguistic variables (Table 2) for decision-makers to assess fuzzy ratings of alternatives with respect to individual attributes obtain the decision-opinion and pool them to obtain the aggregated fuzzy ratings. Let $\tilde{x}_{ijt}= (o_{ijt}, p_{ijt}, q_{ijt}, r_{ijt})$, *i = 1, 2, . . . , m; j = 1, 2, . . . , n; t = 1, 2, . . . , k,* be the linguistic suitability rating assigned to alternatives A_i for attributes C_j by decision-maker D_t. The aggregated fuzzy rating, $\tilde{x}_{ij}$ of alternative A_i for attribute C_j assessed by the committee of *k* decision-makers is defined as

$$\tilde{x}_{ij} = (I_1 \otimes \tilde{x}_{ij1}) \oplus (I_2 \otimes \tilde{x}_{ij2}) \oplus \ldots \oplus (I_k \otimes \tilde{x}_{ijk}), \quad (19)$$

which can subsequently be represented and computed as,

$\tilde{x}_{ij}= (o_{ij}, p_{ij}, q_{ij}, r_{ij})$, *i = 1, 2, . . . , m, j = 1, 2, . . . , n*

where $o_{ij} = \sum_{t=1}^{k} I_t o_{ijt}$, $p_{ij} = \sum_{t=1}^{k} I_t p_{ijt}$, $q_{ij} = \sum_{t=1}^{k} I_t q_{ijt}$, $r_{ij} = \sum_{t=1}^{k} I_t r_{ijt}$.

Step 8: Construct a fuzzy rating matrix based on fuzzy ratings.

The fuzzy rating matrix $\widetilde{M}$ can be concisely expressed in the matrix format

$$\widetilde{M} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdot & \cdot & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \vdots & \vdots & \tilde{x}_{2n} \\ \vdots & \vdots & & & \vdots \\ . & . & \cdot & \cdot & . \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdot & \cdot & \tilde{x}_{mn} \end{bmatrix}$$

where $\tilde{x}_{ij}$, $\forall i, j$ is the aggregated fuzzy rating of alternative A_i with respect to attribute C_j.

Step 9: Derive the total fuzzy scores for individual alternative by multiplying the fuzzy rating matrix by their respective weight vectors.

Obtain the total fuzzy score vector by multiplying the fuzzy rating matrix $\widetilde{M}$ by the corresponding weight vector *W, i.e.,*

$$\tilde{F} = \widetilde{M} \otimes W^T = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdot & \cdot & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \vdots & \vdots & \tilde{x}_{2n} \\ \vdots & \vdots & & & \vdots \\ . & . & \cdot & \cdot & . \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdot & \cdot & \tilde{x}_{mn} \end{bmatrix} \otimes \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ . \\ W_n \end{bmatrix} = \begin{bmatrix} \tilde{x}_{11} \otimes W_1 \oplus \tilde{x}_{12} \otimes W_2 \oplus \cdots \oplus \tilde{x}_{1n} \otimes W_n \\ \tilde{x}_{21} \otimes W_1 \oplus \tilde{x}_{22} \otimes W_2 \oplus \cdots \oplus \tilde{x}_{2n} \otimes W_n \\ \cdot \\ \vdots \\ \tilde{x}_{m1} \otimes W_1 \oplus \tilde{x}_{m2} \otimes W_2 \oplus \cdots \oplus \tilde{x}_{mn} \otimes W_n \end{bmatrix} = \begin{bmatrix} \tilde{f}_1 \\ \tilde{f}_1 \\ \cdot \\ \vdots \\ \tilde{f}_m \end{bmatrix} =$$

$\left[\tilde{f}_i\right]_{m*1}$, where $\tilde{f}_i = (s_i, t_i, u_i, v_i)$. (20)

Step 10: Compute the crisp values using a defuzzification method and finally, determine the order of establishment of TLHs.

Defuzzify the fuzzy scores $\tilde{f}_1, \tilde{f}_2, \ldots, \tilde{f}_m$ by using signed distance method. The following defuzzification equation is used to determine the crisp total scores of individual locations.

$$d(\tilde{f}_i) = \frac{1}{4}(s_i + t_i + u_i + v_i) \qquad i = 1, 2, \ldots, m \quad (21)$$

where $d(\tilde{f}_i)$ gives the defuzzified value (crisp value) of the total fuzzy score of location alternative A_i.

Step 11: Finally, rank the location alternatives based on the crisp values to determine the order of establishment of TLHs. The location alternatives with larger crisp values should be established first followed by the location alternatives with lower values.

Numerical example

To support the usefulness of the proposed methodology for selecting the number, location and the order of establishment of TLHs, numerical experiment was performed using disaster data from April 2015 Nepal earthquake.

Step 1: To determine the optimal number and location of TLHs, we consider seven supply points, eleven candidate TLHs, and 13 demand points. The optimal solution is achieved by minimizing total cost and total unsatisfied demand over the entire planning horizon. An operational horizon of five weeks is considered with each period lasting for one week. We considered a single package relief delivery system. A single emergency relief package was assumed to weigh 10 kg and include essential items such as meals, a basic medical kit, blankets, baby supplies, and clothing. We assumed that a single emergency relief package was sufficient to sustain an individual for a week. The demand, cost, and the available units of relief supplies are assumed to be dynamic. The model was coded in Lingo 17.0 Optimization modeling software. All the experiments were run on a personal computer with an Intel (R) Core (TM) i3-3220 CPU (3.30 GHz) and 8 GB of RAM. All the test problems were computed in under 10 minutes.

The model results in a total of eight optimal TLHs with locations in Gorkha, Kathmandu, Kavrepalanchok, Makwanpur, Nuwakot, Ramechhap, Sindhuli, and Sindhupalchok. The eight selected TLHs result in the minimum value of both objectives over the entire planning horizon.

Step 2: Eight attributes were identified via a combination of review of literature on facility location problem in humanitarian operations and lessons learnt reports published by different entities. The eight attributes are: availability of open spaces (C_1); Transportation accessibility via Road (C_2); Transportation accessibility via Air (C_3); Level of safety (C_4); Availability of skilled manpower (C_5); Availability of necessary infrastructure (C_6); Disaster vulnerability of selected locations (C_7); and Proximity to disaster affected areas (C_8).

Step 3: A committee of four decision-makers, D_1, D_2, D_3, and D_4, from four humanitarian organizations active in disaster management in Nepal was formed.

Step 4: The decision-makers were assumed to be homogeneous hence the degree of importance is equal for all the decision-makers.

Step 5: Table 3 shows the decision-opinion of four decision makers using the linguistic weighing variables. The aggregated fuzzy weight of individual attribute is computed by using equation (16) with reference to fuzzy numbers corresponding to each linguistic variables (Table 1).

Step 6: The importance weight of the attributes is calculated by defuzzifying the fuzzy numbers using signed distance approach represented by equation (17) and the normalized weight is calculated using equation (18). The crisp values after defuzzification and the normalized weight is shown in Table 3.

Attributes	D1	D2	D3	D4	Aggregated fuzzy weight (AFW)	Defuzzified value of AFW	Normalized AFW
C_1	VH	VH	VH	H	(6.5,9.25,9.25, 10)	8.750	0.147
C_2	VH	VH	H	VH	(6.5,9.25,9.25, 10)	8.750	0.147
C_3	M	H	VH	VH	(5.25,8,8, 9.5)	7.687	0.129
C_4	H	M	H	H	(4.25,6.5,6.5, 9.5)	6.687	0.112
C_5	M	VL	H	M	(2.25,4.25,4.25, 7.25)	4.500	0.076
C_6	VH	H	VH	M	(5.25,8,8, 9.5)	7.687	0.129
C_7	H	VH	H	H	(5.5,7.75,7.75, 10)	7.750	0.130
C_8	VH	VH	M	H	(5.25,8,8, 9.5)	7.687	0.129

Table 3: The importance weight of attributes

Step 7: The decision-opinion of decision-makers in terms of fuzzy rating of all eight alternatives were obtained using the linguistic variables in Table 2. The Table 4 shows the aggregated fuzzy rating computed for each alternative criterion combination obtained using equation (19).

Selected locations	Aggregate fuzzy number	Defuzzified total score	Order of establishment
Gorkha	(29.75, 49.11, 60.14, 77.29)	54.07	5
Kathmandu	(47.48, 66.75, 72.38, 88.76)	68.84	2
Kavrepalanchok	(45.47, 65.47, 73.79, 91.67)	69.10	1
Makwanpur	(42.70, 62.70, 70.94, 89.47)	66.45	3
Nuwakot	(35.28, 55.28, 66.50, 85.85)	60.73	4
Ramechhap	(24.88, 44.24, 53.76, 73.76)	49.16	6
Sindhuli	(24, 42.71, 54.30, 72.92)	48.48	7
Sindhupalchok	(19.23,37.85,50.46, 69.17)	44.18	8

Table 4: Decision-makers evaluation and fuzzy rating matrix

Step 8: With the aggregated ratings (Tables 3 and 4) construct the fuzzy rating matrix Table 5.

Attributes	Gorkha	Kathmandu	Kavrepalanchok	Makwanpur	Nuwakot	Ramechhap	Sindhuli	Sindhupalchok
C1	(35,55,67.5, 77.5)	(30,45,45, 65)	(57.5,77.5,85, 100)	(50,70,70, 85)	(52.5,72.5,72.5, 92.5)	(37.5,57.5,57.5, 77.5)	(37.5,57.5,70, 85)	(22.5,37.5,52.5, 72.5)
C2	(52.5,72.5,77.5, 92.5)	(50,70,70, 85)	(52.5,72.5,85, 100)	(60,80,85, 100)	(45,65,80, 100)	(22.5,42.5,72.5, 92.5)	(37.5,57.5,65, 85)	(30,50,57.5, 77.5)
C3	(0,15,15, 35)	(65,85,85, 100)	(30,50,50, 70)	(37.5,57.5,72.5, 92.5)	(0,20,42.5, 62.5)	(22.5,42.5,57.5, 77.5)	(15,30,35, 55)	(0,15,22.5, 42.5)
C4	(45,65,72.5, 92.5)	(60,80,85, 100)	(52.5,72.5,80, 100)	(45,65,80, 100)	(45,65,72.5, 92.5)	(45,65,65, 85)	(22.5,42.5,57.5, 77.5)	(22.5,42.5,57.5, 77.5)
C5	(15,35,50, 70)	(45,65,85, 100)	(52.5,72.5,72.5, 92.5)	(52.5,72.5,72.5, 92.5)	(30,50,72.5, 92.5)	(30,50,57.5, 77.5)	(22.5,42.5,57.5, 77.5)	(7.5,27.5,42.5, 62.5)
C6	(7.5,27.5,50, 70)	(50,70,85, 100)	(30,50,70, 85)	(22.5,42.5,65, 85)	(15,35,50, 70)	(7.5,22.5,27.5, 47.5)	(15,35,42.5, 62.5)	(7.5,27.5,42.5, 62.5)
C7	(30,50,65, 85)	(45,65,70, 85)	(37.5,57.5,65, 85)	(45,65,65, 85)	(37.5,57.5,65, 85)	(7.5,27.5,42.5, 62.5)	(15,35,50, 70)	(15,35,50, 70)
C8	(45,65,77.5, 92.5)	(37.5,57.5,65, 85)	(52.5,72.5,80, 100)	(30,50,57.5, 77.5)	(52.5,72.5,77.5, 92.5)	(30,50,50, 70)	(22.5,37.5,55, 70)	(42.5,62.5,75, 85)

Table 5: Aggregated fuzzy number and order of establishment

Step 9: Combine the normalized weight in Tables 3 and fuzzy ratings in Table 5 using equation (20) to obtain total fuzzy scores for each location. Table 5 shows the resulting scores.

Step 10: Obtain the crisp values of the total fuzzy scores using the defuzzification equation (21), shown in Table 5.

Step 11: Rank the alternatives based on the defuzzified total scores to determine the order of establishment of TLHs (Table 5).

Conclusion

Deciding on the best location and the order of establishment of TLHs to aid humanitarian relief distribution often involves more than one decision-maker, numerous attributes, and the trade-off between multiple objectives. Although, several studies have addressed the problem of determining the location of temporary facilities using optimization approach they have failed to address problems that may arise due to multiple objectives, numerous decision-makers, and resource limitation while establishing those facilities. On the other hand, several other studies have used multi-attribute decision making approach to determine the location of facilities with subjective/objective attributes they simply assume, the location alternatives are already there. In this study, we developed new approach that includes a mathematical model to determine the optimal location for TLHs by using a multi-objective optimization model with dynamic demand, cost, and capacities and a fuzzy simple additive weighing under GDM to determine the order of establishment of TLHs by evaluating various subjective attributes.

The model proposed herein was implemented using data obtained from the Nepal earthquake in 2015. The results of the optimization model accounts for the trade-off relationship between minimizing total costs and unsatisfied demand. Emphasizing on minimizing costs results in decreased demand satisfaction whereas emphasizing on minimizing unsatisfied demand leads to increased cost. The results of the questionnaire with humanitarian organizations show the heterogeneous nature of decision opinions while evaluating location alternatives with respect to subjective attributes highlighting the importance of including multiple decision makers in TLH location problem.

The outcomes of this study are valuable to decision-makers for relief distribution planning when there are non-commensurable objectives, multiple decision-makers, and various subjective attributes. The proposed fuzzy simple additive weighing approach under GDM is especially useful for decision-making during emergency situation because of its ability to take account of vagueness and imprecision. Finally, the practical implications of involving multiple decision-makers early in the location selection process might help to develop a sense of ownership that may aid in enhancing coordination efforts.

However, the model proposed in this study assumes all decision-makers have equal importance, which might not hold true in real-world disaster operations. Developing a method to determine the relative importance of decision-makers and incorporating it into the model is thus a possible extension of the model. Another possible extension would be to consider stochastic nature of relief demand.

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PURSUING SUPPLY CHAIN SERVICE EXCELLENCE AT A REGIONAL SERVICE CENTRE

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Abstract
Purpose: This research project is a real-life case study on an international company that specializes in Test and Measurement instruments which provides various services and solutions to customers in the electronic measurement industry. At one of their Singapore Service Centre, there was a substantial dropped in their customer satisfaction scores attributed to frequent customer complaints. The aim of this project is to purse service excellence in the company's Singapore service centre using six sigma techniques to identify factors that has influence over customer satisfaction as well as to uncover logistic issues that lead to customer dissatisfactions

Design/methodology/approach: The goal of this case study is to provide initiatives to purse service excellence for the company's Singapore Service Centre. The approach used is to utilise Six-Sigma (DMAIC) methodology as the overarching design and using qualitative and quantitative technique to collect and analyse the data.

Findings: Customers' feedback from survey results are sorted into different categories. Using Pareto analysis, we have identified the main critical factors that contributed to most customer dissatisfaction are service turn-around time (33%), service quality (28%) and communication (20%) whereby customers expect a shorter service time of their equipment with better service quality and more efficient communications. Since service turn-around time (TAT) has the highest impact to customer dissatisfaction, an-depth root cause analysis was performed to identify factors that influenced the service turn-around time, which mainly due to work processes, people, availability of resources (core equipment, tools, parts) and environment issues.

Research limitations/implications (if applicable): In a service center context, delay is unavoidable and cannot be totally eliminated due to unexpected factors such as availability of parts, sudden technical failures on core equipment or traffic conditions, etc.

However, it is important and necessary to keep the customer informed of the order progress and alert them on potential delay.

Practical implications (if applicable): The company recognised the importance of excellent customer service and service quality will creates good reputation, customer loyalty as well growth in business because customers are more likely to return to the business if the company is able to resolve their issues, exceed their expectations and delight them with the service experiences. Hence, with the implementation of three improvement solutions expect to increase customer satisfaction level and service performance in terms of improvement in service turn around, service efficiency and customer experience.

Originality/value: The research is undertaken at a company based in Singapore.

Keywords: Parts Management, Repair center, supply chain management, Six Sigma

Introduction

In today's competitive market, companies need constant enhancement on their services delivery in order to strive for better customer satisfaction and to be stays the leading edge in the industry.

XYZ Company in this research paper is one of the Test and Measurement expertise that manufacture and offer solutions to the communications, aerospace/defence, computer and semiconductor industries. The organization has about 9,500 employees and 20 service hubs strategically located worldwide to provide sales and post- sales support (repair & calibration services) of their products to their customers.

In order to stay competitive and provide high customer service standards, one of the key strategies the organization adopt is to produce quality work and pursue shorter turns around time in their services so as to minimise customer's production downtime. As such, it is vital for the organization to identify savings opportunities in terms of cost, quality, and rework along the value chain to improve productivity and responsiveness to their customers.

Figure 1 is the illustration of the Order-to-Delivery process in Singapore Service Centre for their Calibration & Repair service.

As the organisation believe and emphasize customers are the heart of the company, the management recognise the importance to gains insight through active listening to identify customer needs and to looks outside in vs inside out, to deliver customer-centric solutions.
However, based on the past quarters customer satisfaction surveys, the ratings on the service level were mediocre and the common issues gathered include:
• Service turn-around-time (TAT) - Can be timeless, especially for repair services
• Customer Communication - Responsiveness and customer Interaction
• Service Quality - Accuracy of the information or reporting
• Price – steep compared to competitors
• Local hub capabilities – need transhipment to other overseas hub, which affect overall service TAT
• Damages – customer's unit damaged due to poor handling and packaging

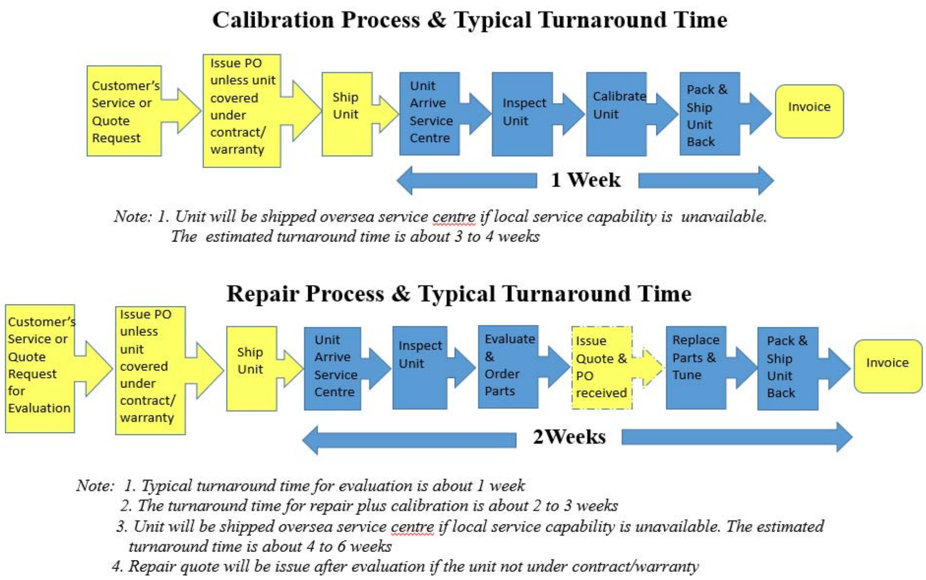


Figure 1: Order-to-Delivery process in Singapore Service Centre for Calibration & Repair

Hence, it is crucial to understand the dynamics and available touch points of the entire process to optimize service efficiency and customer interaction to improve the customer satisfaction.

Research Methodology

In Traettino (2010), a manufacturer of high-quality flow meters and accessories for accurate liquid measurement has applied Six Sigma methodologies to improve their service delivery processes to service their customer better. Along the line of Six Sigma method, a homebuilding business company used the customer satisfaction survey results to measure their current performance and implement changes in their process to meet theirs customer needs and expectations (Thomas, 2014). Echoing this, IKEA made use of Six Sigma methodologies and techniques to revamp their existing process workflow to improve their customer service quality and thus successfully reduced the number of customer complaints (Miski, 2016).

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.
Data collection for this project mainly will come from primary and secondary sources extracted from the organisation's business system. The primary data consists of the cycle times of an order at each process stage, from the time an order is logged, to when service starts, to the time service completion, to the time equipment shipped. The secondary source data are mainly collected from the Voice-of-Customer (VOC), can be from external or internal customers, via survey, emails, online feedback, telephone interviews and face to face meetings. Both sources can be a mixture of qualitative (text, images) and quantitative (numbers), as many research papers usually collect and combination of these two to obtain better evaluation data.

VOC is a process used to collect customer's requirements/feedback through a survey about the quality and customer satisfaction levels on the services they received. Collecting such data is a key component under Define phase of DMAIC, just like a report card which provides information to the company on their performance in terms of service quality and customer satisfaction level of their service, as well to understand what customers' expectations and requirements from the service they delivered.

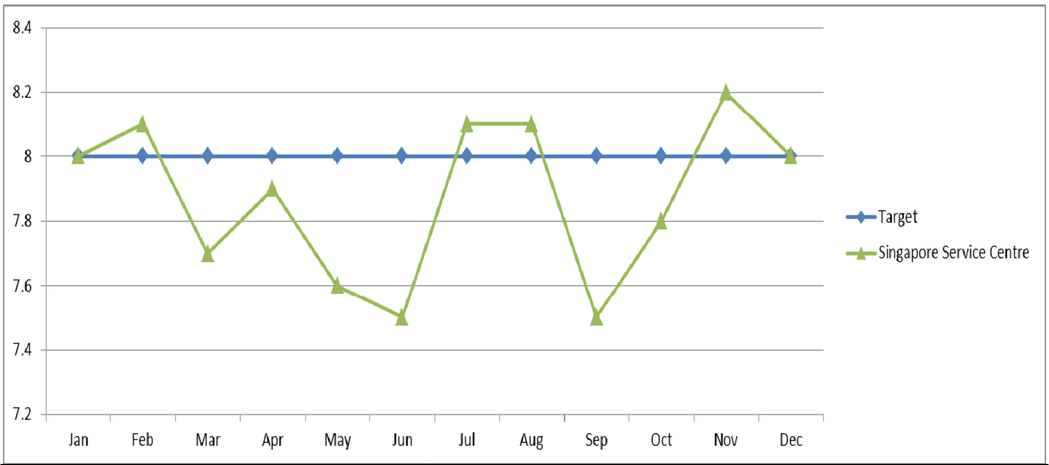
XYZ Company carried out customer surveys weekly with an average of about 20 customers randomly selected by the system based on the service orders logged within the past 6 months. Customer was asked to rate with a score of 0 (poor) to 10 (excellent) on the service they received from XYZ. The survey questions ranged from how customer was treated and experience to their perception of the service performance of XYZ in form of speed and quality throughout the entire service of their equipment. Customer is also asked to provide comments or suggestions on how XYZ can improve their service levels.

Results

Customer Satisfaction Trend & Performance

Based on year 2014 monthly survey, the customer satisfaction average rating for XYZ's services was mediocre and some of months the ratings fall below the target as shown below:

Despite of that, most of the customers still satisfied with XYZ's service delivery where 5% ranked as very good, 41% as good and 43% feel Ok, except 11% considered the service received was not so good or bad.



Customer Survey Score	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Target	8	8	8	8	8	8	8	8	8	8	8	8
Singapore Service Centre	8	8.1	7.7	7.9	7.6	7.5	8.1	8.1	7.5	7.8	8.2	8

Figure 2: Customer Satisfaction Trend & Performance for Year 2014

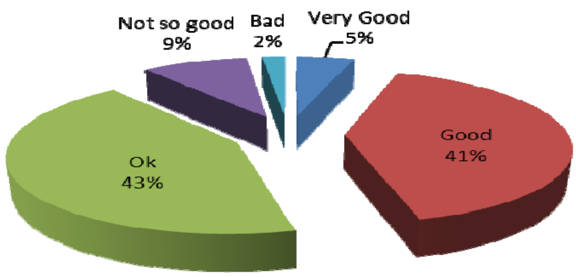


Figure 3: % of Customer Satisfaction on XYZ' Service

In order to analysis what factors that bothers customer satisfaction, XYZ classified the customer feedbacks into the categories as shown in below:

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%**	

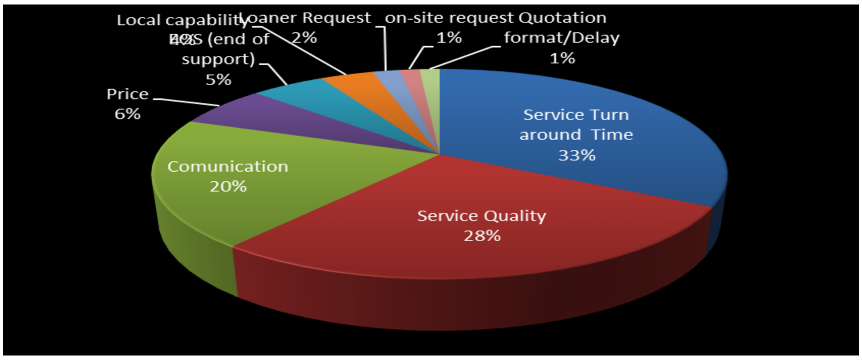


Figure 4: Classification of customer's feedback

Pareto Analysis
Using the breakdown of the customers' feedbacks, Pareto Chart is plotted to identify which are the top critical factors (20%) that contribute most of the customer dissatisfaction (80%). From the chart in Figure 5, we can see the major problems contributed 80% of customer dissatisfaction lies on service TAT (33%), follow by the service quality (28%) in terms of logistic issues and the communication (20%).

We will be focusing on the service TAT since it has the highest percentage and look for improvement opportunity to this issue at roots by using Cause and Effect diagram analysis.

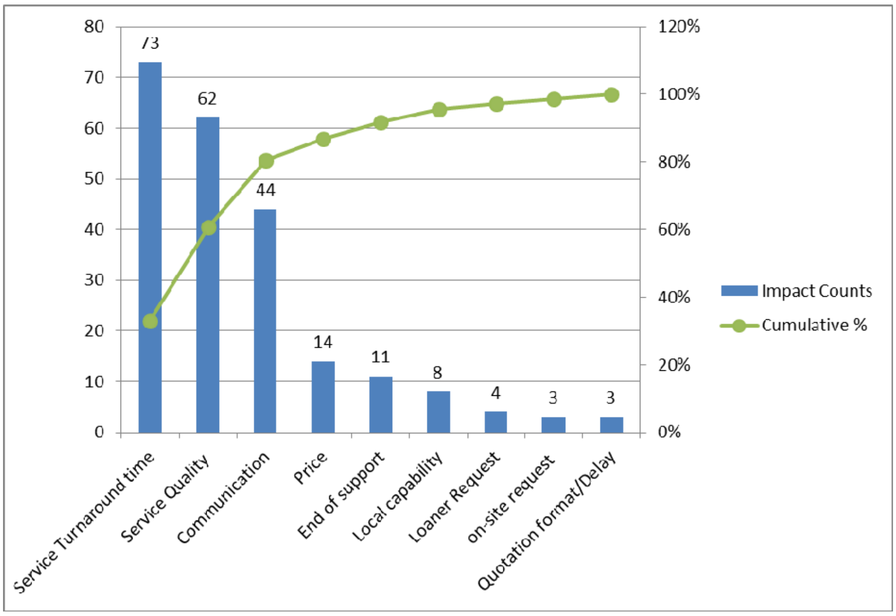


Figure 5: Pareto chart analysis on factors contributes customer dissatisfaction

Cause and Effect Diagram
With the cause and effect diagram, it helps to list down what are the potential causes that contribute and affect the service turn around, and then we will need to look for possible solutions to eliminate these causes.

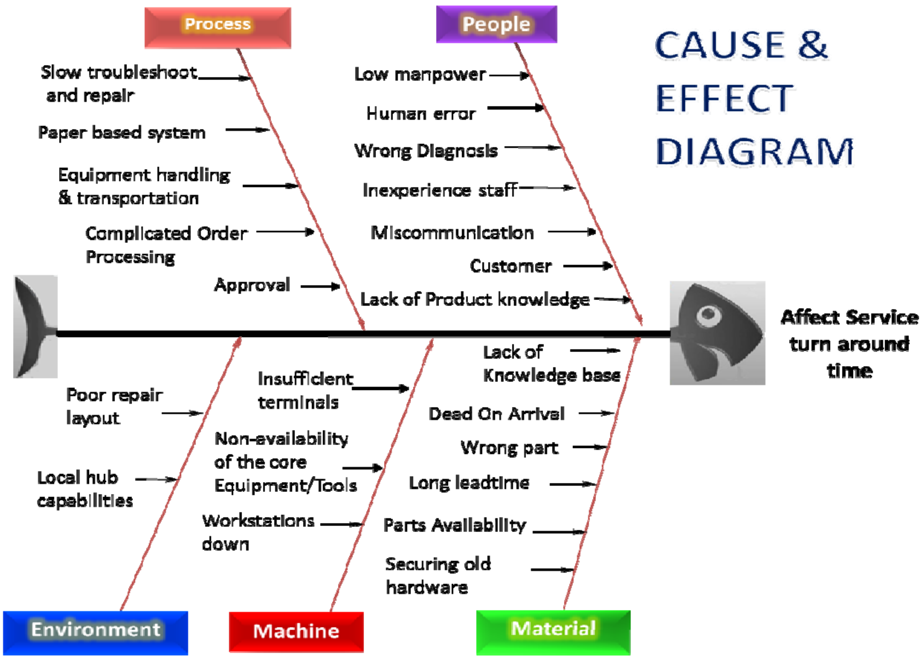


Figure 6: Cause and Effect Diagram

Before looking for improvement opportunities, let's take a look at XYZ normal TAT performance against general customer expectation.

Service type	Normal TAT (local)		Customer expected TAT
Calibration	Within 7 days (72%)	Within 10 days (86%)	Within 3 to 5 days
Repair	Within 7 days (60%)	Within 14days (85%)	Within 7 days

Figure 7: Normal TAT vs Customer Expected TAT

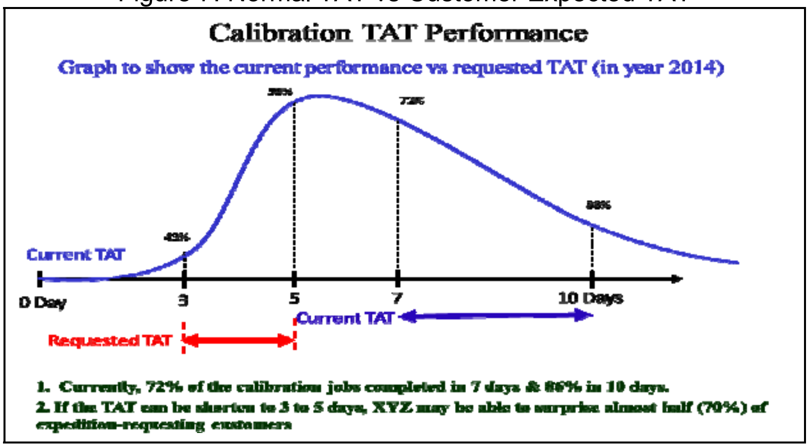


Figure 8: Current calibration TAT performance

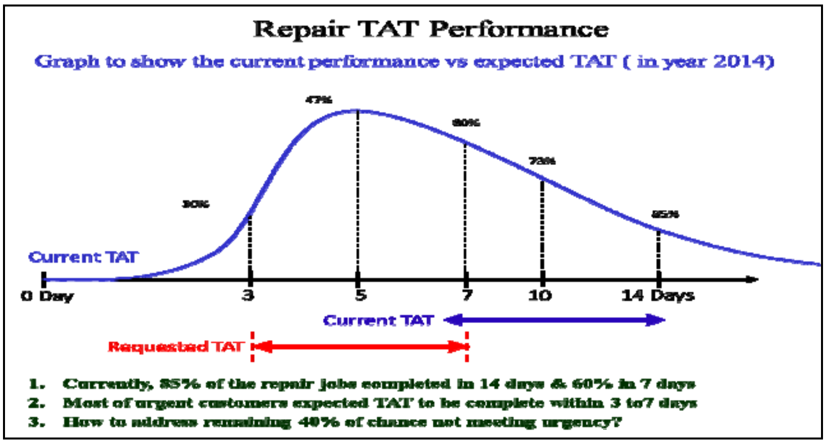


Figure 9: Current repair TAT performance

Through the brainstorming sessions and from perspectives of customer service, service center and logistics, some possible improvement ideas were determined and presented with an affinity diagram as below for management decision on what need to be done.

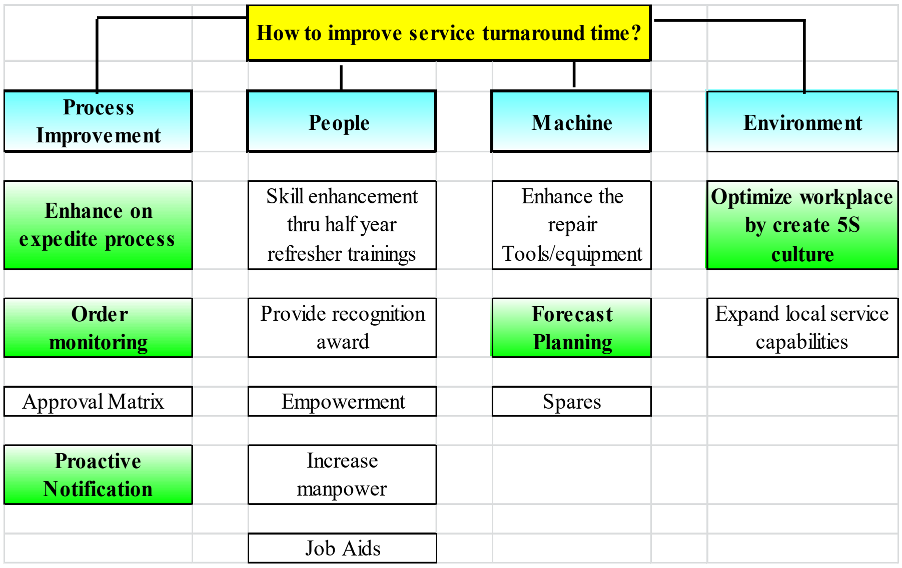
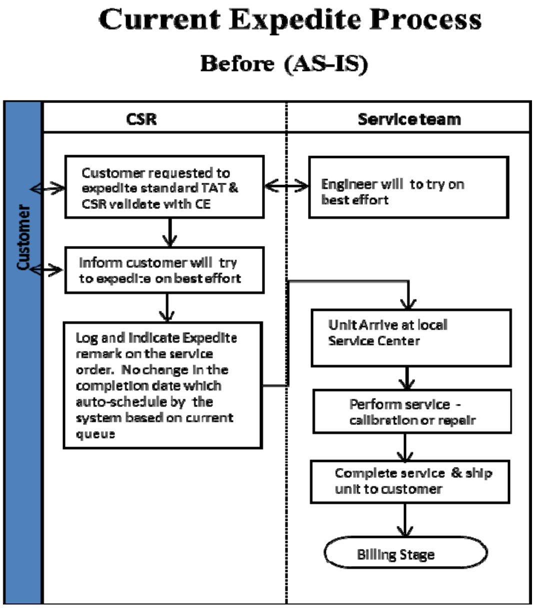


Figure 10: Affinity diagram on possible ideas

Enhancing the Expedite Process

XYZ have been practicing manual TAT expedite process to address customer urgent needs and the expedited TAT will be on best effort basis without firm commitment. Most customers felt satisfied with this best effort when the TAT has been shortened. However, customers felt unhappy when XYZ is unable to provide a no firm commitment on schedule return date or failed to meet their expected return date. Moreover, customers will have to pay extra premium if needs for an express service, which most customers are unwilling to unless otherwise. Hence, it would be a great, from the customer's perspective, if XYZ is able to reduce the general turn-around time or meeting customer's expected date, and yet customers do not have to pay an express premium.



1) Customer Service Representative (CSR) will upfront provide the standard TAT to set the right expectation to the customer.
2) When customer needs shorter TAT, expedite process kicks in where CSR will email service team for expedition and inform customer their urgent request will be on best effort.

Figure 11: Current expedite process (AS-IS)

As proposed in Figure 12, the new to-be process steps not only creates TAT improvement but gives an more heart touching customer experience in terms of:

- Assurance as customer feels assured that XYZ really make efforts and goes all the way to expedite to meet his request.
- Date commitment as XYZ commits to ship on time and customer knows exactly when he will get his unit back.
- Optimize customer interaction as CSR will give a happy return call back to close the loop with the customer and delight them on the new TAT expedition experience.

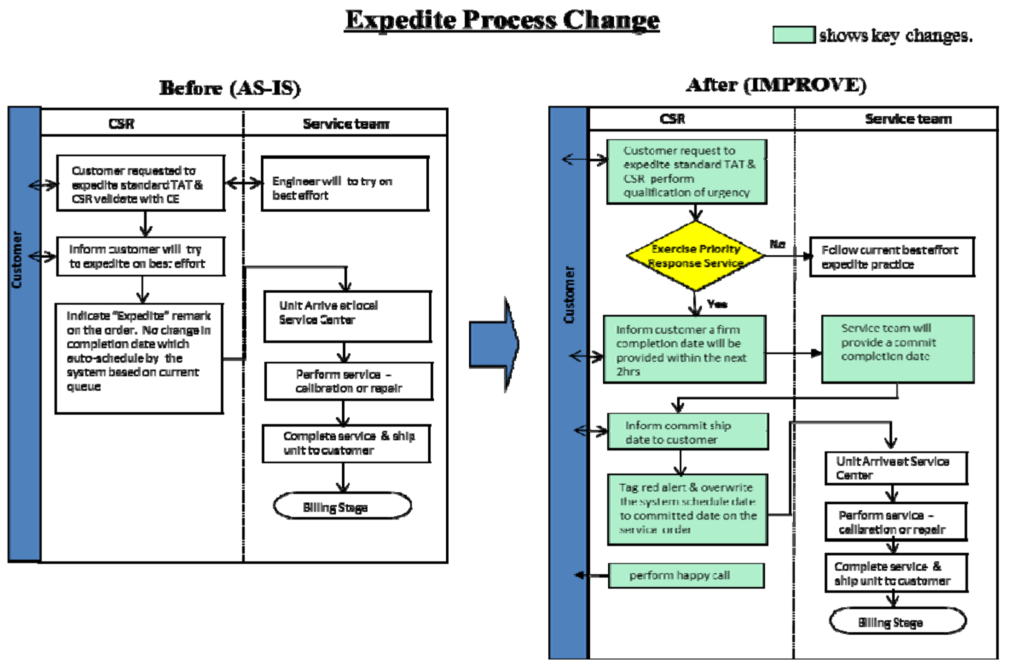


Figure 12: Expedite process change (TO-BE)

Conclusion

First of all, we have collated customer's feedbacks from surveys results into different categories. Using Pareto analysis, we have identified the main critical factors that contributed to most customer dissatisfaction are the service turn-around time (33%), service quality (28%) and communication (20%) whereby customers expect a shorter service time of their equipment with better service quality and more efficient communications.

Since service TAT has the highest impact on customer dissatisfaction, an-depth root cause analysis was performed to identify factors that could influence the service TAT which have been identified as work processes, people, availability of resources (core equipment, tools, parts) and environment issues.

Through brainstorming sessions and using affinity diagram, we have proposed 3 areas of improvement and made use of process mapping to illustrate process improvement to assist us in achieving the 3 research objectives outlined:

- Enhance the Expedite Process – create new priority response service process to manage urgent request and improve customer experience.
- Create 5S culture in the service center – to increase work efficiency by eliminating wastes and optimization resources and layout structure improvement.
- Proactive notification to the customers on service status – managing and delivering alerts, reminders and updates to the customers at all stages of the order cycles.

XYZ recognised the importance of excellent customer service and service quality will create good reputation, customer loyalty as well growth in business because customers are more likely to return to the business if XYZ able to resolve their issues, exceed their expectation and delight them with their experience on the serviced provided. Hence, with the implementation of three improvement solutions expect to increase customer satisfaction level and service performance in terms of improvement in service turn around, service efficiency and customer experience.

In order to pursue customer service excellence and stay competitive, XYZ has to be continually focus of what their customer wants thru the on-going survey results and cultivate a mind-set to think from customer's perspective.

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REDESIGN A TIME RESPONSIVE DISTRIBUTION NETWORK USING SIMULATION

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ABSTRACT

This paper aims to redesign a more effective distribution network for a fast-moving consumer goods (FMCG) company in Singapore so as to ensure a higher service level with minimized cost structure. Both strategic and operational approaches are applied in this study. At the strategic level, well-known distribution network models are introduced and five most important factors required for selecting the design of the distribution network for the company (response time, product availability, inventory, transportation, and facility & handling) were identified. After analysing the delivery data of the company, two demand and delivery patterns were identified for the five current delivery channels. For the second part of the study, at operational level, an agent-based simulation model is developed to investigate the trade-off analysis of service level versus cost. Clustering method is implemented to aggregate demand points according to their geographical locations. At strategic level, two different distribution network designs are recommended for identified demand and delivery patterns. For the first demand pattern, manufacturer storage with direct shipping is suggested while distributor storage with last mile delivery is recommended for the second demand pattern. At the operational level, a simulation model assists the company to analyse the effects of different scenarios such as opening a new DC, modifying fleet size, changing replenishment policy, closing/opening channel(s), etc. For instance, the results revealed that adding a new distribution centre reduces the operating costs by 30%. This cost saving covers new DC's expenses such as rental, manpower, etc.

Keywords: Distribution network, Simulation model, Service level, Operational costs, Consolidated deliveries.

Introduction

Singapore is ranked number one among more than 170 countries in the World Bank's 'Ease of Doing Business' rankings. Company based in Singapore enjoy greater ease of trading across border and policy maker is also interested in trade facilitation to reduce non-tariff barriers. The beverage industries have significant impact in Singapore economy and development. According to Tonby (2016), beverage and food industry contributed to 38% of manufacturing related Foreign Direct Investment in Singapore. The objective of this paper is to explore distribution network design that enables a beverage company to win in Singapore market. The desired distribution network has the following features: 1) meet customer demand with better agility and responsiveness. 2) competitive and sustainable cost structure. At strategic level, two distribution models are selected based on industry and market characteristics. At operational level, an agent-based simulation model is developed to evaluate different scenarios before implementation phase.

A few innovations in supply chain industry are considered to improve the base distribution model on both service level and cost structure. For beverage industry, products are generally fast moving and consumer demand could be easily fulfilled by competitors. Therefore demand coverage and distribution responsiveness are most important performance measurement for the new network. The custom clearance at Singapore and Malaysia border and road congestion during peak hours are identified as key bottleneck. If custom clearance and urban logistics can be handled with better efficiency, the beverage company can achieve higher service level with lower distribution cost.
In next section, a thorough literature review on distribution network design and recent innovations on urban transportation is provided. Section 3 is the analysis of specific models relevant to the company's situation and discussions relating to the conceptual network design. In section 4, we study the distribution network in an operational level and develop a simulation model. Our findings are summarized in Section 5.

Literature Review

In logistics sector, Singapore in ranked number one in Asia Pacific region based on Logistics Performance Index published by World Bank in 2015. Singapore outperforms most of countries regionally on custom clearance efficiency and complexity, infrastructure quality, shipment timeliness, competence of local logistics industry and so on ("Ranking of economies - Doing Business - World Bank Group." 2010). According to Layton (2007), these advantages make Singapore the top choice to international companies to start and develop business. On the other hand, Singapore is one of the most densely populated cities with more than 5.5 million residents. Company based in Singapore has to face challenges in resource scarcity in land, transportation and labour. To deal with the limitations, De Souza et al. (2014), discussed consolidation warehouse and synchronized last mile as solution to urban logistics constraints.

According to Chopra, (2003), distribution network can be classified into six distinct designs: 1) Manufacturer storage with direct shipping. 2) Manufacturer storage with direct shipping and in-transit merge. 3) Distributor storage with package carrier delivery. 4) Distributor storage with last mile delivery. 5) Manufacturer/distributor storage with customer pickup. 6) Retail storage with customer pickup. Each design has its own strength and weakness and the six models can be adopted in hybridly to achieve better performance. In both Chopra, (2003) and Xia, (2009), work, service level and distribution cost are identified as key measures to evaluate distribution network performance. Service level considered various elements impacting network structure: responsive time, stock availability, product variety, customer experience, order visibility and returnability. Distribution cost can also be categorized into transportation cost, facility and handling cost, inventory cost and information cost.

De Souza et al. (2014) proposed the concept of consolidation centre to enhance multi-party coordination in urban logistics. The consolidation centre is a facility in which goods are consolidated to bundle inner-city transportation. Use of consolidation centre can increase load factor, decrease commercial vehicular traffic, reduce emission and increase overall service level. However, to rely less on governing authority and make the operation financially viable, a flexible and dynamic model is needed to attract and retain different parties and stakeholders. Use of logistics service provider is one of the ways to join the collaborative network. Vasiliauskas et al. (2007), examined advantages and disadvantages in 3PL application. Outsourcing the warehouse to 3PL can benefit company in a few aspects. Firstly, company will be able to better utilize resource to focus on their own competency and core business. Secondly, utilizing a 3PL distribution provider allows flexibility to set up and scale distribution model as demands shift. Furthermore, company save significant capital expenditures in warehouse set up and obtain economies of scale by outsourcing. Lastly, company can leverage 3PL expertise in process and industry to improve service level. However, there is risk in selecting and maintaining a 3PL as strategic partner. Distribution network design has been a very active research area. Macharis et al. (2011), presented a Multi-actor multi-criteria analysis on night-time delivery for urban distribution. Various stakeholders' perspective are incorporated into the case study. It is promising to implement night-time deliveries but only in selective time and type of business. As there will be conflict of interest among stakeholders, their concerns must be addressed appropriately to win general support on implementation.

After the single window concept is widely embraced by ASEAN, the regional community has set further plans to integrate the existing system for better trade facilitation. The ASEAN Framework Agreement Facilitation of Goods in Transit (AFAFGIT) set the legal framework for ASEAN Customs Transit System (ACTS) ("Brochure ACTS - Arise - Asean." 2014). It is on track to complete pilot implementation in Singapore, Malaysia and Thailand by 2016. The ACTS offers direct access to all traders through a secure and efficient computerised Customs transit management system. By increasing the efficiency for legitimate trade, this facilitation allows traders to shorten transportation lead time with cost reduction.

Allan et al. (2005), discussed numerous Urban Consolidation Centre (UCC) scheme in literature and existing set-ups and constructed a framework for urban consolidation centre. The report also summarized advantages and disadvantages of urban consolidation centre. Key elements in UCC scheme evaluation are identified as number of vehicle trips, travel distance, travel time, number of vehicles, goods delivered per delivery point, vehicle load factor, loading/unloading time and frequency, total fuel consumption, vehicle emission and operational cost. UCC also has impact on other supply chain activities such as transport operation, inventory control, delivery location and product flow. Essentially, UCC help to maximize utilization of available capacity by reducing the time and distance travelled and number of vehicles needed in final delivery stage. However, the benefits need to be considered together with the capital and operating cost, added supply chain complexity and also the security and liability issues.

Strategic Level Analysis

Different Distribution Networks Design

Distribution network of a company mostly handle and store the goods of the company and maintain the flow of the goods from suppliers to final customers. It is very important to select the appropriate distribution network, as it is directly related to the cost and service level of the company. Distribution network for different companies are different depending on the specific objective of the particular company. The ultimate goal of the distribution network is not to achieve highest performance in every area of the supply chain, rather to fulfil the requirement of the customer while maximizing the profitability of the company. In case of the companies, which customers can endure long response time, can have fewer location with higher storage capacity. On the other hand, the companies with customers who expect lower response time need to have many facilities with low capacity and closer to the end customers. According to literature, the performance of any distribution network should be evaluated along two dimensions:

1. Customer needs that are met, which influences the company's revenue
2. Cost of meeting customer needs, which influences the profitability of the delivery network

The different Designs of distribution networks are specified based on two decisions:

1. Whether the products will be delivered to customer's location or the customers will pick up the products from a predetermined location
2. Whether the product will flow through an intermediary

Based on the above-mentioned decisions, six different designs are defined:

A. Manufacturer storage with direct Shipping
B. Manufacturer storage with direct shipping and in transit merge
C. Distributor storage with package carrier delivery
D. Distributor storage with last mile delivery
E. Manufacture/distributor storage with customer pickup
F. Retail Storage with customer pickup.

Choosing distribution network for the beverage company

While choosing distribution network for any company, it is very important to consider the product characteristics as well as the service and cost factors, which are more important for that particular company. As discussed before, different networks have different merits and demerits. It is very important to first define the product characteristics and the network requirement for the company before choosing the appropriate distribution network. Characteristics of a bevarage company are listed below:

- The products are fast moving consumer goods.
- Profit margin of product is quite low.
- It has several big competitors, so the pressure for the competitors is quite high.
- Weights of All the products are mostly heavy.

Network Requirements

There are six factors in customer service, which influence the distribution network. Those factors are response time, product variety, product availability, customer experience, order visibility and returnability. On the other hand different distribution network design affect some supply chain costs, which are inventories, transportation, facilities and handling and information. Chopra, (2003) has created a table where he ranked different strength and weakness of the six-network design relative to each other's. According to the table, one particular distribution model cannot be selected, which will fulfil all the factors important for a beverage company. For example: response time and transportation is showing high performance for retail storage with customer pick up but in case of product availability and facility and handling, the table is showing low performance. In order to find the most appropriate distribution network for the company, the data related to the customers and delivery need to be analysed.

Data Analysis

Total drop size for all the channels per week is 500,000, which is quite large. Table 1 shows the total drop size for all the channels per week and their percentage.

Channels	Total drop size/week	Percentage
A	100,000	20%
B	120,000	24%
C	150,000	30%
D	80,000	16%
E	50,000	10%

Table 1: Drop Size per Week

According to the graph, the drop size for channel A is 20%, channel B is 24%, channel C is 30%, channel D is 16% and channel E is 10%. According to the data the drop sizes for channel A are quite large comparing to other channels but the relative drop size for the channel is not highest compares to other channels. The main reason behind this difference is the number of drop point for each channel. For channel A drop points are only 5 whereas the drop point for other channels are 21,030. So it is clear that it would be feasible for the company does use different distribution networks for the different channels. Table 2 shows trips per week per channel and the drop size per week per delivery points.

Channels	Trips per week	Drop size/delivery point
A	30	3,500
B	6,000	20
C	7,000	25
D	5,000	10
E	3,000	5

Table 2: Trips per week and drop size per delivery point

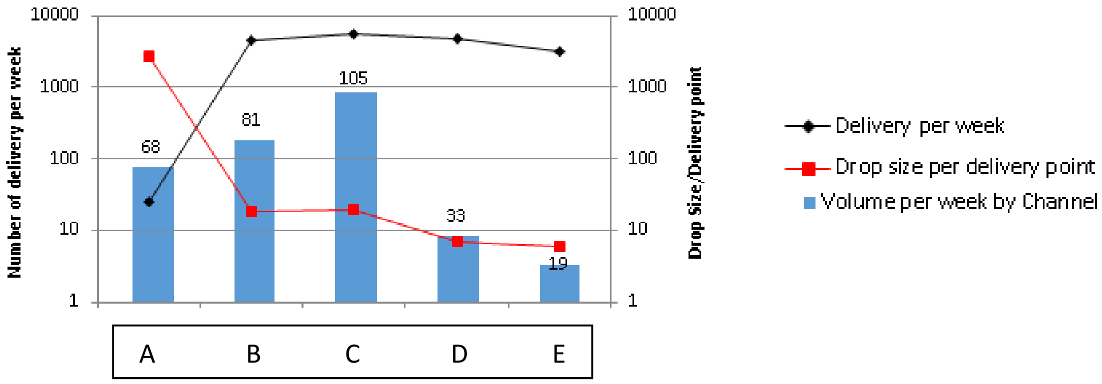

Figure 1: Comparison between Delivery Size and Frequency by Channel

Figure 1 shows, given the volume of the channels per week, as the delivery frequency decreases drop size per delivery point increases. It can be said that there are two demand and delivery patterns for the given five channels of retailers. For first pattern, which is for channel A, the drop size per point is quite large but the frequency of delivery per week and the total numbers of delivery points are quite low. The second pattern, which is for the rest of the channels or retailers, drop size per point is quite low but the frequency of delivery per week and the total numbers of delivery points are quite high. The company has different types of customer with different demand pattern. So it is not feasible for the company to deliver the products to different channels by using the same distribution network. After analysing the data, it can be said although the company has five different channels or parties where the company need to deliver the products, there are mainly two different type of delivery pattern. One pattern is for channel A and another one is for the rest of the channels. So the distribution networks suitable for these two patterns are as follows: In case of channel A, the drop size per point is quite large but the frequency of delivery per week and the total numbers of delivery points are quite low. In this this scenario, most suitable distribution network is the manufacturer storage with direct shipping. In case of rest of the channels, drop size per point is quite small but the frequency of delivery per week and the total numbers of delivery points are quite high. The company actually delivers their product to every outlet under this category. So for this demand pattern the most suitable distribution network is distributor storage with last mile delivery.

<u>Operational Level Analysis</u>

Supply Chain map

Supply Chain map of the company in Singapore is demonstrated in Figure 2. The network consists of 2 plants, 1 distribution centre, 5 warehouses and 6 distribution channels.

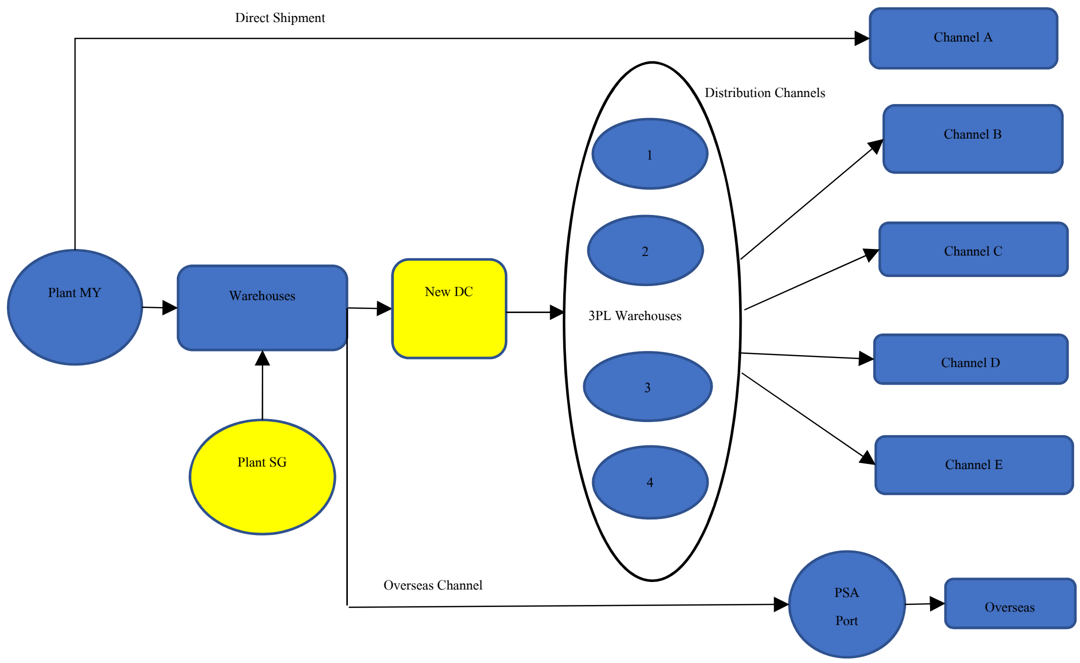

Figure 2. Supply Chain Map

Considering high manufacturing costs of SG plant and low transportation costs between Malaysia and Singapore, the company decided to shut down SG manufacturing and fulfill Singapore market's demand from Malaysia plant.

Creating Master File
Starting the data collection phase, we realized that there is no integrated data base to be used as simulation model input. Therefore, we created a master file using excel VBA which combines all available single files and exports required data to an integrated file based on some key and unique indexes. We collected historical demand data and used "EasyFit" software to fit an appropriate distribution function.

Simulation Model
We developed a simulation model using Anylogic as a multimethod simulation modeling tool. An agent-based simulation methodology is applied that combines elements of game theory, complex systems, emergence, computational sociology, multi-agent systems, and evolutionary programming. The model contains three main mudules which are listed below:

Clustering: To define four clusters (West, North, East and Central) according to customers locations.

Order Consolidation: To consolidate all received orders based on zone definition and cut off time.

Truck Assignment: To assign trucks to deliver to retailers located in each zone based on truck type and order amount.

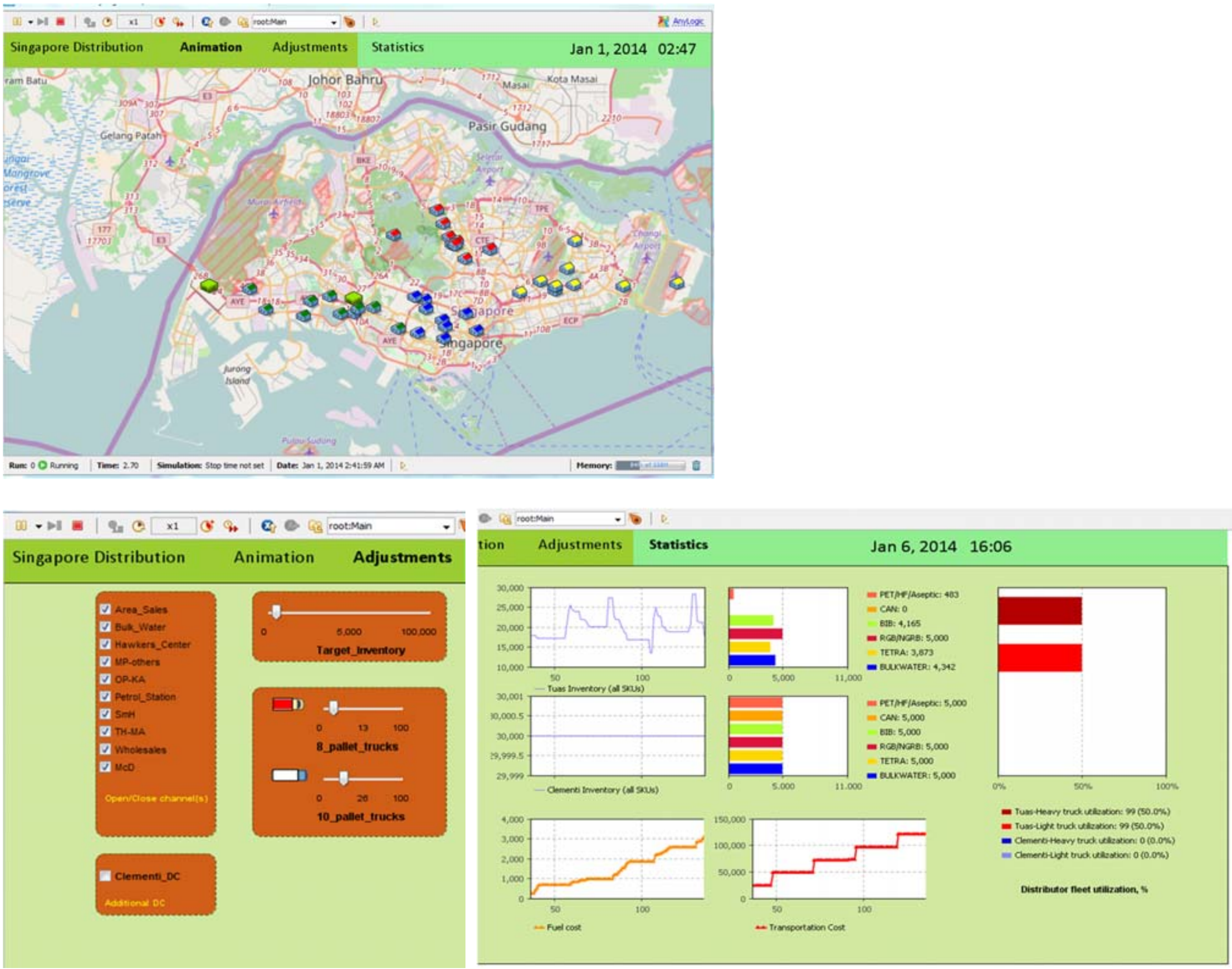

Figure 3. Simulation Dashboards (Animation, Adjustment and Statistics)

We use Master file as input of simulation model and output is a trade-off analysis of service level versus cost (Figure 3). This helps the company to compare different scenarios of the number and quality of distribution features and make the best decision based on desired service level and its associated costs.

Conclusion

This paper seeks to undertake the study of different distribution network models and innovative distribution strategies to build an appropriate distribution network for a beverage company in Singapore. The company has decided to shut down the manufacturing plant in Singapore and use the plant in Malaysia to fulfil Singapore market demand. The main goal is to establish an innovative distribution network for the company in Singapore to ensure higher service level with minimized cost structure. We applied both strategic and operational approaches in this study to figure out what is an appropriate distribution network design for the company in Singapore. At the strategic level, well-known distribution network models are introduced and five most important factors required for selecting the design of the distribution network for the company, which are response time, product availability, inventory, transportation, and facility &handling, were identified. After analysing the delivery data of the company, two demand and delivery pattern was recognized for the five currents delivery channels. Two different distribution network design are recommended for identified demand and delivery patterns. For the first pattern, which includes channel A, manufacturer storage with direct shipping was chosen and for the second pattern, which includes other channels, distributor storage with last mile delivery was chosen. For the second part of the project, at operational level, we developed a simulation model using agent-based methodology. A master file has been created to integrate all required data for simulation model. The simulation model uses the master file as an input and the output of the model will be a trade-off analysis of service level versus cost. The transportation costs considers in the model as integral portion of distribution network costs and Delivery in Full on Time (DIFOT) performance is defined as service level indicator. For validation propose, the developed model has been run using two months provided data and the results support accuracy of the model. This simulation model can support the company to evaluate the outcome performance of new scenarios before implementation phase. We ran the model for the scenario of shutting down SG plant and opening a distribution centre at Celementi area. The result revealed that this decision leads to 30% reduction in operating costs.

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RESTRUCTURING A PRE-EXISTING SUPPLY NETWORK IN THE FMCG INDUSTRY AND ANALYSIS OF STAKEHOLDERS CONFLICTS

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Abstract

Purpose: This paper seeks to provide an understanding of the key parameters to consider in the decision making process for restructuring effectively and efficiently a pre-existing supply network of a fast-moving consumer goods (FMCG) supply network in the Asia Pacific region. The perspectives of the various stakeholders are compared, and the differences highlighted.

Design/methodology/approach: We apply the combined fuzzy Analytic Hierarchy Process (fAHP) and fuzzy TOPSIS to select the critical parameters to consider in the decision making process, to determine weights of the criteria/sub-criteria, and finally identify the best actionable strategies to implement across the supply network.

Findings: The preliminary results suggest that the manufacturer and distributors have different motivations and hence have conflicting objectives for the optimization of their respective supply chains. While the manufacturer focuses on enhancing the availability of goods on the shelves of the final stores, the distributor would rather prioritize on cost savings and inventory minimization. This leads to myopic optimization and highlights an opportunity for better synchronization.

Research limitations/implications: The main limitation of this work is the sample size used in the analysis, leaving us with a guarded conclusion. MCDM would need to be extended to include the conflicting motivations and objectives for bi-level optimization

Practical implications: The practical results provided by this paper bring a real-life understanding of the stakeholders' conflicting views and motivations for the optimization of their supply chains.

Originality/value: It adds value to the supply chain management literature by providing an actual case study. This case is able to support bi-level decision making when designing cost effective and time responsive supply networks, taking note of the various stakeholders' objectives when framing a model for solution.

Keywords: Supply network restructuring, MCDM, Fuzzy-AHP, Fuzzy-TOPSIS

Introduction

A supply network (SN), which typically includes various stakeholders like suppliers, manufacturers, third party logistics service providers (3PLs), distributors, stores, and final consumers, starts with input of raw materials and ends with product consumption (Yanfang, et al., 2016). Due to market globalization and raised competitiveness, stakeholders within the same SN are nowadays required to work even more closely one to another as to drive cost savings and overall SN effectiveness (Jang, et al., 2002). However, effective coordination manufacturing-distribution (MD) remains a major challenge, with competitiveness and profitability of the various organizations being constantly at stake. In the context of fast-moving consumer goods (FMCG) sector, challenges derived from MD conflicts are further magnified by the combination of factors such as rampant market competitiveness and low customer retention, especially in developing geographies of Asia Pacific region.

Previous research groups have developed a fair number of model in the domain of MD conflicts and coordination, but only a limited number of researches, with practical applications, are actually available. Few scholars have given attention to development of model and algorithms, and even fewer link the conceptual developments with practice. Yanfang et al. (2016) have developed a bi-level programming to model an integrated MD that involved both conflict and coordination. The model considers the core firm as the leader in the hierarchical process that makes strategic decisions (e.g. closing/opening new warehouses, warehouse locations) as to minimize the total cost to reach out to the market. In the lower level, the distributors' objective is to minimize the costs in just in their own branches, and make decisions based on core firm's decisions. A hybrid approach which combines fuzzy logic controller algorithm with priority-based two stage genetic algorithm is proposed to address the optimization problem, and a real world example is used to test the model and the algorithm. Sabri & Beamon (2000) looked at both strategic and operational MD planning from the standpoint of multi-objective decision analysis and measurement of system performances as to incorporate cost, customer service levels, and flexibility. Other research groups like Liang (2008) and Chen (2010) have respectively focused their efforts on developing a multi-objective linear programming to solve integrated multi-product and multi-time period production/distribution MD planning decisions and investigating the effects of various factors relevant to item substitution on two-echelon MD networks in decentralized SN. In the reality, stakeholders included within the same SN, might have conflicts due to their own aims and interests (Xu, et al., 015), and MD planning might get significantly impacted by the mutual influences of such conflicts (Yanfang, et al., 2016). To date, no research has dealt with MD problem involving supply chain restructuring in developing nations in the case of more than one decision maker involved. Limited literature is available about actual case studies on MD conflicts and conflictive views on key parameters[7] to consider in the decision making process for restructuring effectively and efficiently a pre-existing supply network in the Asia Pacific region. To fill this research gap, we have integrated fuzzy Analytic Hierarchy Process (fAHP) and fuzzy TOPSIS to a real world MD case in the FMCG sector. The remainder of the paper is structured as follows. Section 2 sets the background of the research. Attention is paid to multi criteria decision making methods, particularly fuzzy AHP and fuzzy TOPSIS methods. The complete framework of methodology is then presented in section 3. Section 4 describes the case at hand, situational analysis, criteria and alternatives for the case. Results are presented in section 5. Finally, the implications of this research are presented in Section 6.

Literature Review

Multi Criteria Decision Making (MCDM) indicates a discipline of operations research that considers decision problems in a context of a number of decision criteria (Triantaphyllou et al., 1998). Specifically, MCDM includes a series of techniques "aimed at supporting decision makers faced with evaluating alternatives taking into account multiple, and often conflictive, criteria" (Thokala, 2011). A generic MCDM modelling can be developed in a multi-step approach which includes: a) Identification of alternative solutions, b) Definition of criteria (or attributes) against which the alternatives are to be compared, c) Determination of scores that reflect the value of an alternative's expected performance on the criteria, and, d) Determination of criteria weights that measure the relative values of each criterion as compared to others (Thokala, 2011). It follows a concise description of the fuzzy MCDM tools utilized is this research: fAHP and fuzzy TOPSIS.

Fuzzy AHP (fAHP)

Fuzzy AHP integrates Saaty's AHP theory with fuzzy set theory. In the fAHP methodology, experts are required to provide in inputs in the form of linguistic expressions in a pairwise comparison matrix. Then, values are converted using fuzzy judgment matrices, whereby all elements and weight vectors are represented by triangular fuzzy numbers. Finally, fuzzy arithmetic operators are used to rank the alternatives on the bases of the rank of fuzzy numbers (Viswanadham & Samvedi, 2013).
For the case at hand. fAHP is used to determine the criteria weightage (score), and criteria will be compared using linguistic terms shown in Table 1. These factors will be then be used to make pairwise comparison matrices. The weights of the criteria for strategy[8] selection are found from these matrices using the synthetic extent value method described in Tang & Lin (2011).

[7] In this paper, the word "parameter" is used interchangeably with "criterion"
[8] In this paper, the word "strategy" is used interchangeably with "scenario"

Numerical values	Definition	Fuzzy triangular scale
1	Equally Important (Eq. Imp)	(1, 1, 3)
2	Weakly Important (W. Imp)	(1, 3, 5)
3	Fairly Important (F. Imp)	(3, 5, 7)
4	Strongly Important (S. Imp)	(5, 7, 9)
5	Absolutely Important (A. Imp)	(7, 9, 11)

Table 1. Linguistic terms and corresponding Triangular Fuzzy Numbers (TFN), fAHP

Fuzzy TOPSIS

TOPSIS is a MCDM method which allows to rank alternative solutions from a finite set of alternatives. TOPSIS starts with the determination of ideal positive and negative solutions. Then, alternatives are compared with these ideal solutions, and distances calculated. Scores will be determined upon the values of such distances. Usually, the alternative which is the closest to ideal positive and the farthest from ideal negative is ranked as optimum. Fuzzy TOPSIS integrates Chen's TOPSIS theory with fuzzy set theory, by utilizing triangular fuzzy numbers and introducing crisp Euclidean distance in between them (Viswanadham & Samvedi, 2013).

Fuzzy TOPSIS is here used to determine the score on strategies' expected performances on criteria. Experts are required to provide in inputs in the form of numerical values in a comparison matrix, and after converting the values into fuzzy numbers using linguistic terms shown in Table 2, calculation are performed. The score on strategies' expected performances on criteria are found from these matrices using the method described in Kutlu & Ekmekçioğlu (2012).

Numerical values	Definition	Fuzzy triangular scale
1	Extremely Worse than current	(1, 1, 2)
2	Much Worse than current	(1, 2, 3)
3	Slightly worse than current	(2, 3, 4)
4	No Impact	(3, 4, 5)
5	Slightly Better than current	(4, 5, 6)
6	Much Better than current	(5, 6, 7)
7	Extremely Better than current	(6, 7, 7)

Table 2. Linguistic terms and corresponding Triangular Fuzzy Numbers (TFN), f-TOPSIS

Methodology

A combination of fAHP and fuzzy TOPSIS was applied using the following multi-step approach:

1. Identification of all potential actionable strategies, or scenarios, to implement across the supply network, using inputs from local supply chain experts;
2. Definition of a comprehensive set of parameters for strategy selection against which the alternatives are to be compared, using inputs from local supply chain experts;
3. Determination of criteria weightage (score) that measure the relative importance of each parameter as compared to others, using cross-comparison of selection criteria and fAHP;
4. Determination of scores that reflect the value of a strategy's expected performance on the criteria, using fuzzy TOPSIS;
5. Rank of strategies, using cross-comparison of strategies and score of criteria.

Figure 1 shows a visual representation of framework of methodology.

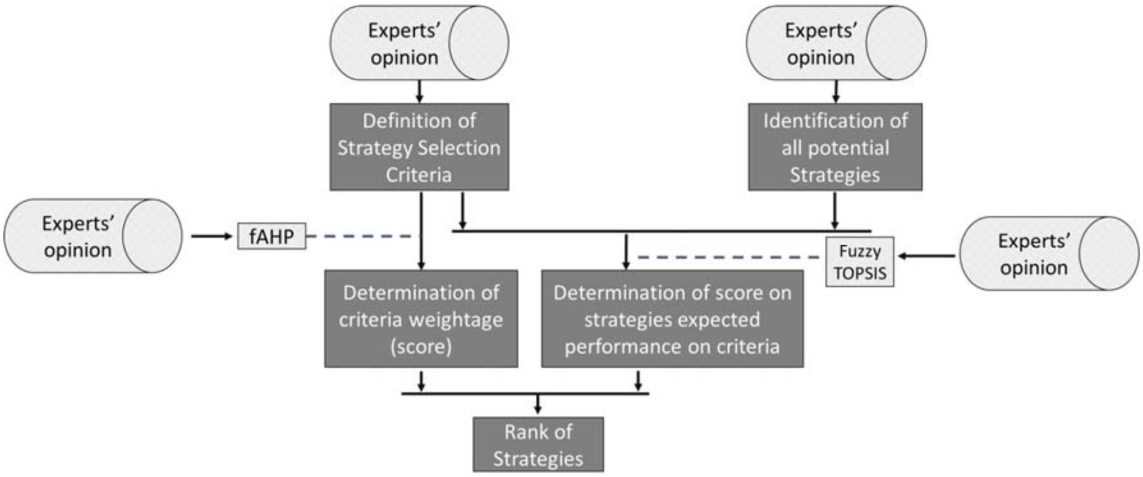

Figure 10.Framework of Methodology

Problem Case

Located in the South East Asia region, Indonesia is the 15th largest nation in the world which covers 1,811,569 square kilometres of land and 5,800,000 square kilometres of water. From east to west, the country spams three time zones and counts over 260 million people with a yearly population growth rate of 1.49%. For an archipelago with more than seventeen thousand islands with such a large logistical acitivity, poor domestic and international connectivity continues to be an alarming issue hindering the nation from achieving its goal of becoming of the world's 10 largest economies by 2025 (Westphal, 2014). Due to the combination of factors such as heavy reliance on land transportation (78.32% of transportation cost are for on wheels transports with a subsequent underutilization of maritime corridors), road congestion, worsening traffic conditions, poor infrastructures e.g. to support intermodal transportation, empty backhaul[9], bureaucracy and onerous regulations across the 33 local governments (provinces), logistics cost[10] are extremely high and constitute a serious impediment to the country economic growth [(Westphal, 2014), (Indonesia-Investments, 2013)]. The low performances of the logistics system in fact is dragging down the country's export capabilities and constraining it from a quick and significant reduction of the notorious in-country disparities[11] with the provision of an easier and cheaper access of the commodities on the domestic market (Indonesia-Investments, 2013) Prices of primary commodities – including fuel – are quite heterogeneous with the extreme East side of the country experiencing prices of to 20 times more expensive than Jakarta.

In such a challenging – yet high potential - country, designing an effective and efficient SN is the key enabler to increase margin profits. We look at identify the critical parameters to consider in the decision making process of restructuring a pre-existing SN along with the best actionable strategies to implement across the SN, while capturing both manufacturer and distributor views in a pilot from the FMCG sector.

Selection Criteria for Strategy Selection

A pool of 12 sub-criteria to compare the scenarios against have been defined. The scenario which is expected to perform best against each criteria will be the one which, based on experts' inputs, has highest potential for maximizing simultaneously availability of goods at final stores (OSA), while reducing cost and cash across the SN. The MCDM hierarchical structure for the case at hand is in Figure 2.

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[9] Cargo fill rate from Papua/Maluku back to Java is usually in the range 25%-30%

[10] Indonesia-Investments (2013) estimates that logistics cost in term of respective national GDP among ASEAN countries are at 27% for Indonesia, 13% for Malaysia, 8% for Singapore.

[11] Contributions to national GDP: Java 58.5%, Sumatra 22%, Kalimantan 8%, Sulawesi 6%, Bali 3%, Papua and Maluku 2.5%.

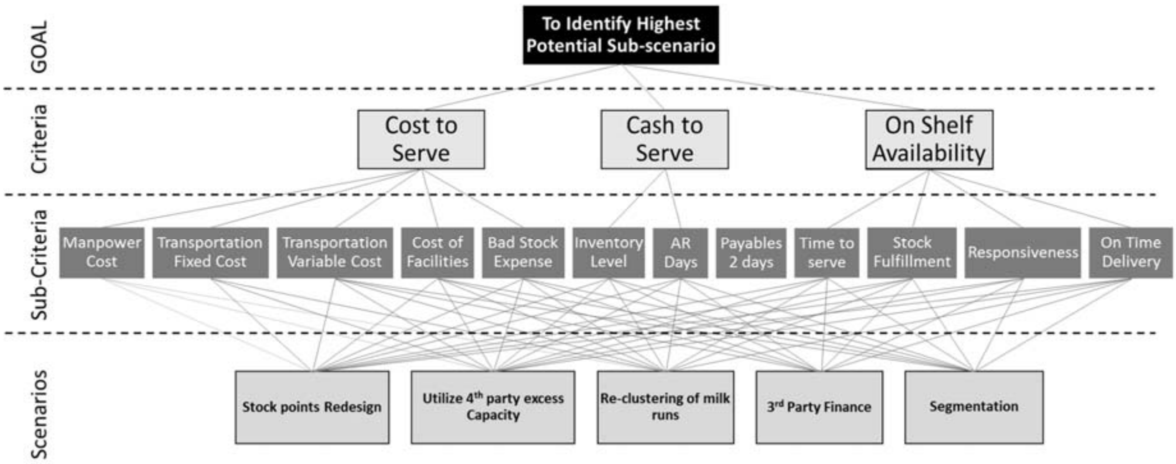

Figure 11. MCDM Hierarchical Structure

It follows a brief description of the various criteria and sub-criteria.

C1 Cost to Serve. This criterion refers to the total cost needed to deliver the goods from the main in-country Distribution Centre (DC), to the store. Five sub-criteria that is Manpower Costs (C_{11}), Transportation Fixed Cost (C_{12}), Transportation Variable Cost (C_{13}), Cost of Facilities (C_{14}), and Bad Stock Expense (C_{15}) are defined.

- C_{11} Manpower Cost – it refers to overall labour costs which includes manpower for deliveries (i.e. drivers, helpers) & warehousing (i.e. lift drivers, pickers etc.)
- C_{12} Transportation Fixed Cost – it refers to transportation assets and related depreciation
- C_{13} Transportation Variable Cost – it refers to transportation time and its equivalent cost in terms of fuel, maintenance etc.
- C_{14} Cost of Facilities – it refers to rent of third party storage facilities (rental of warehouse building, warehouse utilities) and/ or owned ones (depreciation, property tax)
- C_{15} Bad Stock Expense – it refers to costs related with damaged items

C2 Cash to Serve. This criterion refers to the amount of cash which are invested to keep stockpiles. Three sub-criteria that is Inventory level (C_{21}), AR Days (stores – DO) (C_{22}), and Payables 2 days (C_{23}) are defined

- C_{21} Inventory Level – it refers to overall level of stockpiles held at different Distribution Centres, including opportunity costs for "in transit" inventories.
- C_{22} AR Days (stores – DO) – Account Receivables, meaning how soon stores need to pay the distributor after goods are received
- C_{23} Payables 2 days – it refers to how soon the Distributor needs to pay the manufacturer after good is received

C3 On-Shelf Availability. This criterion includes three sub-criteria that is Time to Serve (C31), Stock Fulfilment (C_{32}), and Responsiveness (C_{33}), and On Time Delivery (C_{34})

1. C_{31} Time to Serve – it refers to the timeframe between the placement of an order by a Store and received shipment from a Distribution Centre
2. C_{32} Stock Fulfilment – Service Rate to Stores
3. C_{33} Responsiveness – it refers to capabilities of the supply chain network to adapt and quickly respond to unforeseen events (i.e. market needs, introduction of new products, disruptions)
4. C_{34} On Time Delivery – it refers to the amount of items delivered to customers on time and in full.

Alternative Actionable Strategies (Scenarios)

Five unique scenarios have been identified as suitable for the pilot case in analysis and their concise description, with a list of possible benefits for each, is available in Table 3.

No	*Scenario*	**Possible Effects**
1	Stock points Re-design	Warehouses more strategically placed → Reduce lead time, transport costs → increase OSA, reduce cost to serve
2	Utilize 4th Party Excess Capacity	Convert fixed transport and warehouse cost to variable costs → reduce cost to serve. Reduce empty backhaul, optimize utilization of warehouse → reduce cost to serve
3	Re-clustering of Milk Runs	Optimize delivery capacity → reduce cost to serve
4	3rd Party Finance	Stores have financial ability to buy sufficient goods to meet demand → increase OSA. Distributor receives cash earlier → distributor also have increase financial ability to buy goods to meet demand → increase OSA
5	Segmentation	Prioritize deliveries and/or increase delivery frequency to specified customers → increase OSA, reduce cost to serve.

Table 3. Description of Scenarios

Results

To collect qualitative information from practitioners for the a) Cross Validation of MCDM Framework, b) Determination of criteria weightage (score), and c) Determination of scores that reflect the expected performances of each scenario on the criteria, a survey on MS Excel was distributed to respondents during direct face-to-face interviews at an ad-hoc workshop event held in Jakarta in December 2016. The questionnaire was pretested on one sample composed of two supply chain specialist working in the regional manufacturer office of Singapore. After the pre-tests, the questionnaire was revised to suit the Indonesian scenario. Sample of responders were carefully chosen and cross function representatives identified (i.e. Logistics, Distribution, Customers, Transportation, Finance etc.). This helped to gain multi-perspective and relevance for the local context. In total, 10 individual responses from the manufacturer were collected. Likewise, additional 2 aggregated group responses from the distributor were also collected. Since responses were in the form of pairwise comparisons, consistency ratio to verify the level of consistency of data was required and was guaranteed using real time verifications in MS Excel platform. An example of asked question to determine criteria weightage (score) that measure the relative importance of each parameter as compared to others was "If you were to re-design your supply chain, what Criteria would you consider as more relevant?". An example of asked question to determine the scores that reflect the value of a strategy's expected performance on the criteria was "If you were to implement scenario XX, how do you rate its impact on the identified sub-criteria YY?".

Measurement of constructs –Results on strategy selection

As briefly mentioned in the literature review, collected data (pairwise comparison matrixes) were initially translated into fuzzy numbers (triangular distribution), then aggregated and normalized. Using MATLAB software, weights of criteria and sub-criteria (Table 4 and 5) were determined using fAHP algorithm, and results inputted for prioritization of scenarios (Figure 6) which was carried using fuzzy TOPSIS.

Criteria	**Criteria Weight**	**Sub criteria**	**Sub criteria Weight**	**Final Value**
Cost	0.402	Manpower	0.472	0.190
		Transportation Fixed Cost	0.203	0.082
		Transportation Variable	0.157	0.063

		Cost		
		Cost of Facilities	0.102	0.041
		Bad Stock Expense	0.066	0.026
OSA	0.486	Time to Serve	0.225	0.109
		Responsiveness	0.211	0.103
		On Time Delivery	0.251	0.122
		Stock fulfilment	0.390	0.190
Cash	0.112	Inventory	0.591	0.066
		AR days (stores-DO)	0.242	0.027
		Payables 2 days (DO-PG)	0.167	0.019

Table 4. Criteria and sub-criteria weights (manufacturer)

Criteria	Criteria Weight	Sub criteria	Sub criteria Weight	Final Value
Cost	0.4315	Manpower	0.122	0.05
		Transportation Fixed Cost	0.180	0.08
		Transportation Variable Cost	0.171	0.07
		Cost of Facilities	0.366	0.16
		Bad Stock Expense	0.161	0.07
OSA	0.1738	Time to Serve	0.264	0.028
		Responsiveness	0.347	0.042
		On Time Delivery	0.307	0.035
		Stock fulfillment	0.082	0.014
Cash to Serve	0.3947	Inventory	0.135	0.053
		AR days (stores-DO)	0.6	0.341
		Payables 2 days (DO-PG)	0.265	0.105

Table 5. Criteria and sub-criteria weights (distributor)

Scenario	Manufacturer		Distributor	
	Score	Rank	Score	Rank
Segmentation	0.64	1	0.75	1
Re-clustering of Milk Runs	0.54	2	0.45	3
Stock points re-design	0.47	3	0.43	5
Utilize 4th Party Excess Capacity	0.46	4	0.44	4
3rd Party Finance	0.44	5	0.67	2

Table 6. Prioritization of scenarios

Conclusion

The preliminary results suggest that the manufacturer and distributors have different motivations for the optimization of their respective supply chains.

In terms of criteria, the manufacturer focuses on enhancing the availability of goods on the shelves of the final stores, whereas the distributor would rather prioritize on cost savings and inventory minimization. In terms of sub-criteria, while from manufacturer perspective the key cost to reduce in order to achieve efficiency is manpower, the distributor would rather focus efforts over optimization of warehousing assets. In terms of scenario to prioritize both parties see the value segmentation, although there is a substantial difference over the 3rd party finance, which appears to be a priority only for the distributor. This is in line with the concern of the distributor over cost and inventory minimization.

Outcomes of these initial analysis highlight that - due to the different companies' aims and interests - conflicts among stakeholders operating within the same SN exist. Operational efficiency gets clearly affected by such frictions, which ultimately lead to a myopic optimization of the SN. However, a clear opportunity for better synchronization is also highlighted.

This study has few limitations. The sample size we have used for the current analysis is limited, and a greater sample size would have provided deeper insights. Hence, a wider sample of supply chain experts can be employed to reinforce the results for the case at hand. The scope of MCDM needs to be widened to include the conflicting motivations and objectives for bi-level optimization. Second limitations regards the weights (scores) calculated for the identified parameters for strategy selection. Specifically, findings on the relative values for each criterion as compared to others, cannot be generalized to other contexts. Each country has its own peculiarities in terms of logistics landscape, and each sector has its own peculiarities too, and therefore by changing sector and country the rank of criteria may change.

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SECURITY EXTENSION IN EXPORT SUPPLY CHAIN IN INDONESIA: AN AGENCY THEORY PERSPECTIVE

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Introduction

Security constitutes an important aspect of supply chain operations where the risk of terrorism, by its definition, has been a major concern (Voss et al., 2009, Urciuoli, 2010, Marlow, 2010). The risk of tampering with cargo and smuggling explosives in legitimate containers has raised security issues in port specific export supply chains. In response to the increasing global insecurity in supply chains, the World Customs Organization (WCO) has developed the Framework of Standards to Secure and Facilitate Trade, popularly abbreviated as the SAFE Framework. SAFE contains the Authorized Economic Operator (AEO) program, a security initiative that is claimed to have essential features for supply chains.

When risk in a supply chain is defined as the likelihood and impact of an unexpected event with adverse effects that leads to failure (Ho et al., 2015), an argument on the probability of risk occurrence often appears to rationalize security investment (Tang, 2006). Firms find it difficult to justify the investment for a robust security strategy (Rice and Caniato, 2003, Zsidisin et al., 2004), so that it is important for a security program to also support business continuity during “normal” conditions (Tang, 2006). The AEO addresses these concerns by not merely focusing on security measures, but also offering privileges from customs to certified firms when they conduct international trade (WCO, 2012).

More than its balanced approach to security and facilitation, the AEO has also been promoted for its chain integration and standard compliances of risk management (WCO, 2012). Meanwhile, many definitions of supply chain include a perspective on integration between the supply chain members regarding their activities (Soltani et al., 2011, Davison, 2008, Hodges, 2012). Jayaram and Tan (2010) defines supply chain integration as a coordinated cooperation to achieve mutual outcomes. This theoretical perspective that underwrites the supply chain integration provides an appropriate context for the AEOs intending to secure a safe delivery of goods. Supply chain is a sequence of operations where a single activity, regardless of its size and position will have a devastating effect on the delivery of merchandise if adequate security is not extended from one party to the other, specifically from the AEO-certified exporter to their chain partners, like forwarding agents, trucking companies, and container yard operators.

The paper, therefore, investigates the extent of security practised along the whole of the export chain and, the way chain integration can help in achieving that. Agency theory is chosen as a tool to diagnose the sustainability of the relationship where many problems are caused by ineffective management of inter-organizational relationships (Richey et al., 2010). The relationship is reflected in the integration mechanism assessed by the theoretical lens of agency theory defining AEOs as the principal and their chain partners as agents. Eisenhardt (1989) argues in his seminal work that agency theory sheds light on uncertainty and risk associated with supply chains comprising the principal and agents. Therefore, the agency theory is used here to explain the security extension from AEOs to their chain partners to assure equal security standards being performed along the chain, especially where principal-agent monitoring is lacking.

The next section presents a brief literature review related to studies in the area. Subsequently, a section on the methods employed in the study precedes the section on the discussion of the findings. The last section draws on the conclusion and limitations.

Literature Review

The growing concern of security forces the firms to assess risk and security in their business strategy (Rice and Caniato, 2003, Zsidisin et al., 2004). More related literature observes the global development of risk and uncertainty affecting supply chain post 9/11. For examples, Bichou et al. (2014), Banomyong (2005), Altemöller (2011), Grainger (2007), discuss the introduction of international security initiatives.

These authors agree that security initiatives must not add any burden to firms in a supply chain, rather the objectives must be consistent with the character of a supply chain where efficiency and speed are prominent. With the increasing risk of security issues, business sustainability lies not only within the business itself, but in their supply chain (Peck et al., 2003). Therefore, a security initiative that combines control and facilitation is more appropriate in this environment. However, very few studies have addressed the Authorized Economic Operator (AEO) program (Mikuriya, 2007, Ireland, 2009, Fletcher, 2007, Noda, 2004, Zhang and Preece, 2011) and none of them use agency theory to evaluate its implementation.

Agency theory is about delegation of works from one party (principal) to another party (agent) (Eisenhardt, 1989, Lassar and Kerr, 1996). This includes an authority regarding control and decision making about certain tasks (Wilding et al., 2012). Recognizing that AEOs' chain partners are not always security-certified entities, agency theory addresses a question on how security objectives are extended when the AEO exporters, as principals, outsource their logistics operations to chain partners, as agents.

Agency theory is particularly relevant for studies with problems of cooperative structure (Eisenhardt, 1989) which is appropriate in the AEOs' export supply chains. Moreover, Eisenhardt (1989) argues that agency theory *"offers unique insight into information systems, outcome uncertainty, incentives, and risk and is an empirically valid perspective (p.57)."* This argument is justified in this research. First, the extent of integration between AEO and the trading partners is likely to affect their mode of information sharing, chain outcomes, incentives and risks carried by each member in the chains. Their coordination and inter-relationship significantly contribute to those aspects of the AEOs' security objectives. Second, the security awareness among the trading partners appears to be quite low. When the AEOs are fully aware of their security measures and include terrorism as a risk, most chain partners only follow the agreed common terms and conditions without a complete understanding of the likely risks. Therefore, it is true that security values may deteriorate along the supply chains where goods change hands. At this point, the agency theory aims to explain the problems when the interests of the principals and agents conflict (Eisenhardt, 1989).

The literature reveals that there is a lack of study on a supply chain security initiative that involves both integration and risk management perspectives under the lens of agency theory. With the awareness that supply chain is a network of inter-connected activities (Davison, 2008, Hodges, 2012), this paper fills the gap where the agency theory is used as the lens to evaluate the extension of security from the AEOs to their chain partners through integration mechanisms.

Methods

Recognizing the complexity of supply chains, a case study is an ideal method to provide a comprehensive description and evaluation (Zikmund et al., 2012). As a popular research method often employed across disciplines (Thomas, 2011), a case study approach is commonly agreed to offer a detailed approach to complex research objects (Simons, 2009). The data collection involves observation of implemented security measures, review of security related documentation, agreements and contracts, and compares implemented measures with AEO related standards. Semi-structured interviews are conducted with managers and staff in charge of export and security in the three AEO exporters and their chain partners that constitute the AEO export chains. Under the lens of agency theory, the research proceeds to identify agency cost in the extension of security concerns from the AEOs to their partners. This process evaluates measures taken by the AEOs to ensure that security is assured along the nodes and links in the flow of the goods from AEOs' premises to the port of exportation.

Thematic analysis (Braun and Clarke, 2006) is used to identify, analyse and report the patterns found in the data collected. Themes are determined prior to field work and classified in accordance with the research questions: integration mechanisms and security measures (Figure 1). Several analysis techniques are simultaneously considered to reveal similarities and differences between the cases. They are pattern matching, explanation building and cross case analysis (Yin, 2014). The result is a synthesis of themes across the interviews and observations to create a general description of the phenomenon (Collingridge and Gantt, 2008).

The scope of the research is the flow of containerized goods and information from AEOs to the port of export via their chain partners. This port oriented export starts from the AEOs' premises and finishes at the ports of exportation. The upstream part of the supply chain from suppliers to AEOs and the downstream part beyond the domestic ports are excluded from this research. The generic players in this logistics episode include customs brokers, forwarding agents, trucking companies, warehouse operators, shipment consolidators and port operators. These stakeholders are included in the interviews to investigate the extent of security they maintain while the goods change hands.

Findings and Discussion

The research starts by mapping the AEOs' chain structures and identifying elements of integration in each chain. The security-integration framework (Figure 1) used in this research is an adaptation of Robinson's Chain Constructs (Robinson, 2009). The modification takes into account the aspects of security in the context of supply chain integration. Parameters of chain structures include identification of individual players, their functions and context of existence. The integrating mechanisms and processes are assessed on ownership, contractual arrangements, operational interdependence, and information system for data transfer. The security per se includes cargo, conveyance, premises, personnel, trading partners, stated under AEO security standards (WCO, 2006). The identification of both integration and security parameters are to help determine the extent of security extension from the AEOs to their chain partners. It compares the security level of individual players and the collective measures as expected by the AEOs. This framework is designed to answer whether individual and collective security measures are at the similar level, as well as to identify the agency cost in ensuring their equality.

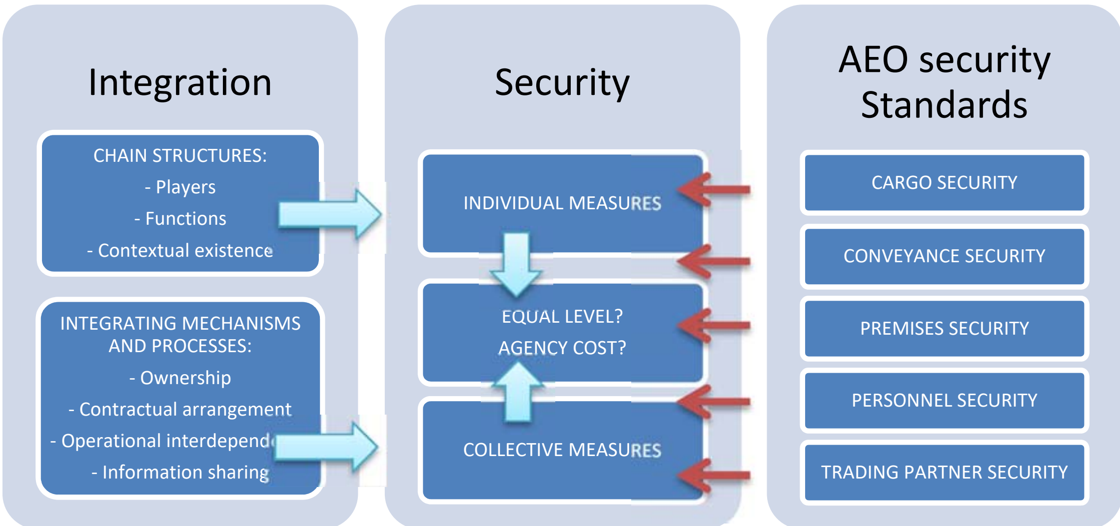

Figure 1: Security-Integration Framework

Integration mechanisms identified in each AEO are summarized in Table 1 with different patterns of distribution of responsibilities and risks. AEO-1 fully transfers the responsibilities to its forwarding agents as the only known chain partners. The dyadic relationship restricts the information flow between AEO-1 and forwarding agents who then extend the AEO-1 message to the other chain members engaged by them. The findings show that AEO-1 informs the forwarding agents about any new development of security certification. Other chain partners, like the trucking companies and shipping agents, are not aware of this development directly from AEO-1. This results in dilution of security information as it moves further away from AEO-1. The degree of integration is likely to deteriorate with the absence of direct control from AEO-1.

AEO-2 operates relatively in a more integrated way and demonstrates a full control over the whole export chain. It does not necessarily own all chain functions, but the individual contractual relationship with each chain partner allows AEO-2 to control and ensure the effective extension of security along the chain.

In the segment of goods flow from factory to ports of export, AEO-3 owns and manages all the logistics functions like the forwarding agent, warehouse, trucking company, empty container park and port. However, outsourcing of trucks, use of empty container parks, and shipping through other ports etc. are very common. These external parties involved have no contractual relationships with AEO-3. They work casually based on individual load. Given that AEO-3 has total control of ownership, it has no operational interdependence and no information sharing.

Integration aspects	AEO-1	AEO-2	AEO-3
Ownership	Use of total logistics service providers.	Partial ownership.	Total ownership.
Contractual arrangement	Contract is only with Forwarding agent as a single dyad.	Contracts are with all chain partners.	Contracts are with trucking companies and shipping agents.
Operational interdependence	- Regular plan sharing system only with dyad; - Dedicated team in each function; - Periodic meeting; - Functional training.	- Uniform regular plan sharing system for all chain players; - Dedicated team in each function; - Cross-posting of staff; - Periodic meeting; - Regular training and value sharing; - Vendors' improvement program.	- Staff cross-posting.
Information sharing	- Internal integrated information system; - 3PLs limited access (only FA); - Global access from international office; - Only email with other vendors.	- Internal integrated information system; - No 3PLs access; - Integrated 3Pls information network is under development; - Global access from international office; - Only email with other vendors.	- Internal integrated information system; - No 3PLs access; - Only email with other vendors.

Table 1: Integration mechanisms

Arguably, AEO-2 shows the most integrated activities demonstrating more integration features characterized by a contractual relationship with chain partners and operational interdependence. The chain organisation is the strong point of these chains. AEO-1 comes second with basic integration of operational security. AEO-3 comes last since there is no sign of external integration but total ownership promotes reasonable security within this supply chain.

Agency theory in AEOs' integration mechanism

The literature suggests that contract has been used as a tool to bridge the operational gap between the principal and the agent to reach their objectives (Wilding et al., 2012). All the efforts taken by the principal to ensure that agents are appropriately doing their given tasks is called agency cost (Eisenhardt, 1989). In this context, the integration mechanisms, except for ownership, represent the concept of agency cost. Measures found under the group of contractual arrangement, operational interdependence and information sharing are indeed the efforts to bridge the gap between the principal and the agents when ownership is absent at this function. The following discusses integration and security implementation in the three AEOs in the light of agency theory.

AEO-1

In the case of AEO-1, having only forwarding agents as its direct agents, the firm is minimising the agency cost by controlling its dyadic chain partner relationship. The legal contract acts as the direct control between AEO-1 and forwarding agents (FA). AEO-1 restricts the cost of operational interdependence and information sharing to the FAs. Further control from FA over other trading partners is very likely to deviate from the agreed work standard (Zsidisin and Ellram, 2003). The emerging risk results in security deterioration due to the lack of a principal's direct supervision.

The contractual pattern in AEO-1 is complex to embody several groups of agency patterns (See Figure 2). AEO-1 and the two FAs form the principal-agent pattern. The FA-1 has their own agency pattern with the trucking companies (TCs) who may also have vendors (Vs) to back up their operations during peak time. FA-2 works with different TCs, SL, and Container Consolidators (CC) who together constitute a separate principal-agent relation. Above the AEO-1 is its international headquarters which manages contracts with shipping liners (SL). The SLs then employ shipping agents (SA) in different countries who use the service of empty container parks (EPs). AEO-1 is central in this web of agency schemes interconnecting operations in its export chains.

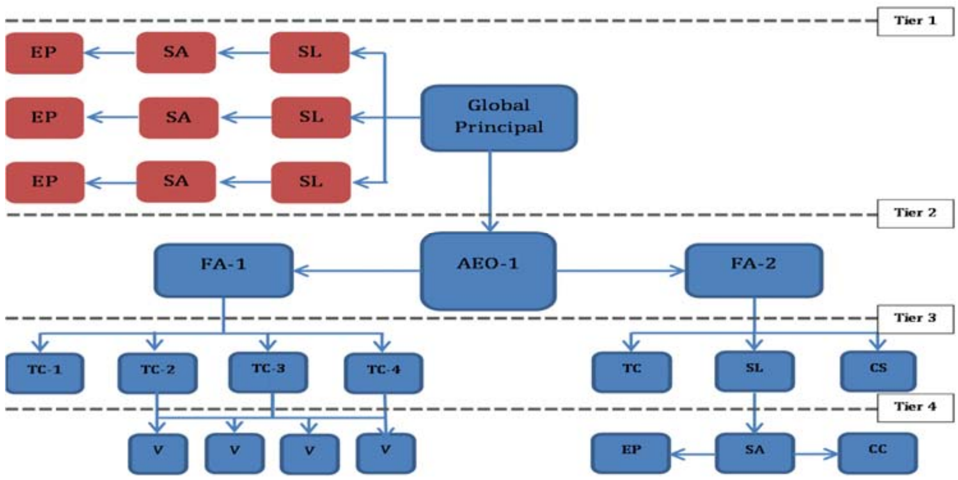

Figure 2: Principal-Agent structure in AEO-1

AEO-2

The approach taken by AEO-2 is different. AEO-2 extends the contractual relations to almost all members in its export chains. However, similar to the chain structure in AEO-1, SLs, SAs, and EPs are not included due to their direct contractual arrangement with AEO-2's headquarters in Asia Pacific region. AEO-2 manages most contracts by itself and executes direct control on all operations. This approach reduces the issue of monitoring in its agency relationship. It ensures selection criteria are fulfilled by all vendors through periodic tender every two years. Another similarity with AEO-1 is found where smaller fractions of agency relationship occur. In these chains, TCs and yard operator (YO) separately extend their contracts with vendors whose performances are their responsibility. AEO-2 admits that they do not have contractual relations with these vendors. But they claim that their control spans to include all operations within its chains, even though they are not under direct contractual schemes. This situation is portrayed in Figure 3 below.

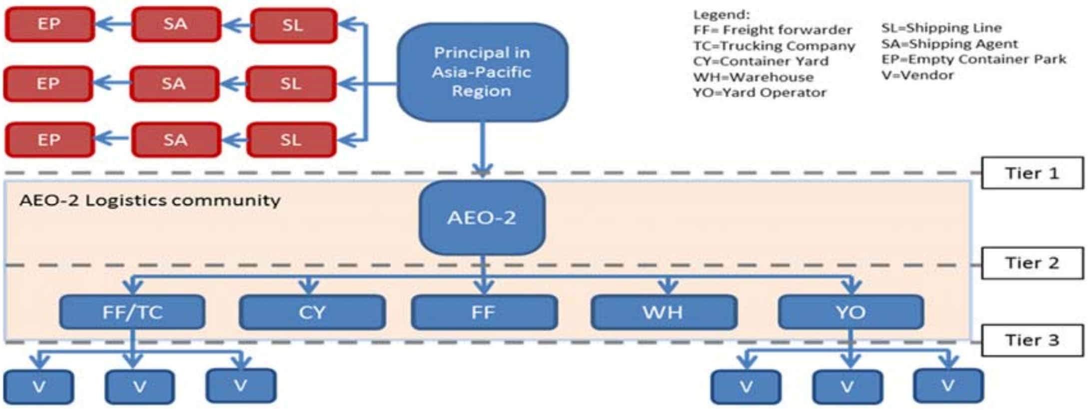

Figure 3: Principal-Agent structure in AEO-2

Compared to other AEOs, AEO-2 shows the widest range of measures in maintaining its relationship with its chain partners. AEO-2 demonstrates its fervent preference for extending its interests and ensuring that the whole chain operates by its standards. Moreover, its efforts in sharing its skills and institutional culture and values (Alfalla-Luque et al., 2013) lead compared to AEO-1 or AEO-3, where these features are not pronounced.

AEO-3

AEO-3 is relatively modest in demonstrating the principal-agent pattern (Figure 4). The ownership scheme in its chain function is more visible as it prioritizes the use of internally owned chain functions whenever possible. It engages external parties only when internal functions are not sufficient especially during peak times. Most of the time, the chain is dominated by players under the same ownership. However, these players are not always from the same division or even the same firm. There are tiers in their organizational hierarchy. AEO-3 is under a holding firm that owns several factories producing different types of paper products in Indonesia. They are located in different parts of Indonesia. The holding firm created a freight forwarding company to manage export and import for all factories under its ownership. It also owns empty parks and a sea port. So even though these entities are under the same ownership structure, there are distances between them where agency theory is still applicable (Eisenhardt, 1989). The distance is the gap that typically exists between silos in an organization. Each function still works in isolation rather than in collaboration. In this situation, the effort to extend security concerns, especially after becoming an AEO, has also been a challenge. With ownership extension, the agency cost that AEO-3 has to spend is relatively lower compared to chains where ownership is lacking. First, it does not have to conclude any contract with any agents. It significantly reduces the cost of control and monitoring or evaluation for the purpose of renewing the contract, as it normally occurs in a contract cycle. Second, it can avoid the cost of information sharing since they all are already connected with their internal system. Information freedom is also a benefit of their ownership structure. Third, the issue of equal concern for value and work culture should be minimized when they all share the same corporate values induced by the holding firm. However, in the process of internal integration, other agency costs such as sharing of risks, plan, and decision-making remain.

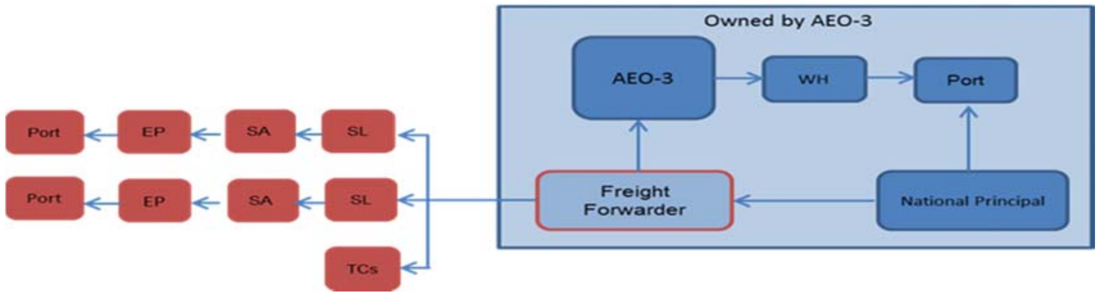

Figure 4: Principal-Agent structure in AEO-3

Agency cost in integration security

As a seminal reference in the literature of agency theory, Jensen and Meckling (1976) broadly define agency cost as any cost that might be incurred in any relationship characterized by any form of collaboration. This cost is not limited to those spent by the principal, but also includes those sustained by the agent. Furthermore, they argue that agency cost consists of monitoring expenditure by the principal, bonding expenditure by agent, and residual costs. In this research, the monitoring expenditure by the principal is represented by the physical existence of contracts, periodic tender, and extension of information, staff cross-posting, and training for chain partners. All these efforts are meant to ensure that the agents behave by the principal's expectation. Physical monitoring and reporting systems are also found to reduce adverse behaviour or moral hazards that potentially happen in agents (Wilding et al., 2012). On the other hand, the agency costs are represented in the forms of participation in tenders, efforts to improve performance and participation in a principal’s security extension programs.

The Table 2 summarises the agency costs found in three cases and their relevance to integration mechanisms.

Agency costs			Integration mechanisms
AEO-1	AEO-2	AEO-3	
- Limited contract only with FAs.	- Multiple contracts with all chain members.	- No contract. Casual order only when needed.	- Ownership - Contractual arrangement
- Transfer all control risk to FAs.	- Maintain full control of all chain players.	- Internal FA maintains full control.	- Ownership - Contractual arrangement - Operational interdependence
- Periodic evaluation but no competitive tender.	- Periodic tender and competitive.	- No tender. Mostly under one ownership.	- Ownership - Contractual arrangement
- Periodic meeting with all chain members.	- Monthly meeting with all chain members.	- Weekly meeting with all chain members.	- Operational interdependence.
- Staff cross-posting (FA and TC at warehouse).	- Staff cross-posting (TC at CY, FA at warehouse, AEO-2 at YO).	- Staff cross-posting (TC at warehouse).	- Operational interdependence.
- Specialized unit to work with FAs.	- Specialized unit to monitor the whole chain.	- None	- Operational interdependence.
- Distribution of shipment plan to FAs.	- Distribution of shipment plan to all players.	- Access to common system.	- Information sharing
- Training to vendors	- Training, improvement program, logistic community.	- None	- Operational interdependence.

Table 2: Agency cost and integration mechanisms

Agency theory is effectively used in this research to help explain the relationship between integration mechanisms and security standards in the whole chain. Table 3 presents the agency costs found in each

AEO in their effort to ensure their security concerns to their chain partners. Most of these costs are found in the areas of cargo, conveyance and trade partner security. Security in chain partners' premises (WCO, 2006) does not come to the attention of these AEOs. However, temporary container yards where container stops or processed is an exception. AEOs do not observe security in chain partners' offices or truck parks. AEO-2 demonstrates more security awareness in the area of a chain partner's personnel who are supported by frequent training and certification programs. Truck driving and safety skills are examples of their popular programs.

Security Standards	Agency costs		
	AEO-1	AEO-2	AEO-3
Cargo	- Issue security procedures for cargo - Issue packaging standards to be followed by WH - Seal affixation procedures - Control on trucks' identity when they enter premises	- Global procedures for locking cars on car carriers - Multiple checks from truck arrival, loading and leaving premises	- Multiple checks from truck arrival, loading and leaving premises
Conveyance	- Require maximum age limit for trucks - Control delivery time - Reporting system	- Require maximum age limit for trucks - Truck inspection and certification - Control delivery time - Reporting system	- Require quality trucks
Premises	Not found	Not found	Not found
Personnel	Not found	Drivers training and certification	Not found
Trading Partner	- Security is not included in contract but in guidance and SOPs	- Security aspects are included in contracts - Continuous campaign and training internally and externally	No contract exists

Table 3: Relationship between security standards and agency costs

Conclusion

This research investigates the security aspects of export supply chains in the context of ports and the way the chain partners coordinate to achieve these. An analysis of interviews and observations of three AEOs reveal that the chain members focus more on their own objectives than the primary objective of the whole of chain integration for better security performance (Stock, 1997). In the relationship between principal and agent, the major challenges identified are the misrepresentation of agents' ability (adverse selection) and lack of their effort (moral hazard) that erodes a principal's objectives of achieving security (Wilding et al., 2012). While a contract is a metaphor for the relationship between the principal and agent in agency theory (Eisenhardt, 1989), the relationship in practice varies significantly from that agreed in the actual contract. This variance in terms and agreement from the original physical contract places the security of the chain at risk.

As a supply chain is characterized as a sequence of activities involving multiple actors to accomplish a wide variety of operations, every secured activity in the chain contributes to a safe outcome for the supply chain. The coordination of actors and their operations appears critical in defining the whole of the chain performance. Lack of any security initiative by one actor does affect the security of others in the chain. While the AEOs believe in a more integrated strategy encompassing multiple players to protect the chain from all possible threats, the security measure by each individual partner can contribute positively. This is where integration is perceived to play an important role in the study of security in supply chains.

However, the study has some limitations. Being newly introduced, the AEOs and the chain partners need more time to settle in terms of their integrated effort to secure the logistics operations. Future research needs to undertake either interviews (qualitative) or surveys (quantitative) of the AEO program to reveal more integrated effort to sustain security. Being exploratory in nature (Yin, 2014), this study does not measure the impact of the agency costs on security outcome. Thus, the future research will shed more light on the effectiveness of security measures from an integration perspective.

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SIMULATION GAME FOR "OUTBOND LOGISTICS" BASED ON COLLABORATION IN CEMENT INDUSTRY

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ABSTRACT
Purpose: Logistics and distributions activities require high costs although these are non value added to products, but these activities for cement industry which has mature on production technology, influences the competition to struggle the market segment. Outbond logistics of cement industry, need to perform daily decisions either strategically or technically.

Design/methodology/approach: logistics and distribution aspects have to be managed effectively in order to avoid shortage or stockout in some market and overstock in others. A simulation approach will be run to imitate the competition of the Indonesian cement industry with multiplayer players to simulate the performance and cost of logistical decisions.

Findings: A new simulation game was developed to imitate the characteristics of outbond logistics on cement industry. This simulator simulates several companies that compete in the same market in some areas in which all player are decision makers. This model is expected to be used to perform various "what-if" scenarios to know the behavior of decision makers in the face of logistics and distribution problems.

Research limitations/implications (if applicable): We demonstrate the players as several companies which have some division of each company to compete the same region and market.

Practical implications (if applicable): This simulation game is expected to be used for academic in learning of logistics activities and can be used for new employees in training activities

Originality/value: The goal is simulate SCM collaboration performance and cost as results of logistics decision

Keywords: Logistics and Distribution, Logistics Simulation Game, SCM Collaboration, Outbond Logistics

Introduction

Logistics is generally a part of a supply chain process that plans, implements, and controls the storage and flow of goods, services, and all kinds of related information from the supply point to the point of demand in order to meet customer demands (Council of Logistics Management, 1998). According to Kwateng et al (2014) Supply Chain Management Council defines that Supply Chain Management covers the planning and management of all activities related to resource procurement, conversion and all logistics activities. Supply Chain Management includes coordination and collaboration with partners which includes suppliers, distributors, 3PL, consumers (Lambert et al., 2006). Logistics is closely related decisions and policies of the company which is necessary to simulate to see the most appropriate and profitable alternative.

Nowadays the need for simulators and games in the field of logistics, distribution and supply chain has developed quite rapidly with variations. Research on SCM simulation is done by Zee et. al (2005), Knolmayer et. al (2007), Dewi et. al (2007), Reimer (2008), Rochman et. al. (2010), which examines supply chain management by applying beer game simulation. Gumus and love (2013), Liu et al (2006), Reimer (2008) and Rochman et. al. (2010) simulates SCM for learning and teaching. Van Horne (2004) mention the development is caused by several factors, including the need to balance the theory and practical in the field, helping simulator users to understand the concepts and problems faced in supply chain and give the user a big picture so that the root of the problem can be seen compared to the solution obtained. According to Vanany et al (2016) many lecturers in business and engineering school uses the games (e.g. Beer game and Supply Chain Simulator) to support their teaching and learning for SCM courses. Zeng and Johnson (2009) point out some SC games can be played on computer or with physical components and predominantly compute based and usually need relevant knowledge. Lee et al (1997) explain that the main benefit of the Beer Game is to help students understand the existence and characteristics of the bullwhip effect.

Effectiveness of logistics and distribution systems has been applied to simulators and games that attempt to mimic cement industry game by using Excel-based spreadsheet tools combined with Visual Basic Application (Siswanto et al, 2006; Dewi et al, 2007). In the game players are the company's decision makers who allocate a product to the distributor by direct route or through buffer warehouse. The observed market is only 7 areas on the island of Java, the demand of each city is aggregated to the province level and the distributor is assumed to be one in each province and the player is a single player with competitors already on scenario by moderators.

This research will apply outbound logistics to simulated cement based simulations with several teams to implement good collaboration and coordination functions to produce the right decision. The game presented in this paper was design to involve the users on managing the decision’s trade off. The user usually spend amount of cost to expand the finished product in object to increase stock in warehouse for the favour of service to consumers, otherwise the cost is tend to reduce customer satisfaction. If the users manage good decision, the better expectation of obtaining optimal results.

The research will be imitated the Indonesian cement industry characteristics that has been mature in terms of production technology and perfect competition that grab market share is highly dependent on the logistics and distribution aspects. For that the logistics and distribution system should be managed more effectively in order to avoid stock out or shortage in one market and over stock in other markets. Over stock will cause losses that can reduce profits while stock outs cause losses due to loss of opportunity to sell products (lose sales).

In section 2, the game design is presented to explore the game’s model descriptions. Sections 3 is the player responsibility. In section 4, the rules of the game and the learning objectives. Finally in sections 5 presented the conclusions.

Game’s Model Description

The game of this paper is simulate the perfect competition of the Indonesian cementing industry in the field of logistics and distribution from the finished product to the customer as retail level. This simulation model describes the competition system that occurs between the three major cement producers in maximizing their sales profit through effective logistics and distribution management. These three producers is a player as a decision maker who seizes the same market share and the same time. The products are shipped from factory using land transportation mode (truck) and marine transportation (Ship) and also delivery of product only in the form of package product (Zak).

This game’s model uses a simple structure in supply chain and focus on outbound logistics which includes manufacturer, marketing planner, distribution planner, retail and customers (see Figure 1). A manufacture have four positions: manufacturer/production, marketing planner, distribution planner and transportation planner. During the game, the customer/market who triggers the order should be fulfilled by retail with a specific number of products and based on the game scenario of the order. This game, focus only on outbound logistics than the inbound logistics was not in scenario. The manufacture produce the cement zak, in order to fulfil marketing planner. In this case have no product defect, i.e. worse quality, broken package product. This game is set to be played by multiple team (3 team) to simulate all the step and scenario to win the competition. The game is designed to encourage each team to achieve the lowest total supply chain cost and obtain the high profit. The team in which successfully obtains the lowest supply chain cost and the highest profit is the winner. Each entity in a team has responsibility which simplifies the real situation in a supply chain.

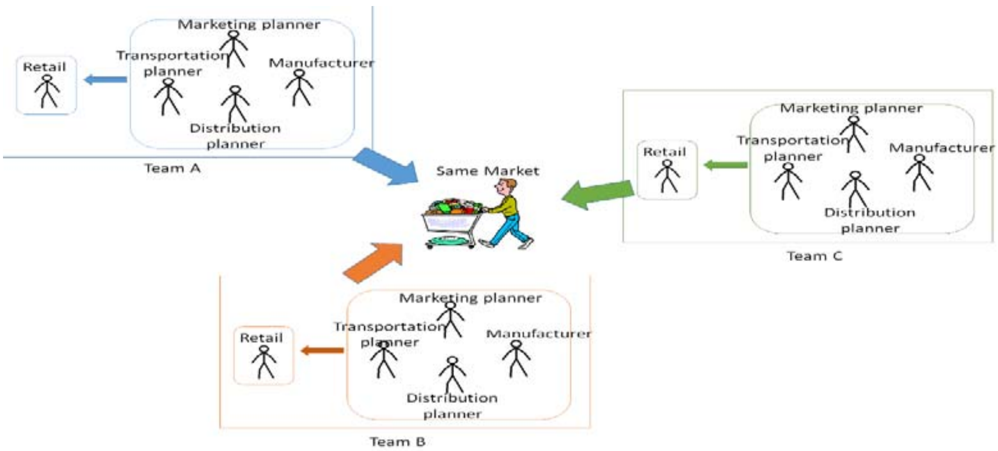

Figure 1. The composition of players to compete in the same market

This simulator model will simulate logistic and distribution decisions taken by 3 team in the distribution of products from the factory to the market, either through the buffer first or directly to the distributor. These three team as the decision makers who play simultaneously in seizing the same market and in the same time (real time) where the decision of each team ultimately affect each other in the internal team and so affect to other team (competitor). The general distribution system in this game's model can be seen in the following figure 2:

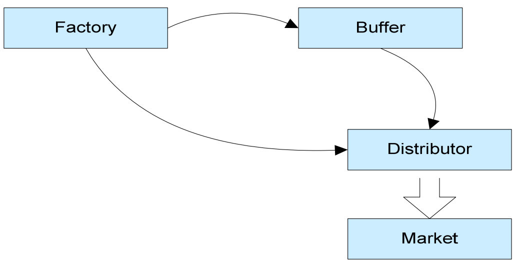

Figure 2. General distribution system in this game's model

This distribution system distributes the product from the factory to the buffer or to the distributor with the same lead time in the same city. While lead time delivery from buffer to distributor does not require lead time in terms of lead time = 0. After the product is delivered to the retail, the product can be sent to the market.

Player Responsibility

The game is simulate by three team which each team consist of 5 players in the entities mentioned earlier as: manufacturer/production, marketing planner, distribution planner, transportation planner and retailer. The responsibility of each player are described in table 1.

No	Position	Responsibility
1	Manufacturer	Order material and calculation the cost of good manufacturing
2	Marketing planner	Arranges a strategy how to meet the demand from the market including promotions
3	Distribution planner	Arranges a strategy when and how much the product send to the

		market
4	Transportation planner	Arranges a strategy how to transport the product including multimode transportation
5	Retailer	Manage and monitor the inventory and calculation the inventory and procurement cost

Table 1. The players' responsibility

Each player on each team have responsibility to calculate the cost that related to the position. The performance of each team is measured by the total cost of supply chain. The type of cost is expected represent the supply chain performance and adopted from the concept of Supply Chain Operations Reference model. The cost in this game is: cost of good manufacturing (COGM), promotions cost, opportunity cost, transportation cost, holding cost, backorder cost. COGM is cost of production, the penalty cost for the manufacturer if the player produce under or exceeds the capacity. Opportunity cost is a penalty charged to the marketing planner if they could not fulfil the market order. The marketing planner be able to determine the price to the market including promotion cost. Transportation cost contain the truck and/or shipment cost including driver and distance cost. The cost related with a retailer is holding cost for product in the warehouse and backorder cost as a penalty if retail cannot fulfil the order by the market's due date.

The rules of the game and the learning objectives

The game start with login for each team and each person. The first data is started by market demand all location which show the first order. The order quantity and due date have been design randomly to represent uncertainty of time and quantity. The uncertainty scenarios are expected to encourage player on develop their own strategy to fulfil all the order. Generally, the design of framework system can be seen in figure 3. Retail receive the demand of the customer and inform to the marketing planner, distribution planner and transportation planner. The result will inform to manufacturer to show the characteristics of the game. All the team must order the product and the orders are sent to the manufacturer by using a standardized purchase order form which also states due date. The amount of market orders and bill of materials for the product is important information which is used by the transportation, distribution, and marketing planner to decide the number of parts that will be ordered from the supplier.

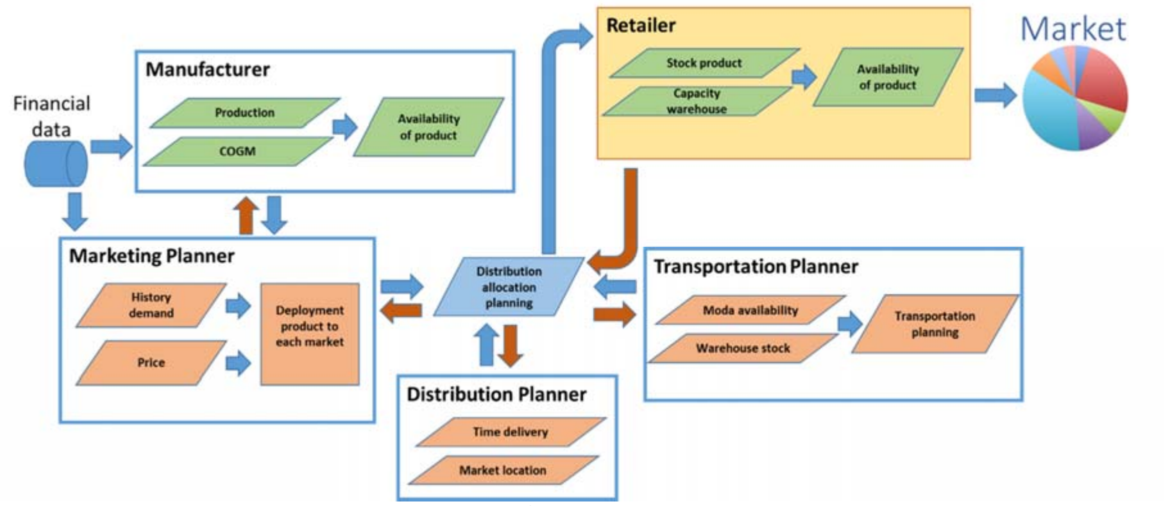

Figure 3. Framework system

General step in this game

(1). Start this simulator, each player must enter username and password. Each player can only be opened by one player. With the six cities to be simulated.

(2). The next step is each player initial initialization is to determine the contract of transport capacity and inventory capacity. The value includes the contract of the amount of product in zak cement and the contract value determines the minimum shipping cost and the minimum inventory cost in the buffer warehouse. In this simulator there are two types of cost per unit (zak) that is regular cost and premium cost. Minimum cost is the cost obtained from the multiplication of the number of products entered on the contract with regular cost.

(3). The next step is to determine the number of product shipments to each city in accordance with the number of production on the day of the order from market. Daily production (quota) has been determined by the system depend on the scenario. This total product shall not exceed the existing distribution quota and there shall be no remaining product that is not distributed or in other words the existing distribution quota must be completely distributed. The products allocated will arrive at the destination according to the lead time of each player and the player is given the demand forecast data on the day when the product reaches the destination.
(4). The number of products allocated to distributors will be allocated to the market. If the player wants to increase the amount of allocation in the market, they can deliver his products from buffer to distributor according to the player's wish (if inventory stock in buffer still exists), and this delivery will be charged regular transportation fee from buffer to distributor).

In determining the total product to be released to the market through distributors, players or decision makers will be exposed the risk of the possibility that the product released exceeds the actual demand (over supply) and the possibility of a lower supply of demand. This is because the delivered product can not be returned to the buffer or the distributor, otherwise there is a shortage of players can not send the product back.

The prices will be influenced by the number of players supply and the number of competitors' supply. If the over-supply condition occurs, the selling price of the player's product will decrease from the selling price yesterday but the player's share volume will increase. Conversely, if the product deficiency in the market, players get the risk of loss sales but the selling price of the product will rise compared to yesterday price and consequently the volume share of this team will decrease.

(5). Next the system will run the cost calculations and display the profit or loss and volume share of each player in each city.

(6). The players either get the profit or loss, in the next stage faced with the option to do promotion with a certain amount that has been set by the system.

(7). The choice of promotion will indicate the end of the player's decision in one day. The promotion will affect the demand in the next day. After a player runs several sessions, each player earns a total daily profit of six cities and a total profit from the first session until the last session. This stage is the final stage in a game period so that each player will be shown also the total profit of its competitors. The player with the highest total profit will come out as the winner of this game.

The Learning Objectives
The game was designed for undergraduate students to facilitate understanding of the basics of cement logistics. The game is focused to achieve some learning objectives: (1) task and responsibilities of each person in each team, (2) supply chain and logistics costs of performance (types of costs in the supply chain, calculate the supply chain cost, and reasons the supply chain results), (3) the goal of purchasing and promotion.
As players in the game, students must understand the role of game, activities/processes and the responsibility that should be adopted. The player should collect the data about supply chain cost performance (opportunity, back order, purchasing, holding costs) and calculate the total supply chain costs.

Conclusion

The conclusions that can be taken in this research are as follows:

- The results of the model design to imitate the competition of cement industry and multiplayer game which is played by some player on some team and can compete in the same time and the same.
- This game was developed to help student understand logistics and supply chain concept,
- This simulator can simulate the performance and cost resulting from logistical decisions. These decisions include:
  - collaboration and coordination of each player to deal with concept of supply chain,
  - Determination of production problem and the related cost,
  - Determination of distribution cases,
  - Determination of marketing planner and the risk of each decision,
  - Determination of transportation decisions,
  - Determination of promotion costs to increase share volume.

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SIMULATION STUDY OF TWIN AUTOMATED STACKING CRANES OPERATION STRATEGY WITH DYNAMIC BUFFER AREA IN SEAPORT AUTOMATED CONTAINER TERMINAL

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ABSTRACT

Purpose:
The purpose of this research is to study the impact of dynamic buffer area operation strategy on the performance of Twin Automated stacking Cranes (ASC's) one of which operate inside landside and seaside zones. Buffer area is a container temporary storage in the middle of container yard (Gharehgozli A. H., 2017). One of ASC's will put container that it carries in buffer area. Then, it will be taken by another ASC's to be placed in the slot location. Today, buffer area which applied in automated container seaport terminal is fixed buffer.

Design/methodology/approach:
Three settings of simulation model are used to test ASC's performance. Those settings are without buffer area, with fixed buffer area, and with dynamic buffer area.

Findings:
Measured performance:
- total travel distance and total travel time of ASC's when fulfilling all requests
- total distance of unnecessary movements (not carrying a container)
- total waiting time of ASC's when there are other ASC's inside buffer area
- total energy cost produced by ASC operation.

Decision variables:
- container slot allocation
- ASC's scheduling
- buffer area location
- buffer area size
- buffer area shape

Research limitations/implications (if applicable): We assume that there is no reshuffling inside container yard and buffer area.

Practical implications (if applicable): A new seaport automated container terminal that use ASC's without significantly applied buffer area just opened in Indonesia. The planning and operation manager of that terminal can use this research to operate ASC's more efficiently.

Originality/value: Some parameters are being considered. Those parameters are:
- the arrival time of vessel and truck to deliver and receive the container.
- 20-ft and 40-ft containers
- the weight of the container
- dynamic buffer area that can be changed based on demand
- the shape of buffer area that can be changed

Keywords: Dynamic handske area, Simulation Model, Twin Automated Stacking Crane

INTRODUCTION
Indonesia Container Port Traffic

In the year of 2014, a new port named Terminal Teluk Lamong (TTL) port has been established in Surabaya city, the second largest city in Indonesia. The TTL port is a multipurpose semi-automatic terminal where all activities in the TTL port like trucking, handling, and others are conducted automatically. The port also claims as the first eco green port in Indonesia.

The Port has implemented advanced technology in eco-initiative efforts such as (i) The trucks which operate within the port area must use fuel Compressed Natural Gas (CNG); (ii) The Combined Tractor Terminal (CTT), which is such automated guided vehicles, run on electric energy and operates automatically in moving containers from the container yard (CY) to the dock and vice versa; and (iii) The usage of Automatic Stacking Cranes (ASCs) which can be operated for 24 hours a day without operator using minimum electric energy. This paper develops a model of operational strategies of ASCs in the container yard.

We focus on the discussion of the role of a buffer area, consist of two rows, which is required to serve as a temporary slot for both ASCs.

Container Yard

Container Terminal using twin automated staking cranes (ASCs) have different configurations compared to container terminals with single crane. Container terminal with single crane serving container from landside (gate area) and seaside (berth area) as pick-up and drop-off point or also called transfer point or input/output (I/O) point (Gharehgozli A. H., 2017). But at container terminals with ASCs have (I/O) points on the seaside and landside. We called container yard area serving container from landside with landside, but container yard area serving container from seaside with waterside. At I/O point of landside, pickup and delivery truck of containers. While at I / O point seaside, automated guided vehicle pick-up and delivery container. Since both ASCs have the same size then there is a possibility pass each other. When the landside ASC has a request close to the seaside, the seaside ASC must provide a space for the landside ASC to complete the request. This potentially increases the ASC travel time. To solve these problems, the ASCs can work together with a transfer zone in container stacking (one block of container yard). The transfer zone is called buffer area. The buffer area is a temporary container storage in container yard so that one ASC may leave the container and request another ASC to take the container and proceed to the next slot destination (Gharehgozli A. H., 2017). In our research, the buffer area we called buffer area. The L-ASC handles retrieval and storage container from and to landside and the S-ASC handles retrieval and storage container from and to seaside (Gharehgozli A. H., 2017). In our research each block equipped by two ASC to move containers in automated CY. The block side which is closer to the gate (entrance port) called as the landside area, while the other block closer to the berth called as the waterside area. Both ASC will move containers from landside to waterside (delivery container) and the other hand containers from waterside move to landside (receiving container). ASC closer to landside area called Landside ASC (LASC), while ASC closer to waterside area called Waterside ASC (WASC). The minimum safety distance between ASC at least 1 bay. The buffer area only 1 bay. The inter-row movements and reshufflings in this research are not considered. The size of container only 20-ft. The proposed strategies are scheduling of containers for each crane, prioritizing of cranes, selecting the size of the buffer area and selecting the number of buffer areas (Gharehgozli A. H., 2017).

Both ASC's size, function, and operating locating are nearly the same. Thus, they are called Twin Automatic Stacking Crane (Twin-ASCs). In order to operate, they need a buffer area within the block. The buffer area served as a transition area for the Twin-ASCs to pass container from the waterside area to landside area, and vice versa.In this case, the buffer area is two-row width and located in the middle of blocks (Figure 1). This buffer restricts the movement of ASC. For example, when a customer ordered to move a container from a waterside area to landside area,the waterside ASC picks a container from the waterside and drops it to the buffer area. Then, the waterside ASC moves back to the waterside area so that the landside ASC can enter the buffer area, picks the chosen container, and moves back to the landside ASC. Another operational restriction which limit the movement of the ASC is the minimum safety distance. The minimum safety distance is the distance between the locations of the twin-ASCs.

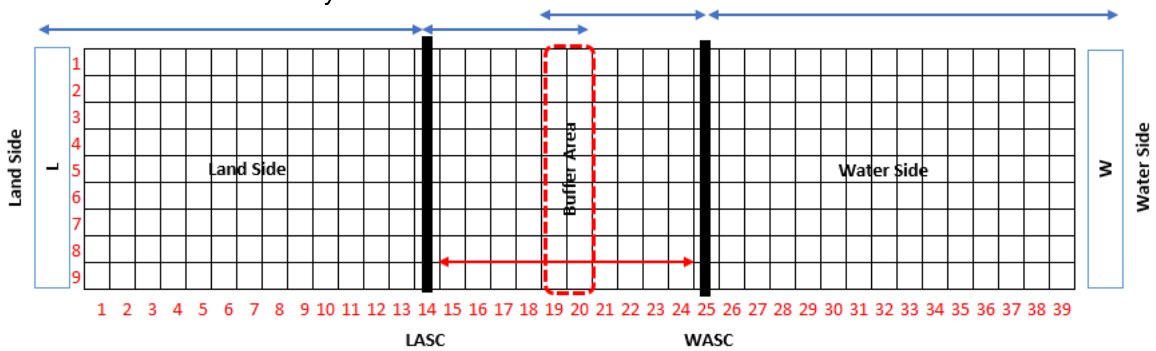

Figure 1 Container Yard Layout in Terminal Teluk Lamong

Both ASCs are used to arrange the containers while waiting for departure time. The arrangement of containers require some criteria to consider. The most widely used criteria are weight of containers, size of containers, type of containers, and container destination (vessel). Vessel and truck arrival time can be a key criterion in making the container arrangement.Container with the smallest departure time will be placed at the forefront in the waterside (vessel) or the landside area (truck). Containers arrangement affectsthe efficiencies of both automated CY and port service level. The efficiency of the automated CY is measured by the total movement distance of Twin-ASCs (total travel distance). In this case, the minimization of the total movement distance of the Twin-ASC will also reduce the electricity usage which results in a greener port.

This paper evaluates the Twin-ASCs operations in arranging containers in an automated CY with some modifications on the position of the buffer area. The paper is structured as follows: in Section 2, this paper describes the port Twin-ASCs problem, the issues to be resolved, and the conceptual models proposed; in Section 3, this paper explained the models and algorithms developed in this study. We also did numerical experiments and analysis about the proposed model and algorithm in Section 4, followed by the discussion of research findings and conclusion in the last sections.

PROBLEM DESCRIPTION

There exists several literature in container port operations especially in discussing container yard operations. Rei and Pedroso (2012) developed a mathematical model of the stacking problem in order to minimize the displacement of containers with regards to arrivals and retrieval of containers. In this system, the displacement was limited to one bay only. Rei and Pedroso (2012) developed a heuristic method with compare Conflict Minimization (CM), Flexibility Optimization (FO), and Flexibility Parameterized Optimization (PFO). In the same year, Izquierdo, Batista, and Vega (2012) developed the Lowest Priority First heuristic method to determine the location of containers in CY based on the priorities assigned by RMGC handling tool.
Twin-ASC-related scheduling research has been done by the Park, Choe, and Ok (2010), Choe (2011), and Gharehgozli et al. (2014). Park, Choe, and Ok (2010) developed a mathematical model of scheduling two RMGC with two objective: minimize the weighted delay time of Automated Guided Vehicle (AGV) and the weighted truck waiting time. Meanwhile, Choe (2011) developed a container movement scheduling algorithm within Twin-ASCsblock to minimize unnecessary movement of loading or unloading container. Hereafter, Gharehgozli et al. (2014) developed a mathematical model of scheduling Twin-ASC in a block to minimize the make spanof both ASC. The researcher conducted a pairwise calculation of travel time for each ASC. Furthermore, Putri et al. (2016) developed a simple mathematical model and heuristic algorithm to optimize the operation of Twin-ASCs by synchronizing the arrival time planning of vessel and truck.

This research developeda heuristic algorithm to optimize the operations of the Twin-ASCs in arranging containers in automated CY by utilizing a dynamic buffer area instead of a fixed buffer area. Currently, the position of the buffer area is located in the middle of automated CY, while the what if conditions used are modifications of the container amount coming from the waterside and the landside. The conceptual model, automated CY dimension, and slot size for this research can be seen in Figure 2, Table 1, and Table 2.

For this experiment, we use smaller number of bay than the real number of bay in Teluk Lamong Port. There are two types of ASC movement, the movement of ASCwhile carrying a container is called Necessary movement, but the movement of ASC without carrying a container is called unnecessary movement. The movement speed of the Twin-ASCs is a constant 270 m/min either carrying a load or not. The ASC lift speed without container is 90 m/min (45 m/min with container).

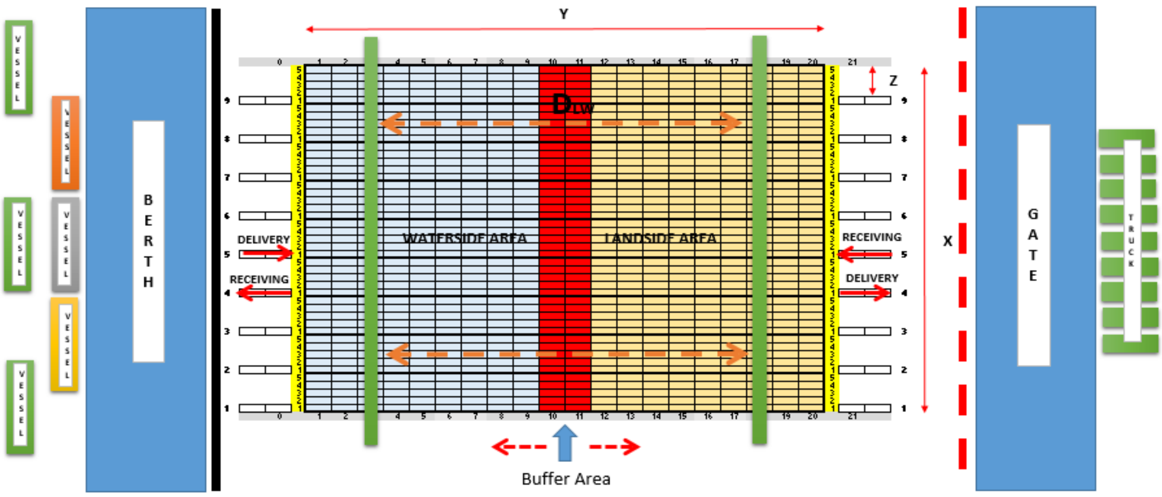

Figure 2 Automated Container Yard with Buffer Area and Twin-ASC Conceptual Model

	Number of Slot
Row (x)	**9**
Bay (y)	**20**
Tier (z)	**5**

Table 7. Block Dimensions

Slot Size	Unit (ft)	Unit (meter)
Length	20	6,096
Width	8	2,438
Height	8.5	2,591

Table 8. Slot Size

MODEL & ALGORITHM DEVELOPMENT

Determining the Buffer Area and Slot Location for Container

Fixed buffer area has weakness in achieving efficiency when there is a tendency towards one of arrival or retrieval container. In the fixed system, usually the buffer areas are located in the middle of each block.

The travel distance of landside ASC will be farther than waterside ASC if the is tendency towards the arrival container, and vice versa. These conditions can make the total travel distance to be less efficient.
Unlike the fixed one, dynamic buffer area will determine the location of the buffer area dynamically based on the container arrival pattern. The buffer area will be placed as close as possible to the side that has high container movement demand. Weekly container arrival planning data (both from vessels and trucks) will be checked daily at the last shift of each day. These data are used to determine buffer area location for tomorrow. In dynamic buffer area, the location of buffer area can be different each day. Let's see the illustration below.

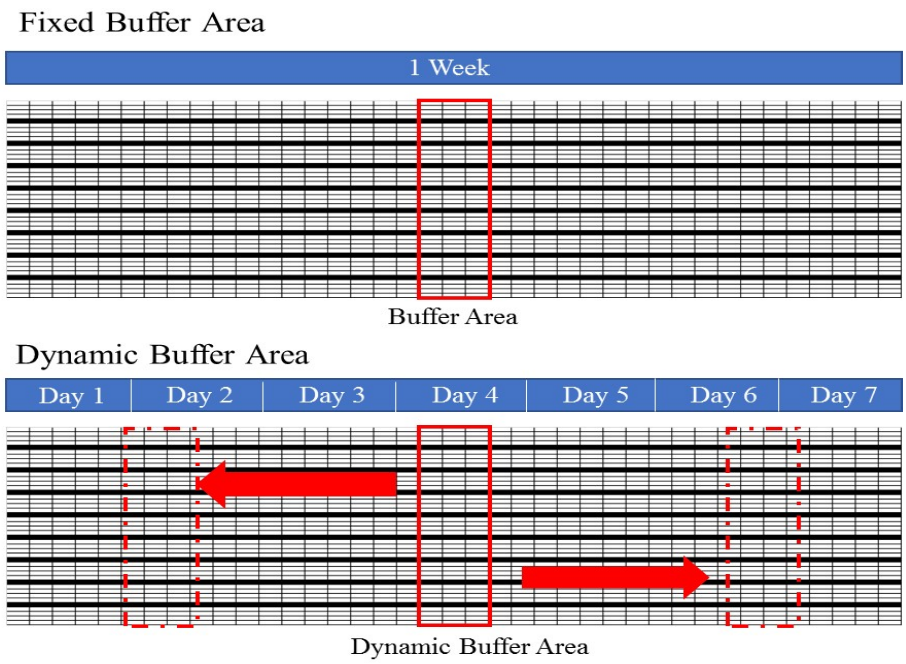

Figure 3 Fixed Buffer Area and Dynamic Buffer Area

Let's say in day 1 and day 2 the demand of landside jobs are higher than waterside, the buffer area will be moved closer to the landside. Starting in day 3 to day 5 the demand of landside jobs is equal to waterside jobs, so the buffer will be moved to the center. In day 6 and 7 the demand of waterside jobs is increase, then the buffer area will also be moved closer to waterside.

Beside the location of the buffer area, the location for temporarily storing the containers can also lead in to inefficiency. We have to decide the locations which minimize total distance between each container to I/O points. To calculate the distance, we used formula in Gharehgozli (2004) which is described below:

$$\boldsymbol{t_{ij} = max\{|x_i - x_j|, |y_i - y_j|\} + z_i + z_j} \tag{1}$$

Notation
i : the location index i (i=1,2….n);
j : the location index j (j=1,2….m);
tij : ASC travel distance frome node i to node j (unit)
x : unit bay (x = 1,2,…9);
y : unit row (y = 0,1,2,..,21); where y=0 -landside I/O point; y=21 -waterside I/O point;
z : unit tier (y=1,2,…5);
(xi, yi, zi) : coordinate of node i
(xj, yj, zj) : coordinate of node j

There are some rules that must be met in allocating slots for containers. Those rules are:

a. Containers for different vessels should not be stacked up
b. Containers for vessel that depart later should not be placed in front of containers for vessel that depart earlier
c. Heavy container should not be stacked above the lighter one

RQ1. Scheduling ASCin Container Yard

The twin ASCs have several jobs in container yard. The first job is called seaside job, a job for moving container to be loaded or discharged from/to a vessel. The second one is landside job, which is done to move container from/to external trucks. Next is job for preparing container in container yard before loading to make seaside and landside jobs faster, this job is called remarshalling. Since each block is equipped with two equal-sized ASCs that cannot move across each other,the seaside jobs are exclusively done by the seaside ASC and the landside jobs exclusively by the landside ASC (Choe et.al, 2015).

Seaside and landside job are classified as main job that will be given priority in scheduling ASC. Remarshalling jobs are only done on ASC's idle time. A discharge container, either from a vessel or an external truck, will be placed temporally in the buffer area. Then it will be moved in the allocated slot by the other ASC.

The aim from scheduling ASC is minimize total energy cost of ASCs. Minimizing total energy cost will be gained from minimizing total travel time or distance. The formulation to calculate travel time and travel distance also following the formula from Gharehgozli (2004) as described in Table 3 and 4. The constraints of scheduling ASC are jobs priority and the distance that must be keep between ASCs. The ASCs cannot move across each other. A job of an ASC consists of four steps of crane movement: empty travel to the target container, picking up of the container, loaded travel to the destination, anddropping off of the container(Choe et.al, 2015).

ASC Activity	t_{ij} (meter)
ASC displacement to carry containers (necessary movement)	$max\{\lvert x_i - x_j \rvert L_s, \lvert y_i - y_j \rvert P_s\} + z_i H_s + z_j H_s$
ASC displacement without carrying containers (unnecessary movement)	$max\{\lvert x_i - x_j \rvert L_s, \lvert y_i - y_j \rvert P_s\} + z_i H_s + z_j H_s$

Table 9 Travel Distance (Meters)

ASC Activity	t_{ij} (minute)
ASC displacement to carry containers (necessary movement)	$max\left\{\frac{\lvert x_i - x_j \rvert L_s}{V_{move}}, \frac{\lvert y_i - y_j \rvert P_s}{V_{move}}\right\} + \frac{z_i H_s}{V_{full}} + \frac{z_j H_s}{V_{full}}$
ASC displacement without carrying containers (unnecessary movement)	$max\left\{\frac{\lvert x_i - x_j \rvert L_s}{V_{move}}, \frac{\lvert y_i - y_j \rvert P_s}{V_{move}}\right\} + \frac{z_i H_s}{V_{empty}} + \frac{z_j H_s}{V_{empty}}$

Table 10 Travel Time (Minutes)

Notation

Ls	: width of slot (meter)
Ps	: length of slot (meter)
Hs	: height of slot (meter)
Vmove	: ASC speed (meter/minute)
Vfull	: ASC full lift rate (meter/ minute)
Vempty	: ASC empty lift rate (meter/ minute)

So, we can find the total travel distance using this formula:

$$TD = \sum_{n=1}^{N} NMD_n + \sum_{u=1}^{U} UMD_u \quad (1)$$

And we can also calculate the total travel time by using this formula:

$$TT = \sum_{n=1}^{N} NMT_u + \sum_{u=1}^{U} UMT_u \quad (2)$$

Notation:

N	: number of necessary movement event
NMD_n	: ASC travel distance for necessary movement n (meter)
UMD_n	: ASC travel distance for unnecessary movement n (meter)
TD	: total travel distance of ASC for doing all activity (meter)
U	: number of unnecessary movement event
NMT_u	: ASC travel time for necessary movement u (minute)
UMT_u	: ASC travel time for unnecessary movement u (minute)
TT	: total travel time of ASC for doing all activity (minute)

The dynamic of the buffer area locations might reduce necessary and unnecessary movements of the ASCs. The shortened movements of an ASC will cause the increasing movements of the other ASC. We need to measure the combination of travel time of necessary/unnecessary movement reduction and the energy needed of lifting the container.

$$TE = \sum_{a=1}^{2} TT_a \times EC_a \times E \quad (3)$$

Notation:

a	: ASC ; a = 1 (LASC); a = 2 (WASC)
TE	: energy total cost
EC_a	: ASC energy consumption (kWh)
E	: energy cost per kWh

The algorithm of determining the buffer area and slot location for container and ASC scheduling is described in Figure 4 below.

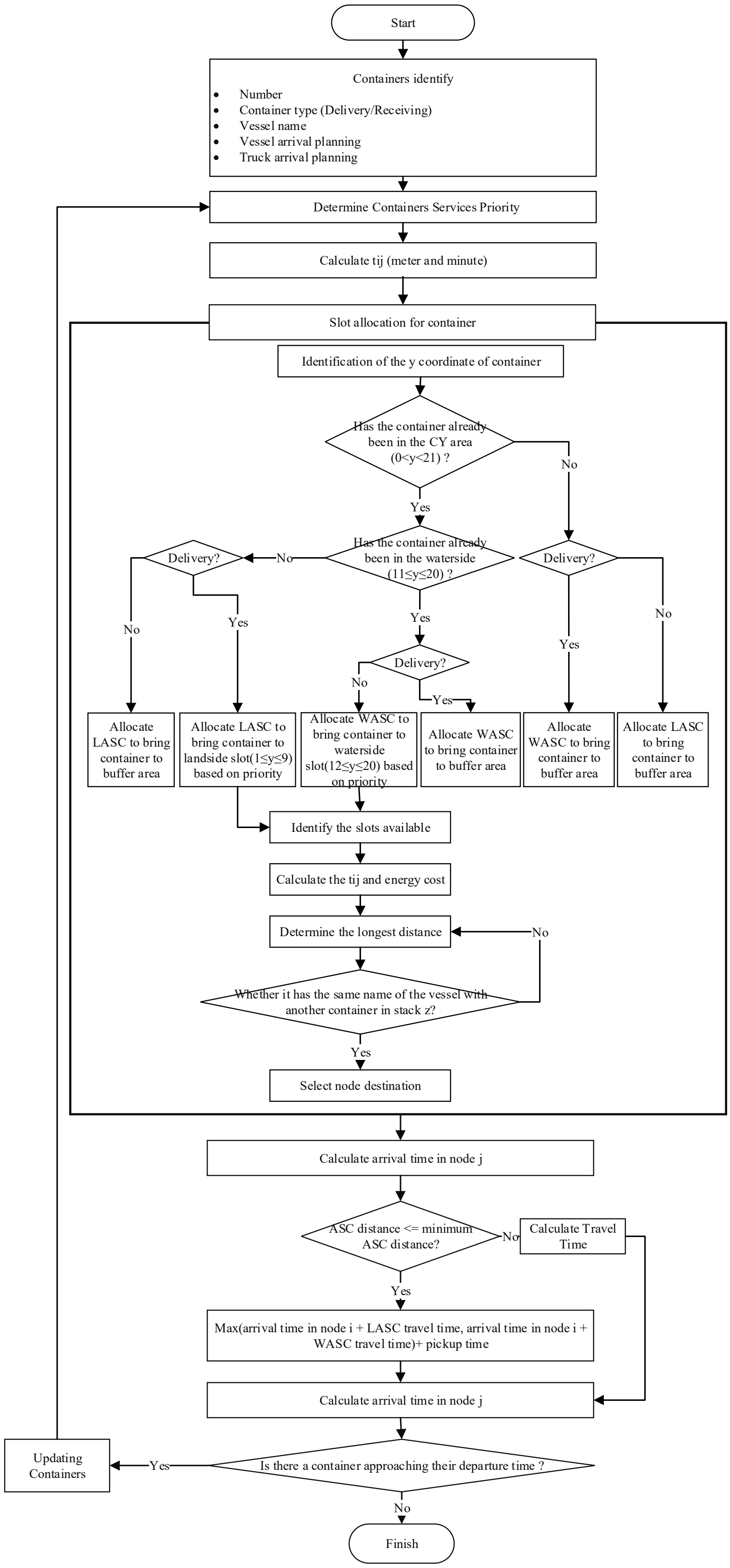

Figure 4 ASC Algorithm

NUMERICAL EXPERIMENT AND ANALYSIS

This section explains the performance analysis from the explained algorithm on Section 3. We did some experiments to find out about that. Aside for tested our algorithm, this experiment aims to evaluating the influence of operation strategic changing on our algorithm performance. Therefore, we did some experiments that are presented on Table 5.

Eksperimen	Perbandingan Demand	Buffer Area	
		Position	**Row**
1	50% (receiving): 50%(delivery)	Center	10 and 11
		Right	12 and 13
		Left	8 and 9
2	60% (receiving): 40%(delivery)	Center	10 and 11
		Right	12 and 13
		Left	8 and 9
3	70% (receiving): 30%(delivery)	Center	10 and 11
		Right	12 and 13
		Left	8 and 9

Table 11 Experiments Detail

The three experiments we do in this chapter still usedfixed buffer area. The performances that are measured form this experiment such as:

1. Total travel distance (meter) of LASC and WASC for each experiments.
2. Total travel time (minute) of LASC and WASC for each experiments.
3. Total energy cost of LASC and WASC for each experiments.

For simplify the operation of our algorithm simulation we develop What If Simulation using VBA Excel.

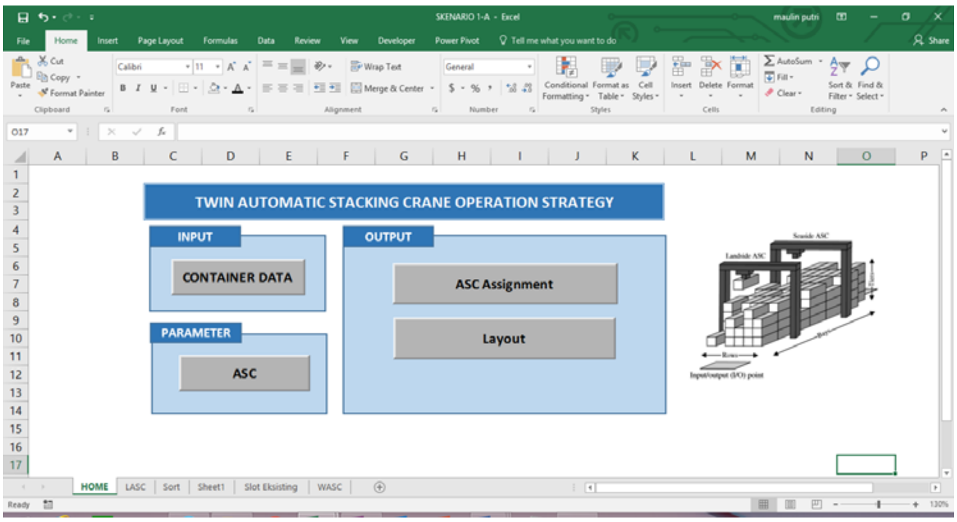

Figure 5 Interface of What If Simulation Using VBA Excel

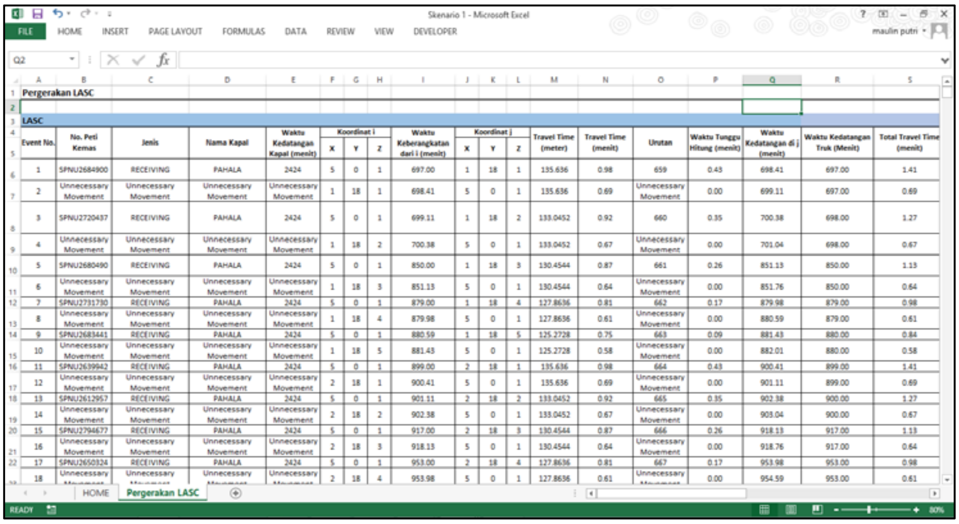

Figure 6 Simulation Process

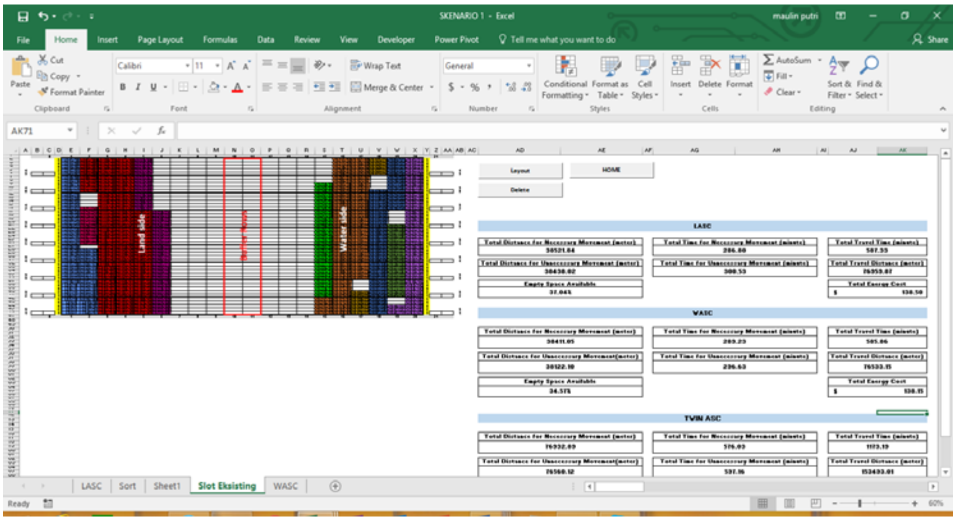

Figure 7 Simulation Result

In this experiment, we operate 1 block container yard with 9 columns, 20 rows, and 5 stacks. There are 6 vessels which coming consecutively (arrival time) in 6 work days that can be seen in Table 6. Those six vessels served by 1 block container yard. The total simulated container during simulation period is 500 containers, and limited on 20-ft dry containers. Table 7 shows the number of receiving and delivery container demand for each experiments. The vessel and container data is a real data form observational object. Observational object is a container port which using twin ASC and only operate for one year, so that, the number of demand has not been so much compared to other ports that have implemented twin ASC.

No.	Vessel Name	Arrival Time (Minute)
1	LUZON	1035
2	PAHALA	2424
3	MARINA STAR 1	3636
4	ALFA TRANS SATU	4818
5	MENTARI SUCCESS	5650

6	ELEGANCE	7971

Table 12 Vessel Data

Experiments		**1**	**2**	**3**
Luzon	**Delivery**	64	31	31
	Receiving	48	81	81
Pahala	**Delivery**	11	11	11
	Receiving	21	21	21
Marina Star 1	**Delivery**	130	129	79
	Receiving	51	52	102
Alfa Trans Satu	**Delivery**	45	29	29
	Receiving	12	28	28
Mentari Success	**Delivery**	0	0	0
	Receiving	85	85	85
Elegance	**Delivery**	0	0	0
	Receiving	33	33	33
Jumlah Petikemas Delivery		250	200	150
Jumlah Petikemas Receiving		250	300	350
Jumlah Petikemas		500	500	500

Table 7 Number of Receiving and Delivery Container for Each Experiments

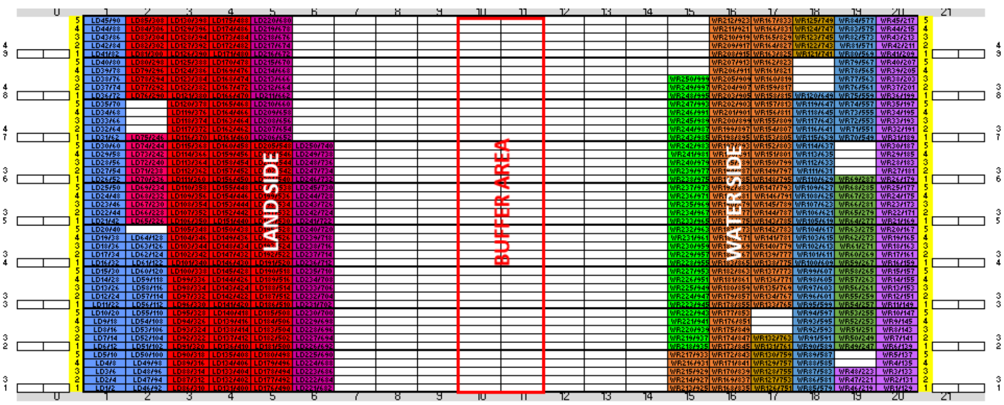

Figure 8 Slot Location from Experiments 1
(50% Receiving : 50% Delivery - Center Buffer Area)

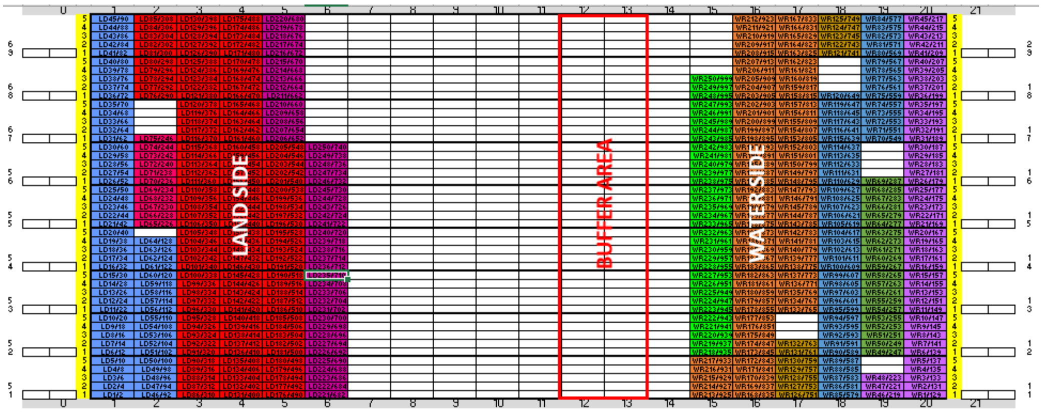

Figure 9 Slot Location from Experiments 1
(50% Receiving : 50% Delivery - Right Buffer Area)

No.	Container Number	Job Type	Vessel	Coordinate k			No.	Container Number	Job Type	Vessel	Coordinate k		
				X	Y	Z					X	Y	Z
1	SPNU2968850	DELIVERY	LUZON	4	2	1	21	SPNU2764522	DELIVERY	PAHALA	5	2	1
2	SPNU2857224	DELIVERY	LUZON	4	2	2	22	SPNU2792165	DELIVERY	PAHALA	5	2	2
3	SPNU2915721	DELIVERY	LUZON	4	2	3	23	SPNU2771440	DELIVERY	PAHALA	5	2	3
4	SPNU4616714	DELIVERY	LUZON	4	2	4	24	SPNU2791699	DELIVERY	PAHALA	5	2	4
5	SPNU2875845	RECEIVING	LUZON	7	20	1	25	SPNU2791451	DELIVERY	PAHALA	5	2	5
6	SPNU2868276	RECEIVING	LUZON	7	20	2	26	SPNU2748732	DELIVERY	PAHALA	6	2	1
7	SPNU2843318	RECEIVING	LUZON	7	20	3	27	SPNU2609953	DELIVERY	PAHALA	6	2	2
8	SPNU2871372	RECEIVING	LUZON	7	20	4	28	SPNU2797017	DELIVERY	PAHALA	6	2	3
9	SPNU2933284	RECEIVING	LUZON	7	20	5	29	SPNU2965208	DELIVERY	PAHALA	6	2	4
10	SPNU2918567	RECEIVING	LUZON	8	20	1	30	SPNU2777941	DELIVERY	PAHALA	6	2	5
11	SPNU2970523	RECEIVING	LUZON	8	20	2	31	SPNU2706531	DELIVERY	PAHALA	7	2	1
12	SPNU2839529	RECEIVING	LUZON	8	20	3	32	SPNU2684900	RECEIVING	PAHALA	2	19	1
13	SPNU2670830	RECEIVING	LUZON	8	20	4	33	SPNU2720437	RECEIVING	PAHALA	2	19	2
14	SPNU2829449	RECEIVING	LUZON	8	20	5	34	SPNU2680490	RECEIVING	PAHALA	2	19	3
15	SPNU2879521	RECEIVING	LUZON	9	20	1	35	SPNU2731730	RECEIVING	PAHALA	2	19	4
16	SPNU2905852	RECEIVING	LUZON	9	20	2	36	SPNU2683441	RECEIVING	PAHALA	2	19	5
17	SPNU2914670	RECEIVING	LUZON	9	20	3	37	SPNU2639942	RECEIVING	PAHALA	3	19	1
18	SPNU2687508	RECEIVING	LUZON	9	20	4	38	SPNU2612957	RECEIVING	PAHALA	3	19	2
19	SPNU2980481	RECEIVING	LUZON	9	20	5	39	SPNU2794677	RECEIVING	PAHALA	3	19	3
20	SPNU2891487	RECEIVING	LUZON	1	19	1	40	SPNU2650324	RECEIVING	PAHALA	3	19	4
21	SPNU2898157	RECEIVING	LUZON	1	19	2	41	SPNU2674460	RECEIVING	PAHALA	3	19	5

Table 13 Container Placement Position in CY

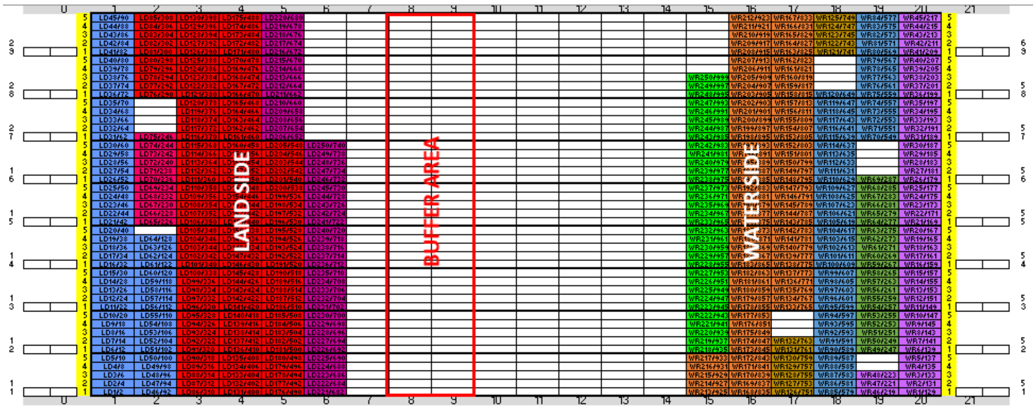

Figure 10 Slot Location from Experiments 1
(50% Receiving : 50% Delivery - Left Buffer Area)

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SMES PARTICIPATION AND SUCCESS OBSTACLES IN PUBLIC PROCUREMENT: A SYSTEMATIC REVIEW

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Abstract

Purpose: There are numerous factors which have been identified in the literature as potential obstacles for SMEs participation and success in public procurement market. This study systematically reviews these factors and proposes some directions for future research.

Design/methodology/approach: The research is conducted employing the critical and systematic review of the extant literature, encompassing studies conducted across business sectors. Future research directions are proposed accordingly.

Findings: Several factors have been identified as potential obstacles for SMEs participation and success in public procurement market. These factors could be classified into six categories. These obstacles generally affect SMEs success in public procurement market in two different phases. While some of these obstacles hinder SMEs from participating in the market, others may affect their success in the contract bidding and competition phase.

Research limitations: The main limitation of this research lies in its current method of literature review. A subsequent empirical validation is necessary to assure the reliability and validity of this research.

Originality/value: This research is original as it provides a comprehensive and systematic review and understanding of factors affecting SMEs participation and success in public procurement market. Based on this, the recommended research directions provide indications for future studies as well as guidelines for SMEs in their preparation for successful public procurement projects.

Keywords: small and medium enterprises (SMEs), public procurement, public procurement participation, public procurement success, critical factors.

Introduction

A large part of GDP (Gross Domestic Product) in every country is related to public purchases. Therefore, public procurement related costs can have a substantial impact on the economy (Croom and Brandon-Jones 2007). In Australia, enterprises with less than 200 employees are considered to be medium-sized, and enterprises with less than 20 employees are deemed to be small enterprises (OECD, 2015). Based on the statistics by Australian Bureau of Statistics (ABS, 2017), small businesses contributed about 33% to total industry value added in 2015. Industry value added (IVA) is a measure of contribution by firms in each industry to GDP. In 2015, SMEs (small and medium enterprises) added 343.4 billion and 233.6 billion respectively to the economy, together they account for 57% of GDP in Australia. Construction, real estate, professional services, healthcare and military are sectors which make the majority of contributions (OECD, 2015). In Australia, SMEs employ 70% of the Australian workforce and provide 55% of the economic outputs (OECD, 2015). Australia is the 21st among 34 countries in terms of the size of government purchasing and public procurement accounted for 12% of the GDP in 2011. In 2013, statistics show that procurement expenditures account for 33.9% of government spending. This is higher than the average global percentage of 29.0% (OECD, 2015).

Based on the statistics of the Organization for Economic Cooperation and Development (OECD, 2015) in 14 countries including Australia, SMEs are the major economic operators in terms of quantity, accounting for 95% of the organizations. A survey by the Australian Bureau of Statistics (ABS, 2017) provides a count of Australian businesses in each industry and sector. Based on these statistics, finance and service are the fastest growing sectors while the agriculture and farming sector have the highest amount of decrease in the number of businesses. Meanwhile, households are still the largest institutional sector although the number of the household businesses that accounts for 56% of the total number of businesses has decreased by 7% since last year (this sector had the highest exit from business rate during the last year) (ABS, 2017). Based on 2015-2016 statistics produced by the ABS, although SMEs represent about 89% of participants in public procurement contracts, they just succeeded in getting 24% of the entire value of the contracts (Department of Finance, 2017). According to Australia's Department of Innovation, Industry Science and Research, Australian SMEs face two main problems for survival: one is the lack of sufficient access to technology and networks, and the other is the insufficiently developed managerial skills. Public purchasing could, therefore, be used to provide chances of growth for local enterprises and therefore assist SMEs. By encouraging SMEs' participation in public procurement, both employment rate and economic growth would improve (Karjalainen and Kemppainen, 2008). Although SMEs' share in public procurement contracts is 24% during 2015-2016 period, this amount has dropped by 15% over the last few years from 39% during 2011-2012 period. The decreasing share of SMEs in public procurement, in the context of Australia, is a point of concern (Thurbon, 2015).

This paper, therefore, addresses the topical issue of critical success factors for SMEs in public procurement. These factors are categorised into two groups. The first group contains factors which may impede SMEs' participation in public procurement contracts and meeting pre-requisite conditions, while factors in the second group are those which could be hindrances for SMEs when they have decided to participate and enter the competition by bidding for those contracts. Specifically, these factors will be systematically reviewed so that future research directions can be proposed accordingly. The remainder of this paper is organised as follows. The next section explains how the literature review is conducted, followed by findings from this review. Discussion and recommendations are then elaborated and the last section concludes the paper.

Methodology

This paper employs a systematic approach to reviewing extant literature through multiple databases. The critical factors identified in this paper are drawn from 38 academic papers. These papers are selected from 165 different research papers based on their relevance to the topic using the keyword of "factors that are hindering SMEs success in public procurement". After the critical factors had been identified from this process, they were divided into two groups, namely, critical factors in the participation phase and those in the contract bidding phase. Based on their nature, these factors were further divided into six different categories.

Critical factors for SMEs' participation and success in public procurement

Public procurement is used to achieve multiple purposes and benefits, and promoting innovation is one of them. Therefore, it is the perfect tool for promoting innovative technologies because it allows the demand and supply to meet while preserving sustainability and efficiency goals (Aschhoff and Sofka, 2009). Public organisations can help the private parties in delivering the public procurement contract in multiple ways, and the most common ways include providing specialized knowledge and know-how or helping with compliance cost. The rationale behind supporting SMEs in awarding public procurement contracts could be classified as follows (Zheng, et al., 2005):

- SMEs encourage innovation and entrepreneurship.
- SMEs are more adaptive to the needs of the purchasers.
- SMEs contribute to job creation.
- SMEs development leads to economic growth and local sustainability.

Despite the above, there are numerous obstacles which hinder SMEs from participation and being successful in public procurement contracts. These are classified as follows.

Critical factors in the participation phase

Financial obstacles: In the research by Curran (2000), cost of participation, and most important of all the payment delays are the obstacles identified for SMEs. Payments made by the public sector are relatively late compared to that of the private sector (Curran, 2000). A report published by Morrison and O'Dwyer (2015) explained certain financial obstacles in the case of Australian SMEs. Mortgage or loan interest rates for SMEs are higher than that of bigger firms. The reason is the increased risk associated with SMEs. These enterprises either have no credit history or do not have enough assets as a deposit and this increases the perceived risk and hence the interest rate for these enterprises. Although the loan approval rate had increased severely for SMEs, the interest associated with them is still higher than other enterprises (Morrison and O'Dwyer, 2015).

Information asymmetry related obstacles: It has been identified in the literature that factors relating to information asymmetries can negatively affect SMEs' chance of winning public procurement contracts (Morrison and O'Dwyer, 2015). Specifically, lack of awareness has been perceived as the most important barrier by the SMEs. Lack of understanding about pre-requisite conditions and lack of knowledge of the procurement procedure cause difficulty getting on the approved supplier list and hinder SMEs from participating in public procurement contracts (Loader, 2015). SMEs do not always realize the benefits of participating in public procurement contracts and, as a result, they may not consider going through the training or promotion activities required to participate in public procurement contracts. The alternative draw back from participating in these contracts is that sometimes SMEs are scared that they will lose their autonomy over their business (Zheng et al., 2005).

The research by Love et al. (2014) shows that in Australia the traditional one-phase procurement is still the main way of procurement. Early contractor involvement (ECI) allows the private contractor to participate in the design, risk assessment, and planning phase of the project. Australian contractors are not well informed about benefits of ECI (Love et al., 2014). Adopting ECI can contribute to improving the communication between public and private parties, in providing realistic cost estimates and increasing the project design efficiency (Patterson, 2013). Certain barriers to ECI were identified during this research including a reduction in competitive tendering, fear of opportunistic behaviour by the contractor, and lack of experience from the contractor. Since ECI appoints contractor through the negotiated process, there exists the perception that this would decrease the competition, and hence the profit margins. However, in two-stage models, the contractor is required to submit the price in the first phase and the risk of decrease in the competition is removed. This signifies the fact that the main factor hindering ECI is the misconception about ECI benefits and costs (Love et al., 2014).

Regulatory obstacles: Factors such as lengthy and complex tendering process, overly prescriptive requirements, insufficient consultation prior to tender, scale of contract unsuitable to SMEs, restrictive requirements, e.g. environmental, lack of track record etc. are all identified as obstacles hindering SMEs in public procurement (Loader 2015). Although SMEs cannot be preferred to other firms, one improvement help would be increasing transparency and accessibility of the tenders since complicated and lengthy contracts with lots of conditions could eliminate SMEs from competitions (Aschhoff and Sofka, 2009). The regulatory framework could be the possible reason for some of the SMEs drawbacks in the public procurement market. SMEs face lots of problems in dealing with foreign public procurement including different regulations and language barriers and complex bureaucracy (Krumbholz et al., 2000). In order to increase the quality of public procurement, the awarding criteria must be changed from lowest initial cost to MEAT (most economically advantageous tender). Moreover, the procurement process must involve the suppliers more. The rationality behind this is, if the suppliers understand the problems and needs of the demand side, they would be able to help better design and implement the projects (Edler and Georghiou, 2007).

Lack of regulatory support for SMEs is another obstacle. In Australia, AUSTFA (Australia and United States free trade agreement) is the most comprehensive international agreement that also affects public purchasing. Based on this agreement, public agencies must act unbiased between foreign and domestic bidders. AUSTFA agreement has prohibited any bias against foreign firms as well as any offsets in procurement systems (Austrade, 2017). Being a member of AUSTFA, the US government has been able to provide support for its SMEs when public procurement contracts are less than the certified threshold in AUSTFA. In comparison, the Australian government has not provided enough offsets for SMEs (Bell, 2005). Although AUSTFA has limited purchasing power of the Australian SMEs, there is room for public agencies to use their power to nurture local SMEs through (Thurbon, 2015):

- Using the contracts that are below the value indicated in AUSTFA.
- Understanding that PTAs (preferential trade agreements), including AUSTFA, allow the governments to employ discrimination if it is for helping SMEs.

Obstacles relating to SMEs' characteristics: The study by Karjalainen and kemppanien (2008) explored the problems that SMEs might face for participating in public procurement markets. The lack of resources, skilled staff and administrative expertise are slowing SMEs' development in public procurement markets (Karjalainen and kemppanien, 2008). The majority of contractors do not have the ability or confidence to participate in ECI programs and therefore would rather have a traditional method of tendering (Love et al., 2014). This confirms the observation about uncertainty avoidance culture of SMEs (Love et al., 2008).

Critical factors in the contracting phase

Contract-related obstacles: The main elements influencing SMEs success, based on GHK study (2010) are nature of the procurer, the industry and sector of the procurement, tendering procedure used, the awarding criteria, "most economic bid" or "most economically advantageous tender" and the total value of the contract. Certain industries have a higher SME participation rate. In the UK's public sector, when partnership network is used in public procurement as tendering procedure SMEs have less success in getting public contracts. However, short term contracts with smaller size are more achievable for SMEs (Loader, 2011). Edler and Georghiou (2007) mentioned that the current major trend in public procurement in the EU is using MEAT as the awarding criteria. This method signifies lowest price possible as the contracts awarding criteria and, therefore, other features and aspects of procuring are not considered as much. Bigger suppliers can cope up with lower prices by reducing their income margin whereas such opportunities do not always exist for SMEs and, as a result, this contract awarding criteria could be another obstacle for SMEs (Edler et al., 2006). A study by Croom and Brandon-Jones (2007) suggested that, since the high value of the contract could be a barrier towards SMEs' participation, usually breaking the contracts into smaller lots could help in overcoming the problem.

Regulatory obstacles: A study by Johnston et al. (2007) revealed that the benefits provided by public procurement are not equally divided between firms based on their country, industry, technology and their size (Johnston et al., 2007). SMEs barriers for winning public procurement contracts are different based on the industry and country. Loader and Norton (2015) argued that, in order to be able to identify exact obstacles that SMEs face, their industry must be considered. In this paper, they identified certain barriers like the lack of sufficient feedback by the public sector and subcontracting procedure related problems. these obstacles are present to craft supplying SMEs that are active in the heritage sector of public procurement (Loader and Norton 2015). There are many strict rules regulating this process, so deviation from any of them could exclude SMEs from the bidding process (Karjalainen and Kemppainen, 2008). Thurbon (2015) examined the effects of PTAs (Preferential Trade Agreements) on the Australian government's ability to use public procurement for local industry developments. Although PTAs limit government's policy making abilities, they still leave enough room for governments to strategically support local businesses and SMEs (Thurbon, 2015).

Obstacles relating to SMEs' characteristics: Inefficient monitoring process is one of the main problems that SMEs face during participation in public procurement (Howe and Landau, 2009). In a study by Loader (2015), about 67% of the SMEs believed that certain barriers existed in the way of their participation and success in public procurement market. Strategic orientation of SMEs has a role in their underrepresentation in public procurement market. Strategic orientation includes MO (market orientation) and EO (entrepreneurial orientation) of SMEs. MO is about establishing good relations with current customers and providing high compatibility with customer's needs, whilst EO relies on staying competitive and seizing market opportunities. The result of study by Tammi et al. (2016) identified MO as a potential obstacle for SMEs.

Cultural obstacles: Australian public purchasing favours foreign (especially the US) suppliers. After the Second World War, most of the government departments prefer purchasing from the large, established, foreign companies, these companies are deemed less risky because of their history and reputation (Lember, et al., 2014). There are many cultural biases in the way of public purchasing as a technology oriented industry in Australia, from buy-non-Australian bias to complicated tender processes that make it harder for the suppliers (Lember et al, 2014). Table 1 provides a summary of the critical factors that are identified in the literature.

Factor categories	Phases in procurement process	Critical factors	References
financial obstacles	Participation	tender participation cost	(Loader, 2005)
	Participation	high mortgage or loan interest assigned to SMEs	(Flynn et al., 2015)
	Participation / Contract bidding	SMEs lack of capital record	(Loader, 2005) (Walker & Preuses, 2008) (Pickernell et al., 2011)
	Participation	lack of assets	(Morrison and O'Dwyer, 2015)
	Participation	lack of credit history	(Morrison and O'Dwyer, 2015)
	Participation	high risk associated with SMEs	(Morrison and O'Dwyer, 2015)
Information asymmetry related obstacles	Participation / Contract bidding	insufficient information sharing and miscommunication	(Karjalainen and Kemppainen, 2008) (Loader, 2015)
	Participation	lack of knowledge about regulatory framework	(Karjalainen and Kemppainen, 2008)
	Participation	lack of awareness about the benefits of public procurement	(Zheng et al., 2005)
	Participation	Misconception about ECI benefits and costs	(Love et al., 2014)
	Participation	lack of awareness about areas of weakness	(Edler and Georghiou, 2007).
	Participation	negative perception towards the outcome of the tender	(Akenroye and Aju, 2013) (Zheng et al., 2005)
Regulatory obstacles	Contract bidding	SME uncertainty in market	(Love et al., 2008)
	Contract bidding	insufficient use of set asides by government	(Thurbon, 2015) (Bell, 2005)
	Participation	lack of government insurance for purchase of goods and services from SMEs	(Curran, 2000)
	Participation	complicated pre tender perquisites for SMEs	(Akenroye and Aju, 2013) (Loader,2015)
SME related obstacles	Participation	lack of access to technologies and ICT	(Karjalainen and Kemppainen, 2008)
	Participation	Lack of resources and capabilities	(smallbone et al., 2009)
	Participation / Contract bidding	insufficient information sharing and lack of awareness	(Loader, 2015)
	Participation	Lack of ability or confidence to participate in ECI	(Love et al., 2014)
	Participation / Contract bidding	lack of administrative staff and experience	(pickernell et al., 2015) (Karjalainen and Kemppainen, 2008)
	Participation	low annual firm turnover	(Loader, 2011)
	Contract bidding	non effective	(Zheng et al., 2005) (Industry,

		management practices in firms	2017)
Cultural obstacles	Contract bidding	buying non Australian bias	(Johnston et al., 2007)
	Contract bidding	buying from reputable large companies	(Lember et al., 2014)
	Contract bidding	industry and sector related bias	(Loader and Norton, 2015)
Contract-related obstacles	Contract bidding	total value of the contract	(Erridge et al., 1998) (Loader 2007) (sedita and apa, 2015)
	Contract bidding	complicated, lengthy and unclear contracts	(Cabras, 2011 (Zheng et al., 2005) (Loader, 2007)
	Contract bidding	contract awarding criteria	(Cabras, 2011) (GHK, 2010)

Table 1. Critical factors to SMEs' participation and success in public procurement

Discussion and recommendations for future research

SMEs are the biggest part of every economy and public procurement market provides many benefits for the supplier. As a result, it is important to make sure that the biggest part of economy exploits these benefits and is not excluded from public procurement market. Based on previous studies in the literature, critical factors that negatively affect SMEs participation and success in public procurement market are derived and also classified into six different categories. This systematic classification provides a clear overview of these factors for scholars who are conducting research in this area. In addition, it can also help SMEs to identify areas for improvement so as to increase their success in public procurement.

In view of the extant literature, one less explored area is the ECI and the relationship between SMEs and public buyer and supplier involvement. Supplier involvement provides multiple advantages for the public buyer and could be used for increasing SMEs' participation and success in public procurement. Adopting ECI can contribute to improving the communication between public and private parties, in providing realistic cost estimates and increasing the project design efficiency (Patterson 2013). Certain barriers to ECI were identified during this research including a reduction in competitive tendering, fear of opportunistic behaviour by the contractor, and lack of experience from the contractor. Future research can be conducted to explore the obstacles for ECI in public procurement and develop a model for optimizing SMEs success in public procurement market.

Conclusion

In this research, several critical factors have been identified as potential obstacles for SMEs participation and success in public procurement market. These obstacles generally affect SMEs success in public procurement market in two different phases. Some obstacles hinder SMEs from participating while others negatively affect their success in the contract bidding and competition phase of public procurement contracts. These factors are further groups in six categories, namely, financial, information asymmetry, regulatory, SMEs-related, cultural and contract-related obstacles. Future research can further build on and expand from this research by focusing on supplier-buyer relationship and early contractor involvement (ECI) which provide several benefits for both the buyer and supplier and may enhance SME's participation and success in public procurement contracts.

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SUSTAINABLE AND RESILIENT SUPPLY CHAIN MANAGEMENT: A SURVEY OF THAI MANUFACTURERS

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Introduction

Supply chain management (SCM) requests the integration and coordination of business processes and strategy alignment throughout the supply chain for the purpose of satisfying the final customers of the supply chain (Green et al., 2008; Green et al., 2012). In a volatile, high-demand market, sustainability and resiliency in an SCM context can lead organizations to achieve competitive advantage (Govindan et al., 2014). However, the incorporation of sustainability and resiliency across supply chains is a greater, more challenging issue than consolidating these concepts (Ahi and Searcy, 2015).

Manufacturing organizations have begun to implement sustainable supply chain management (SSCM) and supply chain resilience management (SRES) practices in response to customer demand for products and services. Therefore, the challenge of this study is to investigate how to integrate sustainability and resiliency in SCM, develop tools to measure the implementation level, and then suggest possible practices to enhance supply chain and organizational performance. This study was developed from extant literature which provided linkages between SSCM and SRES (Joradon et al., 2015) and allowed development of a measurement scale (Joradon et al., 2016). This paper will provide results and insights from a survey of Thai manufacturers in the electronic, electrical and automotive sectors as these industries have been vulnerable in recent years.

For example, in 2011 Thailand suffered huge flooding which had a high impact on Thai manufacturing. Some organizations permanently closed after the period of disruption or else needed a long time to recover their manufacturing processes, while other organizations were able to recover their production lines faster than their competitors. Furthermore, we believe that sustainability, which is quite a new concept in Thailand, could improve organizational production processes, making them more sustainable, and helping it to become the number one place of interest to do business in the world. Therefore, we advocate that if Thai manufacturing can apply concepts of sustainability and resiliency in its organizations, it will enhance supply chain performance in Thailand, which in turn is related to the Thai government's Manufacturing Logistics Development Plan.

Literature review

According to Joradon et al. (2015), integration between SSCM and SRES still lacks in existing literature. However, we argue that the combination between SSCM and SRES in a new concept of sustainable and resilient supply chain management (SResSCM) will support organizations to be both more sustainable and resilient in the future. Joradon et al. (2016) developed a measurement scale to measure SResSCM practices, supply chain performance, and organizational performance as shown in Figure 1, which was based on the Joradon et al. (2015) literature review and extant frameworks of Carter and Rogers (2008) and Pettit et al. (2010). The empirical study applied these hypotheses and tested them in a survey of Thai manufacturers in the three sectors noted above, i.e. electrical, electronic and automotive industry.

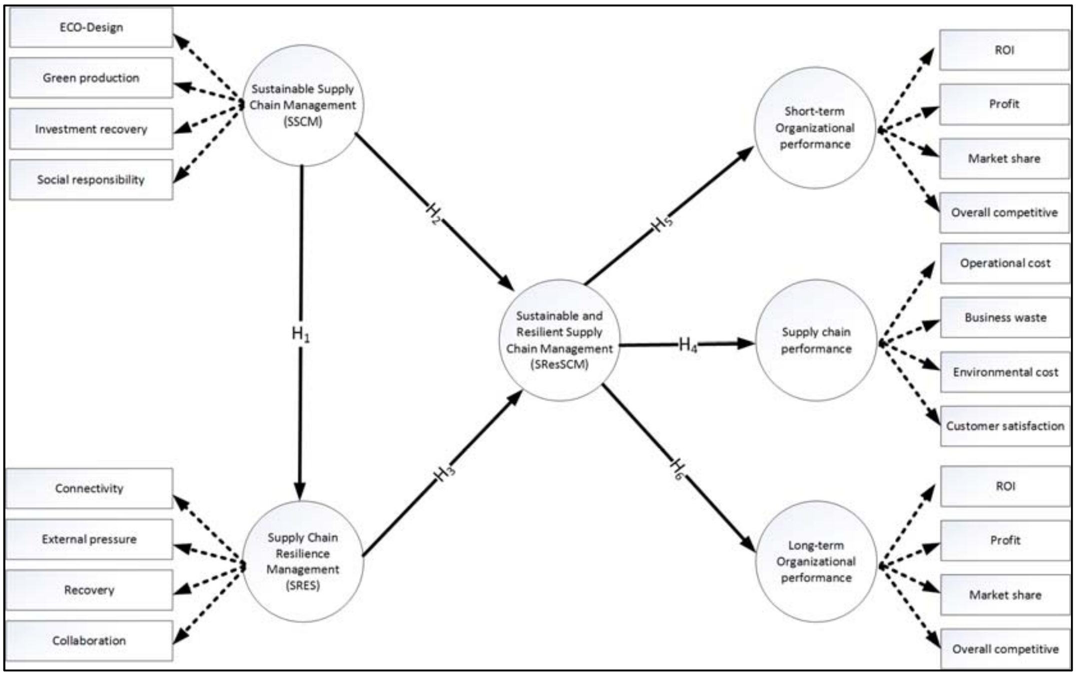

Figure 12: Conceptual model

<u>Survey process</u>

Sample and survey information

This survey was composed of five parts. The first part included questions about definitions of SSCM and SRES in respondent organizations while the second part consisted of different questions about SResSCM practices which could be applied in organizations. The third part consisted of questions about supply chain performance in term of operational cost, business wastage, environmental cost, and customer satisfaction while the fourth part comprised questions about the short- and long-term impact from SResSCM practices on organizational performance. Lastly, the fifth part included general questions about respondents and their organization. A five-point Likert's scale was used in this survey, with different anchors in each part. As a first step twelve practitioners in Thai manufacturing were invited to evaluate whether the individual items appeared to be appropriate measures for their respective constructs (Anderson and Gerbing, 1991). Then, the final survey, initially generated in English, was translated from English to Thai and back-translated (Douglas and Craig, 2007). There were two experts for translation and two experts for back-translation.

The survey was sent to around 2,500 Thai manufacturing organizations via email with a link to an online survey. A total of 113 usable questionnaires were received which represents a response rate of 0.05%. It consisted of electronic organizations (91), automotive organizations (14) and electrical organizations (8). The distribution of firm size was: up to 50 employees (30), from 51 to 200 employees (24) and more than 200 employees (59). Most respondents are in Bangkok and Central Region (79), with the East Region (23), North Region (5), North-East Region (3) and West Region (3) also represented. Over 80% of respondents are in 1st-Tier suppliers (34), 2nd-Tier suppliers (26), manufacturing or focal firm (17), or 3rd-Tier supplier (15). To test the eligibility of the respondents, they were asked about their profession and the length of working experience in supply chain as well. Over 85% are in managerial positions, i.e. managing director (22), operation managers (20), purchasing managers (9) and over 56% of respondents had worked for more than ten years in their industry.

Assessment of bias

Non-response bias was assessed by comparing early responses and late responses. There were 67 respondents who responded to the survey immediately, and 46 respondents who were assigned as late responses. The Mann-Whitney U test was applied to compare the difference between the medians for each question for early responses and late responses, since the majority of the variables in this survey had non-normally distributed data (Pallant, 2016). The results presented that these groups did not differ from each other at the 0.05 level of statistical significance. In these responses, missing value were pairwise deletion, because this approach still calculates valid data in the model, and ignores missing data from each respondent. However, the analysis may be based on different sample size, which can bias the results (Pallant, 2016). Further, the results were also tested for common method variance, which can pose problems for survey research that relies on self-reported data (Podsakoff et al., 2003). Post-survey, a Harman's single factor test was conducted (Harman, 1976) due to the exploratory factor analysis for this study and revealed that eigenvalues greater that 1 for all the total variance in each construct. These findings suggest that non-response and common method variance do not represent a serious problem for this data.

Data Analysis

Measurement development

The first step was preliminary correlation analysis using nonparametric correlations for each construct from the SPSS programme. The second step was to create constructs by using exploratory factor analysis (EFA) with SPSS. The results from the EFA were subsequently employed in the last two steps to evaluate the reliability and validity of scales, variables and resultant constructs by using partial least squares (PLS) analysis with the smartPLS 3.0 programme. Since there were some new questions from qualitative pilot testing translated into Thai, a measurement model was assessed. An assessment of convergent and discriminant validity was conducted since the unidimensionality of a scale must be established before its reliability can be examined (Gerbing and Anderson, 1988). Then, to assess unidimensionality, factor analysis was conducted using the principal component analysis with Varimax rotation (Pallant, 2016). Hair et al. (2010) recommend factor loading based on sample size and for this study factor loading should be 0.55. Therefore, items which have factor loadings less than 0.55 were deleted. Consequently, remaining items for this study are four for SResSCM construct, 16 for SResSCM practices construct (internal and external plan (IEP_01 – 08), investment recovery (IR_01 – 03), ECO-design (ECO_01 – 03), collaboration (COL_01 – 02)), 15 for supply chain performance constructs (customer and operational cost (COC_01 – 06), environmental cost (ENV_01 – 04), business wastage (BUS_01 – 03) and customer satisfaction (CS_01 – 02)) and 32 for SResSCM impact construct (SResSCM practices impact (SRESPI_01 – 16), long-term organizational performance (LOP_01 – 08), short-term financial (STF_01 – 04) and short-term growth (STG_01 – 04)).

Because the sample size of 113 does not allow using structural equation model based on a covariance matrix, a path analysis was investigated using a partial least squares structural equation model (PLS-SEM), more specifically SmartPLS 3.0 programme (Hair et al., 2016). To further ensure the sample size is adequate for the analysis, the researchers used the G*Power 3 software (Faul et al., 2007) to conduct a power analysis, as proposed by Cohen (1988) for the F-test, pertaining to the R^2 value for the endogenous constructs. For this study, the researchers employed a medium effect size ($f^2 = 0.15$) for six predictors, a significance level of 0.05 and a desired power of 0.80. It was found that the minimum sample required for the validity of this study would be about 98 responses. Consequently, the 113 fully completed respondents were sufficient for this study achieved. For this reason, this study applied PLS and the SmartPLS 3.0 programme to test both the reliability and validity of the measurement and structural models (Hair et al., 2016). The measurement model represents the relationship between manifest variables (measurement items) and the unobserved latent variables, while the structural model focuses on hypothesized relationships between latent variables (Hair et al., 2010).

Measurement model

The quality criteria used to confirm the quality of the measurement model were in accordance with Hair et al. (2016), assessing internal consistency reliability (or composite reliability), convergent validity and discriminant validity, as shown in Table 1. All composite reliabilities are well above the recommended threshold, ranging from 0.86-0.98 (Nunnally, 1978). Furthermore, Cronbach's alpha was also well above the average threshold of 0.88, ranging between 0.67-0.98. To evaluate convergent validity the outer loading of the indicators, (preferably above 0.70) and as well as the average variance extracted or AVE (for which a suggested threshold is above 0.50) were conducted (Fornell and Larcker, 1981). All reflective indicators had a loading of more than 0.70. The assessment focused only on the outer loadings of the reflective constructs. Finally, examining the degree of divergence of each construct is known as discriminant validity analysis (Hair et al., 2016). For this study, the square root of the AVE scores for each construct was compared with their correlation with the other constructs (Fornell and Larcker, 1981). It is recommended that the square root of AVE scores should be greater than their correlation with the other constructs (Chin, 1998). According to this test, there was no problem with composite reliability, convergent validity and discriminant validity, which indicates the proposed measurement model is both valid and reliable.

Construct	Indicators	Mean	SD	Loading	CR	α	AVE
Sustainable and resilient supply chain management (SResSCM)	SRESSCM_01	4.160	0.727	0.955	0.922	0.892	0.749
	SRESSCM_02	4.120	0.765	0.809			
	SRESSCM_03	4.110	0.760	0.876			
	SRESSCM_04	4.040	0.870	0.707			
Sustainable and resilient supply chain management practices	The repeated indicator approach with mode B (reflective-formative hierarchical latent variables)						
Internal and external plan (IEP)	IEP _01	4.610	0.784	0.819	0.952	0.943	0.713
	IEP _02	4.420	0.933	0.903			
	IEP _03	4.500	0.955	0.884			
	IEP _04	4.330	1.047	0.852			
	IEP _05	4.460	0.900	0.822			
	IEP _06	4.260	1.081	0.873			
	IEP _07	4.620	0.750	0.795			
	IEP _08	4.100	1.239	0.811			
Investment Recovery (IR)	IR_01	4.020	1.379	0.927	0.904	0.841	0.759
	IR_02	3.680	1.676	0.794			
	IR_03	4.460	1.106	0.889			
ECO-design (ECO)	ECO_01	2.980	1.503	0.744	0.876	0.793	0.708
	ECO_02	3.790	1.187	0.876			
	ECO_03	3.600	1.340	0.889			
Collaboration (COL)	COL_01	3.150	1.622	0.805	0.856	0.671	0.749
	COL_02	3.880	1.332	0.918			
Supply chain performance	2nd order construct, repeated items measuring, COC, ENV, BUS, and CS were employed				0.933	0.923	**0.485**
Customer and operational cost (COC)	COC_01	4.300	0.565	0.829	0.904	0.872	0.611
	COC_02	4.290	0.636	0.753			
	COC_03	4.210	0.725	0.741			
	COC_04	4.250	0.726	0.829			
	COC_05	4.150	0.782	0.771			
	COC_06	4.120	0.670	0.761			
Environmental cost (ENV)	ENV_01	3.960	0.749	0.918	0.922	0.886	0.749
	ENV_02	3.980	0.779	0.943			
	ENV_03	3.890	0.838	0.803			
	ENV_04	4.060	0.698	0.787			
Business Wastage (BUS)	BUS_01	4.170	0.718	0.874	0.895	0.824	0.741
	BUS_02	4.210	0.700	0.802			
	BUS_03	4.150	0.770	0.903			
Customer Satisfaction (CS)	CS_01	3.850	0.847	0.930	0.912	0.808	0.838
	CS_02	3.830	0.915	0.900			
Sustainable and resilient supply chain management impact	2nd order construct, repeated items measuring, SRESPI, LOP, STF, and STG were employed				0.964	0.961	**0.457**
SResSCM practices impact (SRESPI)	SRESPI_01	3.020	1.282	0.925	0.981	0.979	0.765
	SRESPI_02	2.900	1.246	0.914			
	SRESPI_03	2.910	1.162	0.884			
	SRESPI_04	3.020	1.261	0.899			
	SRESPI_05	3.030	1.306	0.915			
	SRESPI_06	2.980	1.157	0.904			
	SRESPI_07	3.060	1.227	0.906			
	SRESPI_08	3.030	1.292	0.897			
	SRESPI_09	2.810	1.192	0.888			
	SRESPI_10	2.990	1.191	0.860			
	SRESPI_11	2.860	1.238	0.875			
	SRESPI_12	2.810	1.148	0.903			
	SRESPI_13	2.860	1.093	0.841			
	SRESPI_14	2.850	1.096	0.792			
	SRESPI_15	2.800	1.240	0.813			
	SRESPI_16	2.710	1.024	0.761			
Long-term Organization performance (LOP)	LOP_01	3.230	0.817	0.885	0.963	0.955	0.764
	LOP_02	3.300	0.804	0.876			
	LOP_03	3.300	0.827	0.927			
	LOP_04	3.270	0.762	0.898			
	LOP_05	3.270	0.820	0.877			
	LOP_06	3.290	0.755	0.855			
	LOP_07	3.330	0.813	0.924			
	LOP_08	3.410	0.767	0.735			
Short-term Financial (STF)	STF_01	2.950	0.718	0.910	0.943	0.919	0.804
	STF_02	2.960	0.713	0.882			
	STF_03	3.000	0.763	0.928			
	STF_04	2.950	0.693	0.866			
Short-term Growth (STG)	STG_01	3.050	0.802	0.954	0.939	0.912	0.795
	STG_02	3.030	0.792	0.907			
	STG_03	3.040	0.738	0.907			
	STG_04	3.140	0.784	0.790			

Table 14: Assessment of reflective measurement models

Structural model
A structural model was used to assess the hypothesized relationships among the constructs, the coefficient of determination (R^2), the path coefficient, and their corresponding significance scores (Hair et al., 2016). To assess the statistical significance between latent variables, traditional parametric tests were inappropriate in PLS (Chin, 1998). Therefore, bootstrapping as a non-parametric test was applied to test the hypotheses relationship between constructs. In this study, 5,000 bootstrap samples were established by resampling with replacement from the original samples. T-statistics are calculated for all coefficients, based on their stability across the subsamples, indicating which links were statistically significant. Table 2 shows the path coefficients, *t* values and *p* values for this study.

	Path Coefficients	*t* Values	*p* Values	Significance?
SResSCM Def -> SResSCM practices	0.172	0.644	0.520	No
SResSCM practices -> SC Performance	0.491	4.162	0.000	Yes
SResSCM practices -> SResSCM Impact	0.386	2.947	0.005	Yes

Table 15: Significance testing results of the structural model path coefficients

Results and discussions
The hypotheses evaluation yielded mixed results. While some of the hypotheses were supported, others were not. Table 3 presents hypothesis test results for this study. The results show sustainable supply chain management and supply chain resilience management are interlinked in the understanding of Thai practitioners. However, it can be seen that their definitions of same do not relate to practices or

procedures applied in organizations. Furthermore, sustainable and resilient supply chain management has a positive effect on supply chain performance improvement and provides positive impact on short-term and long-term organizational performance. Therefore, SResSCM practices, which were provided in this study, will guide Thai manufacturers to develop their organization to be more sustainable and resilient. Short-term impact and long-term impact were combined after the EFA process so we infer that SResSCM practices have a positive impact on both short-term and long-term organizational performance. Figure 2 summarizes the relationship between SResSCM practices, SC performance and organizational performance from this study.

Research hypotheses	Description	Result
H_1	Sustainable supply chain management has a positive relationship on supply chain resilience management	Supported
H_2	Sustainable supply chain management definition has a positive effect on sustainable and resilient supply chain management practices	Not supported
H_3	Supply chain resilience management definition has a positive effect on sustainable and resilient supply chain management practices	Not supported
H_4	Sustainable and resilient supply chain management practices positively affect supply chain performance	Supported
H_5	Sustainable and resilient supply chain management practices have a positive impact on short-term organizational performance	Supported
H_6	Sustainable and resilient supply chain management practices have a positive impact on long-term organizational performance	Supported

Table 16: Hypothesis test results

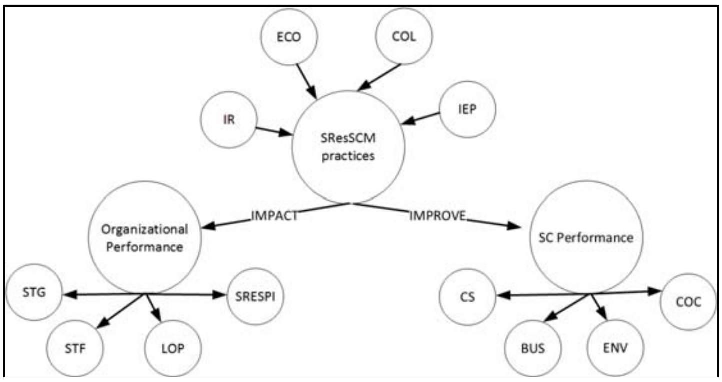

Figure 13: Relationship between SResSCM, SC performance and organizational performance

<u>Conclusions, implications, limitations and future research</u>

The main objective of this paper was to summarize survey results from the Thai manufacturing sector regarding SResSCM. It can be demonstrated from this study there is a relationship between SSCM and SRES. But the results showed that there is no relationship from both SSCM and SRES definitions to SResSCM practices. Furthermore, this study also supports the relation between SResSCM practices to supply chain performance, short-term organization performance and long-term organizational performance.

In respect of managerial implications, the results indicate that SResSCM practices have already been applied in some organizations' strategies; however it was found that there were different levels of implementation, i.e. "considering" implementation, "partial" implementation and "full" implementation of these practices. This study also provides an important framework for supporting decision-making related to sustainability and resiliency in SCM. In this way, supply chain managers can adjust organizational behaviour to achieve better levels on measurement scales for SResSCM practices in order to: 1) reduce risks and impacts while improving organizational sustainability efficiency; 2) improve the supply chain ability to cope with unexpected disturbances; and 3) prepare for the impact of the implementation of SResSCM practices on organizational performance. Supply chain managers can use this knowledge to respond to disruptive events more effectively and with increased confidence.

However, like all research studies this study has some limitations. This study has a low sample size (i.e. 113) requiring the use of PLS to calculate the structural equation model. Future research should use increases sample size to achieve possibly more robust results from covariance based SEM than PLS. Also, this study was a snapshot of a particular point in time. Future research should use a longitudinal analysis in studying SResSCM practices as a means of providing a clear picture concerning its long-term effects. A good example would be to perform a comparison on the outcomes of SResSCM before and after the adoption of SResSCM practices.

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THE EFFECT OF VALUE CHAIN CAPABILITIES ON SUSTAINABLE PERFORMANCE: A STUDY OF THE AIRLINE INDUSTRY

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Abstract
Purpose: This research examines the value chain capabilities and their effect on sustainable performance of airlines in the US and Asia Pacific markets and discusses some resulting academic and managerial implications.

Research Design and Methodology: The initial phase of this research involves the case study approach with the full-service airline industry. Three major airlines, one is based in North America and the other two in Australasia, were chosen as case studies, in which six in-depth phone and Skype interviews with the senior executives in charge of respective value chain areas in each airline were conducted i.e. Operations, Sales and Marketing, Human Resources, Technology, Customer Service and IT. This is to investigate the effect the value chain capabilities on sustainable firm performance in terms of economic, social and environmental performance.

Findings: **It is found that there is a positive relationship between value chain capabilities and sustainable firm performance. Especially, it is consistently acknowledged that resource-based value chain capability such as people and technology are at the core of sustainable performance but management-based value chain capability such as meritocracy, high performing teams and culture are also fundamental and in line with the relevant theories on how firms develop capabilities to improve performance.**

Research limitations/implications: The main limitation of this research is that the data collected are only from the initial phase of a bigger study and thus may not fully unveil the whole findings.

Practical implications (if applicable): This research recognises that there are cultural differences between the airlines and their performance can be reflected by cultural norms. Therefore, monetary reward for high performance by staff is not necessarily accepted in some companies' or national cultures.

Originality/value: There is a link between sustainability and core business which has not been sufficiently recognized by companies as an opportunity but presents great potential for companies. This research is therefore original as there has not been much research on how value chain capabilities can be employed to result in sustainable performance.

Key Words: *Value chain, capabilities, airline value chain, sustainability*

Introduction

Firm performance has been primarily focused on commercial goals and there has been a lack of consideration for ecological and societal aspects which have not been sufficiently recognized as having great potential. This research looks at the value chain capabilities and their effect on sustainable firm performance as it is believed that one of the operational gaps that can make a difference to the performance of an organization is that of the value chain (Bisignani, 2011). The airline industry has attracted so much scholarly attention, yet many important issues that are operationally and share-holder aligned, have remained unresolved.

While there are several studies on supply chain management, there is a gap in the extant literature on value chain management, the enablers of an effective value chain on sustainable firm performance and the capabilities that are critical to the current dynamic environment. It is therefore important to understand the capabilities of the airline value chains, namely, the internal resources, processes, management capabilities and design which can create value and drive sustainable firm performance and add to value-creating strategies.

Literature Review

The Value Chain Capabilities

Value chain capabilities impact firm performance, not only in terms of financial but also non-financial measures. Tangible resources such as equipment and technology and intangible resources such as culture, management capability, processes, service quality, learning and innovation, could lead to enhanced business performance (Waggoner, 1999). However, culture and leadership are important resources in the foundation of an effective value chain and are required for effectively managing the value chain (Presutti, 2013c, Drucker, 2001, Senge et al., 2011), which in turn influence sustainable firm performance. A firm's culture can play a critical role in performance and a culture of innovation coupled with the potential to explore new avenues are both factors that help companies to take up market opportunities (D'heur, 2015). Additionally, design plays a critical role in the competitive arena where organizations require continual disintegration and reintegration to have an advantage. Fine, Vardan, Pethick, and El-Hout (2002) pointed out that, in today's environment, the pace of change due to technologies and markets has made it necessary for frequent reshuffling of structural, technological, financial and human assets.

Resources

Firm resources include all tangible and intangible resources, capabilities, information, knowledge etc. which are used to conceive and implement value creating strategies to improve efficiency and effectiveness (Barney, 1991). If performance of the airline is dependent on resource allocation in terms of brand image, service levels, customer relationship, management and hub dominance these are areas of the value chain that could be the key to performance quality (Wittmer, 2011). Looking at the resource-based view (RVB), which is when a company has valuable, rare, inimitable and non-substitutable (VRIN) resources, they can be sustainably competitive by implementing strategies that create value and cannot be duplicated by competitors (Barney, 1991; K. M. Eisenhardt, & Martin, J. A., 2000; Prahalad, 1990; Teece, Pisano, & Shuen, 1997). RBV provides valuable insights into how a firm can be competitive and sustained over time (Wang, 2015). Thus, one of the objectives of applying the RBV is for firms to identify their capabilities and develop them further (Wang, 2015). Capabilities are defined as complex bundles of skills and collective learning, organized through organizational processes that ensure coordination of the firm's activities (Day, 1994). In the quest for sustainable firm performance, firms have used a number of approaches to achieve a competitive advantage and one of those approaches is the well know competitive forces approach by M. Porter (1985) which has been the dominant paradigm in the strategy field (Teece et al., 1997). This approach puts the emphasis on intense competition and defends against the competition. The capability approach locates the source of competition and applies the hard to duplicate resources which are made up of the firm's assets and capabilities (Day, 1994). Every organization acquires many capabilities to enable them to carry out the activities to move their products and services through the value chain and must be managed through the focused commitment of resources (Day, 1994). Barney (1991) suggested another approach and argued that resource heterogeneity and immobility is a possible source of competitive advantage and that performance of a firm depends on the implementation of strategy which exploits internal strengths in response to external opportunities, while neutralizing external threats. Some strategies require a mix of physical capital, human capital and organizational capital but one resource required for implementation of all strategies is managerial talent. In the airline industry, Farkas, Martin, and Pompeo (1997) postulated the importance of matching resources to industry fluctuations. Of course, it is up to the management to exploit and explore these firm specific internal resources but in time of turbulence, new capabilities must be developed or adjusted (Barney, 1991; Wernerfelt, 1984).

Management Capability

Value Chain Management is the Holy Grail of progressive companies (Trombly, 2000). It has been argued that management capability is the key to success in terms of achieving balance (Schrouder, 2015) and a number of scholars have stated in the literature that how a firm performs is dependent on how the value chains are managed, how quickly decisions are made and how quickly strategies are turned into action. Vurro (2014) considered the managerial approaches to sustainable performance in the value chain and noted that collaboration, open and transparent management influences upstream and downstream activities which impact brand value, customer loyalty and satisfaction. Further, management approaches to sustainability of the value chain through collaborative approaches have shown positive results in some industries and, in the airline industry, a collaborative approach in achieving customer loyalty and satisfaction could impact performance and add value (Vurro, 2014). Management capabilities are critical but more than that is the need for good leaders. Leadership is not management; a manager tries to get an organization from point A to point B using tried and true practices, whereas a leader is entrusted with practically creating a new organization to meet new conditions (Drucker, 2001). "To become a leader, you must first become a human being" says Confucius and wisdom is one of the oldest ideas associated with leadership which plays a role of inspiring others and getting people on board with your vision for a firm and a responsibility to the organizations' culture (Senge, Kleiner, Roberts, & Ross, 2011).

A number of issues have surfaced in the literature and questions are raised as to whether value is the consequence of effective value chain management. Why is it that some firms succeed while others fail? Is there a competency in the locus of leadership skills that is missing because it seems that an element of developing the human side remains challenging for firms even though great effort is put into developing processes to enhance the value chain? In response to some of these questions, Kaplan (1996) suggested four management processes which can contribute to firm performance, being able to translate vision into operational terms, communication, business planning, feedback and learning. K. Eisenhardt (2013) stated that a leader must be able to make fast and conflicting decisions and still keep a team together. Bartol (2011) worked on the premise that there are four basic management principles, namely, planning, leading, organizing and controlling of which leadership is one aspect of the management practice. What then are the leadership capabilities? Good leadership capabilities enable effective management of the value chain and encourage good business behavior which is strongly linked to culture and people, a most important factor in the foundation of an effective value chain. Without a good leader, the culture of the firm is not upheld. Presutti (2013) concurred that one of the enablers of effective value chain management is leadership and together with good strategic plans and decision making skills, it allows for good management of the value chain which drives sustainable firm performance.

The goal is to achieve a seamless interaction amongst all members of the value chain through good communication, vision, planning and feedback.

Processes

Processes is the synchronization of the work of internal activities through bilateral contacts allowing for knowledge sharing (Brajer-Marczak, 2016). It is also a set of repeated activities with the objective of which is to create value for internal and external customers (Brajer-Marczak, 2016). Business processes are now considered one of the firm's most valued asset and continuous improvement has become an imperative (GartnerResearch, 2010). In looking at the processes of an organization, Kaplan (1996) stated that from an internal perspective a firm must consider what the firm excels at and how the firm can continue to improve and create value. In answering some of these questions, it is important to understand how a firm can continuously improve and activities must be measured at every stage of the value chain. The literature makes it clear that measurement of processes, relationships and top management support could lead to enhanced business performance but must be able to adjust to the changing competitive environment (Waggoner, 1999).

Today, information technology is altering the competitive environment, how we do business and how strategy is written (M. Porter, Heppleman, J.E.,, 2014). The major change taking place in the current competitive environment is in information technology whereby smart connected products present major challenges as they alter the functionality of processes and are disrupting value chains causing firms to rethink and retool everything they do internally (M. Porter, Heppleman, J.E.,, 2014). This has been seen twice before in the past fifty years when technology reshaped processes, with the introduction of the computer aided processes in the value chain such as bill-paying and order processing and the internet which allowed for co-ordination and integration across individual activities giving huge rise to productivity and transforming the value chain. Now the third change is becoming integral to the product itself, introducing sensors, processors, software and connectivity which will drive huge improvements in productivity (M. Porter, Heppleman, J.E.,, 2014).

Design

The design of the value chain has traditionally been viewed as static but with the environment as it is, the competitive landscape dictates that this is only a fleeting commodity and is obsolete (Fine et al., 2002). The value chain architecture however is essentially a function of the operations strategy and the decisions on location of the operations, sourcing patterns, and the configuration and customization of the products are all questions that reside within the realm of the wider business strategy (Holweg & Helo, 2014). The value chain architecture is the design of large network structures of value chain partners and basically organizes a plan or map for these networks and considers the relationship between these partners (Holweg & Helo, 2014). Value chain networks can be modular or integral but because of the complexity of the value chain networks, the concept has been used in a limited context for structural decision making (Holweg & Helo, 2014). Some of the key decisions associated with the value chain are location decisions such as whether a factory forms a regional factory supplying locals or a feeder factory, supplying a larger geographical area (Fine et al., 2002; Holweg & Helo, 2014).

van Rensburg (2008) noted that there are a number of principles needed in the design of the value chain to create the appropriate architectural model and these principles deal with best practice, improvement and quality considerations.

Value Chain Capabilities on Sustainable Performance

This research proposes to conceptualize the framework of the effects of value chain capabilities on sustainable firm performance. It looks at the three pillars of sustainability, economic, social and environmental and seeks to find a relationship that will add to value-creating strategy. Value creation through sustainable practices, economic, social and environmental, are areas of opportunity but a gap exists because of a purely economic approach that has primarily focused on commercial goals and a lack of consideration of ecological and societal opportunities. D'heur (2015) stated that there is a link between sustainability and core business but this has not been sufficiently recognized as an opportunity which presents great potential for companies. This can only be achieved, where the approach is embedded in the core business, by leaders who are capable of applying the concepts of value creation. It is an area still being established as the scope is broad and no longer relates to purely environmental sustainability but includes economic sustainability such as profit, cost, strategy, customers, and social sustainability which includes CSR, ethics, diversity and safety (D'heur, 2015; Heymann, 2010; Lindgreen, Maon, Vanhamme, & Sen, 2013; Saeidi, Sofian, Saeidi, Saeidi, & Saaeidi; Schrouder, 2015; Yu-Shan, 2012). Sustainability from the social and economic perspective provides an opportunity for a firm to excel and create value; however, the challenge is to give equal consideration to value, resource efficiency and social wellbeing of customers and employees.

However, it could be argued that management capability is the key to success in terms of achieving this balance (Schrouder, 2015). If therefore management capability is the key to success, Kaplan's four management processes of translating the vision into operational terms, communicating and linking, business planning, feedback and learning can all contribute to overall performance (Kaplan, 1996). This, however, must depend on the type of organization and must be driven from the inside of the organization, which needs the participation of all stakeholders. It highlights the importance of management capabilities and the organization on the whole to be the driver of sustainable practices, transparency and collaboration with customers. Kaplan (1996) discussed the advantages of intangible assets of an organization and used the concept of the balance scorecard as a measure of performance, which could provide value chain managers with a tool to help breakdown and communicate goals in practical and simple terms that can be followed and translated into action. Wenbin (2012) concurred that operational functions are only as effective as how it is managed and the competence of the firms' leaders should evolve to respond to dynamic environmental factors that affect performance. In a high velocity market such as the airline industry, however, this tool needs to be adaptive.

Strategic success needs an understanding of the integrated value chain and it must be remembered that the value chain is a living and dynamic business ecosystem that must be nurtured to provide the desired results (Presutti (2013). However, it has not been fully explored particularly in the airline industry as noted by a recent IATA report (Pearce, 2013). It is seen that the value chain is being deconstructed with new technology and with new thought for the value chain design, which means designing the value chain to suit the strategy which is, after all, not static. Vogt et al. (2005) also noted that there are several companies which have identified the need for enhancement of value chains as a critical competency to improve performance. It is therefore important that the link between value chain capabilities and sustainable performance is elaborated empirically.

Methodology

This research employs a qualitative methodology and comes from a constructivist philosophical position. Using a constructivist theoretical framework, the initial phase of this research adopts the qualitative approach employing the case study method with in-depth interviews to investigate the effect of value chain capabilities on sustainable firm performance and how the activities can support a more efficient and competitive operation for airlines, thus adding to their value-creating strategies. The methodology is conducted based on key management in-depth interviews with senior executives from three leading full-service airlines from the US, Australia and New Zealand.

Six interviews were directed at the six areas of the value chain within each of the chosen airlines and are based on Porter's value chain model of support activities, namely, procurement, human resources, IT and primary activities; operations, sales and service (M. Porter, 1985). The semi-structured interviews are aimed at senior management who have been purposefully selected (non-random) from each of the targeted areas of the three airlines to obtain their strategic perspective on the value chain capabilities and their effect on sustainable firm performance, their practical knowledge and insights for possible areas for adjustment. A senior executive was matched with each of the areas of activity. The interviews were organized and conducted within six divisions of each airline based on Porter's value chain model. By interviewing senior executives from each of these activity areas of the value chain, it reaches the core of the functionality and the data extracted provide the basis of this research. A total of 18 interviews have been conducted.

In seeking to understand the value chain capability and its effect on sustainable firm performance, approximately eight open-ended questions were developed based on the conceptual framework involving resources, processes, design and management capabilities and the effect they have on economic, social and environmental sustainability. All interviews have been conducted through online media communication such as Skype or by phone, depending on time constraints and consideration for uninterrupted discussion.

Data from each airline are analyzed separately to identify the issues and opportunities. They are then cross-examined to compare their operational activities and identify any commonalities that lend insights, which may contribute to the conclusion of the research.

Findings – Value chain capabilities' effect on performance

The findings indicate that there is a positive relationship between value chain capabilities and sustainable firm performance in the case of airlines participated in this research. Especially, it is consistently acknowledged that resource-based value chain capability such as people and technology are at the core of economic, social and environmentally sustainable performance but management-based value chain capability such as meritocracy, high performing teams and culture are key and in line with the relevant theories on how firms develop capabilities to improve performance. As a resource, employee performance facilitated by technology is at the core of sustainable performance and is a common theme expressed across all the divisions of the airlines.

The findings also indicate that all six activity areas of the value chain i.e. sales, procurement, human resources, operations, customer service and IT are focused on their employees, the people they directly work with or people where there is strong and necessary collaboration such as suppliers and third party suppliers. More precisely, emphasis is also placed on high performing teams as a resource. This high performance is mostly achieved through training and cross-training to achieve the skills and knowledge required to provide a competitive advantage. Training is critical in achieving an effective and efficient operation and cross-training allows for a cohesive and collaborative team environment which in turn is resourceful, reactive and responsive. Instead of being very specialized and homogeneous, people have the opportunity to know other areas that their co-workers are working in and collaborate with each other so as to develop them professionally, allow for agile responses and an effectively flexible workforce which will impact positively on social sustainability. Training and performance is highly rewarded and people are at the core of firm performance whether that is from the economic, social or environmental perspective. Incentivizing people to perform is found to be both a tool and a process which becomes part of a company culture because it has proven to be effective in achieving goals. In the human resources area, focus is placed on "meritocracy" and how the distinction is made between folks who are high performers and capability from a talent standpoint – a high performing workforce. It is also evident that culture impacts sustainable performance and the company strategy must include this intangible resource which enables agile responses to buyer behavior.

Table 1 provides a summary of key findings in this research which shows critical value chain capabilities that have a significant effect on sustainable performance. For example, the first cell identifies **economic sustainability**. The cells below identify the **resources** and how the resources **effects** economic sustainability.

Economic Sustainability		***Social Sustainability***		***Environmental Sustainability***	
Resource	**Effect**	**Resource**	**Effect**	**Resource**	**Effect**
People: (Meritocracy Engaged Efficient Empowered Expertise Communication Customer focused)	People are at the core of economic sustainability but high-performing teams through training and cross training achieve the skills and knowledge to sustain performance.	*People:* (Behaviour Ethical Lawful Accountable Prideful, Satisfaction Communicative Relationships Listener)	Effective and efficient people allows for a cohesive and collaborative team environment which in turn is resourceful, reactive and responsive.	*People:* (Belief, Commitment Inclusive Customer focused Flexible)	Creating choice and the belief that being environmentally sound is really ensuring you are connected with your customer.
Technology: (Data Analytics, Artificial intelligence, Sourcing, Communication Product development, Control, Decision making)	Systems are significant competitive advantage, showing opportunity, how the company can do better and how they are already doing well.	*Technology:* (Reputable Trustworthy, Safe, Brand)	Technology help to react in efficient ways and customer friendly ways, measure performance, and is clearly assisting in the societal process.	*Technology* (Leadership, Committed, Communicative, Agile, Motivator)	Decisions to convert from fossil fuel to electric ground service equipment. And use of electric vehicle charging stations to employee parking lots, encourage adoption of low-or-zero-emissions

					vehicles which impact the eco system.
Culture: (Behavior, Trust Ethical, Training Relationships, Partnerships, Meeting customer expectations, Collaborative)	A culture that is consistent and meets the customer expectation. Making sure customers know the product is great and employees are great. Take care of existing customers but proving to new customers.	*Culture:* (Shared purpose, Values, Open Integrity, Empowerment, Diversity, Inclusion Respect, Training, CSR, Prideful)	A culture of building relationships so that partnerships with different co-workers and teams effect the same trust factor as with customers.	*Culture:* (Green equipment, Energy efficiency, Air traffic efficiency, Product quality)	The use of utilities and working with teams to manage how they work and manage equipment, how equipment is rotated and what kind of equipment is being purchased and used and the loading of cargo and baggage.
Reputation: (Quality Security Privacy Operational standards Reliable Brand)	Once you are preferred, there is the obvious benefit that someone is willing to pay a little bit more.	*Reputation:* (Behavior Culture Trust Integrity Safety)	The reputation generates pride so when employees have pride in the workplace it drives certain behaviors.	*Reputation:* (Embeddedness Communication Commitment Opportunity Choice)	Inefficiencies cause longer taxi and wait times for take-off and landing which has environmental impact
Processes: (Automated Flexible, Communication Innovative Integrative Competitive)	The process starts with a clear outline of the goals, then communicated to the employees.	Processes: (User friendly Consistency Organised Flexible Safe)	Clear engagement model and communication path with all the stakeholders, is key to ensuring the right processes.	Processes: (Efficiency Carbon neutral Noise sensitive Time sensitive)	There are Co2 targets so being environmentally aware enough not to create one issue in solving another
Magmt. Capability (EQ, Inclusivity, Expertise, Leadership Communication,	Agility of management makes an impact on sustainable performance.	Leadership (EQ, Being human Supportive, Inclusivity, Empowerment, Expertise, Trust)	The ability to inspire and motivate and inspire employees,	Leadership (Commitment Passion, Inclusion Communication	Corporate customers questions policy on initiatives and this forms part of the

Collaboration)				Ownership Governance)	competition.
Design (Structure)	Structure is an outcome of the strategy, the goals, the process, the design.	Structure (Open Communication Relationship Safety Function)	Some individuals need to have a clear line of sight to be accountable or responsible,	Facilities (Energy Efficient)	Open plan offices allow for savings on energy,

Table 1 – Critical VC Capabilities and the Effect on Sustainability

Conclusion

Building on the hypothesis that firms achieve sustainable performance through the identification of its value chain capabilities such as management of its structures and routines, skills, knowledge and management capability together with technological and operational capability (Trombly, 2000), the findings of this research indicate that there is a strong relationship for sustainable firm performance in the current environment. However, value creation through sustainable practices in terms of economic, social and environmental aspects are areas of opportunity but a gap exists because of a purely economic approach that has primarily focused on commercial goals and a lack of consideration of ecological and societal opportunities. There is a link between sustainability and core business which is starting to be recognized by the three airlines over the last three years approximately. One airline says clearly that empowerment of their staff together with technology has made a significant difference in all three areas of sustainable performance. This can only be achieved where the approach is embedded in the core business, by leaders who can apply the concepts of value creation.

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Admission Information >>>

Admission Criteria

Admission to the program will be based on the Admission Committee's careful evaluation of the applicant's qualifications.

Master's degree requirement

Applicant must hold a Master's degree in related field.

Interview

Applicant must show strong commitment, strong research capability, and ability to communicate in English.

Research Proposal

Only an applicant enrolling for plan I has to submit a research proposal in area of interest and the Ph.D. executive committee will consider and suggest the dissertation advisor who might be interested in the proposal.

Admission Requirements

1) A TU-GET score of 550 or TOEFL score of 550 (paper based), 213 (computer based), 79 (Internet Based) or IELTS score of 6.0 taken within 2 years on the application date.
2) A GMAT score of 550 or GRE score of 1100 (verbal and quantitative parts) or SMART II score of 600 (minimum of 250 for each part) or satisfactory level score of Graduate Program Admission Test taken within 5 years on the application date.
3) Three letters of recommendation
4) A statement of intent to pursue a Ph.D. degree
5) The Research Proposal (for application to Plan I)

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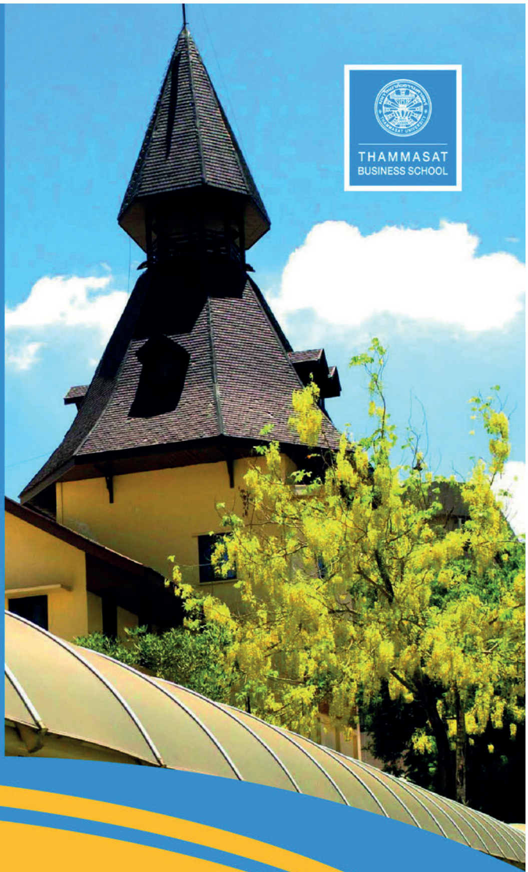

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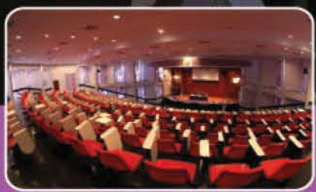

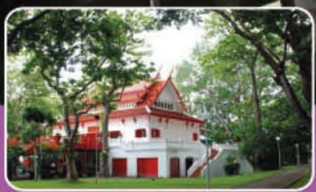

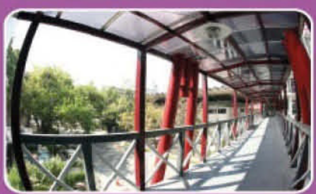

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- *Hold a Bachelor Degree in Engineering*
- *Hold a Bachelor's cumulative GPA of at least 3.00 or minimum 2 year working experience in related fields*

Plan A2. (Coursework + Research)

- *Hold a Bachelor Degree in Engineering. Science or related fields.*

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