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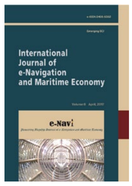

Original article

Compatibility Analysis of New Lean, Agile, Resilience and Green (LARG) Paradigm for Enhancing Seaport Supply Chain Practices☆

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Abstract

Maritime transportation plays a significant role in global economies. Seaports as primal nodes in maritime supply chain are also indispensable in ensuring efficient and effective global trading. On the other hand, seaport inefficiencies have profound influences on the overall performance which can cause congestion, operational disruption, high cost expenses, unnecessary wastes and environmental pollution, which eventually resulting significant financial losses. As a result, business and environmental sustainability will not be achieved. In order to overcome these hindrances, a novel performance model of Lean, Agile, Resilience and Green (LARG) is proposed as management tools for enhancing the business and environmental sustainability in seaport supply chain operations. The compatibility of LARG paradigms in seaport supply chain need to be identified and analysed to achieve the research aim. This paper employed a compatibility analysis for the new LARG paradigm for enhancing seaport supply chain practices. In this analysis, all potential paradigms are thoroughly reviewed and further validated by the domain experts consisting of academic and industry experts. The result of this paper shows that 17 selected LARG paradigms are compatible with 23 seaport supply chain practices respectively. For future research, the identified paradigms can be further investigated for many purposes such as measuring their influence on seaport supply chain practices and even assessing their applicability. It is worth mentioning that this research outcomes can assist Malaysian seaport practitioners to develop an enhanced management paradigm to boost their performance based on LARG model. Moreover, this model also can be applied globally as it is able to be adapted, revised and adjusted to suit the seaport preferences. As a result, this model able to enhance business capabilities, operational efficiencies and competitive advantages of seaport supply chain operations globally.

Keywords: Compatibility Analysis, Seaport Supply Chain, LARG

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1.0 Introduction

Maritime industry is one of the most important industries in Malaysia that leads this country to become the maritime nation. Malaysia depends profoundly on the maritime sector to facilitate their trade and economic growth with the national ports as key gateway to their maritime trade (Kaur, 2015). Although seaport improving in being a vital entity in economic growth, there are some issues occurred in enhancing its business and environment sustainability. With raising competition with neighbouring region seaports in term of cost saving operation, technology, preparation in facing disturbance and environmental sustainability programme, Malaysian seaports need to enhance their strategy in improving their activities to transform into a maritime nation (Khalid and Tang, 2010; Khalid, 2012; Beleya *et al.,* 2015; Othman *et al.,* 2016; Zahid, 2017). Beleya *et al.* (2015) stated that the seaport management and authorities are still focus on making profits as their prime objective which result in neglecting the environment sustainability. Beleya *et al.* (2015) also stressed that Malaysian seaports must transform their management in order to be seen as a preferred destination for shipping and logistics endeavours.

The rapid development in the maritime sector has contributed to the logistics industry to have a sophisticated supply chain management. It is noteworthy to mention that seaports are the vital entity in the international supply chain which make seaport efficiency and productivity are critical elements that need to be focused to ensure the smoothness of international trade. The assimilation of lean, agile, resilience and green (LARG) paradigm is believed to improve supply chain management system to be more streamlined, efficient and sustainable (Azevado *et al.,* 2011a). The LARG system practices minimizing uneconomical activities through lean, rapid respond to customer request through the application of agility, coping with uncertain and disruption to business environment in resilience and manage the environmental sustainability through green (Carvalho & Machado, 2011). The system also has been applied to evaluate the automotive industry before, however, none has been practices in the maritime industry related supply chain (Azevedo *et al.,* 2013; Maliki & Machado, 2013; Azevedo *et al.,* 2016).

The seaport supply chain integration can be defined as extend to which a port authority plans, organizes and coordinates activities, processes and procedures related to physical, information and financial flow beyond its own gates along the supply chain and monitors performance in such activities (Steven & Vis, 2016). Hence, seaport always has been seen as one of the important nodes in the maritime supply chain operation. However, the role of seaport has been emerging from being a node to a vital entity in network as a co-creator of a value and creating the seaport supply chain (Botti *et al.,* 2017).

Therefore, this research aim to identify and analyse all potential LARG paradigm criteria in order to develop a performance model of LARG to assist seaport in enhancing business and environmental sustainability. However, the listed seaport supply chain operation practices are limited compared to activities in seaport operations. This paper will list suitable practices gathered from primary and secondary data. This data will determine their strength influence of the LARG paradigms criteria. The primary data (expert consultation and questionnaire review) is collected from expertise of the related seaport supply chain operation from Malaysian seaports experts and academic experts. The data is then calculated based on average value perceived which determines the compatibility of the selected practices.

2.0 Lean, Agile, Resilience and Green (LARG)

Lean, agile, resilient and green paradigm have been adopted individually or assimilated as a management tool in enhancing supply chain (Marlow & Casaca, 2003; Venkat, 2006; Froon, 2010; Lirn *et al*., 2013; Olesen *et al*., 2015). Azevado *et al*. (2011a) suggest that the simultaneous integration between lean, agile, resilience and green (LARG) paradigms will improve the Supply Chain Management (SCM) system to be more efficient, streamlined and sustainable. Lean paradigm can be used in maximizing profit and at the same time reducing the cost, while agile paradigm purposely meant for maximizing profit by respond rapidly to customers' request (Carvalho & Machado, 2011). On the other hand, resilient paradigm used to enhance the capability of coping with uncertain business environment or disruption while green paradigm manages environmental sustainability of the supply chain (Carvalho & Machado, 2011).

Several researches have been conducted in the application of LARG paradigms in several industries (Azevedo *et al*., 2011a; 2011b; Carvalho & Machado, 2011; Carvalho *et al*., 2011; Cabral *et al*., 2012; Maleki & Machado, 2013; Azevedo et al., 2013; Carvalho & Azevedo, 2014; Fazendeiro *et al.,* 2015; Azevedo *et al*., 2016) as shown in Table 1.

Azevedo *et al*. (2011a) proposed the LARG paradigms to improve operational, economic and environmental performances of a supply chain. Then, they applied the LARG-SCM practice on manufacturing supply chain by using deductive research approach (Azevedo *et al*., 2011b).

Table 1 Application of LARG paradigm in various research area

Authors	Title(s)
Carvalho & Machado (2011)	Integrating Lean, Agile, Resilience and Green Paradigms in Supply Chain Management (LARG-SCM).
Azevedo *et al.* (2011a)	A Proposal of LARG Supply Chain Management Practices and a Performance Measurement System.
Azevedo *et al.* (2011b)	The Influence of LARG Supply Chain Management Practices on Manufacturing Supply Chain Performance.
Carvalho *et al.* (2011)	Lean,Agile, Resilient and Green : Divergencies and Synergies.
Cabral *et al.* (2012)	A Decision-Making Model for Lean , Agile, Resilient And Green Supply Chain Management.
Azevedo *et al.* (2013)	A Fuzzy LARG Index Model to the Automotive Supply Chain. Airports and the Automotive Industry: Security Issues, Economic Efficiency and Environmental Impact.
Maleki & Machado (2013)	Generic Integration of Lean, Agile, Resilient, and Green Practices in Automotive Supply Chain
Carvalho & Azevedo (2014)	Trade-offs among Lean, Agile, Resilient and Green Paradigms in Supply Chain Management: A Case Study Approach
Fazendeiro *et al.* (2015)	A Framework Proposal to Assess the LARG Index of a Supply Chain in a Fuzzy Context
Azevedo *et al*., (2016)	LARG Index: A Benchmarking Tool for Improving the Leanness, Agility, Resilience and Greenness of the Automotive Supply Chain

The implication of their research is manager can use this model as a checklist to identify possible practice and giving insight on how to make the supply chain become more lean, agile, resilient and green. Carvalho & Machado (2011) argue that some supply chain attributes are positively related to all paradigms and creating synergies among them. Carvalho *et al*. (2011) explored the divergences and commitments between LARG paradigms and further investigated the effect of paradigms practices within supply chain attributes. Cabral *et al*. (2012) proposed a decision-making model for LARG supply chain in automotive industry by using Analytic Network Process (ANP) model (i.e. Autoeuropa Volkswagen). This LARG ANP model offers supply chain managers a tool to assist their decision-making by selecting the best practice, key performance indicator (KPI), paradigm, or competitiveness enablers.

Carvalho & Azevedo (2014) investigated the trade-offs among LARG paradigms in automotive supply chain. They suggested that supply chain need a higher implementation level for all LARG practices. Later, Maleki & Machado (2013) developed the generic approach for LARG practices in automotive supply chain by using Bayesian Network model thereafter-qualitative correlations. Then, Fazendeiro *et al*. (2015) assessed the LARG index in their framework based on Enterprise 2.0 and fuzzy logic approaches. Those approaches determined an adequate set of LARG practices; defined the relative weights of the considered practices; adjusted the evaluation policy to the supply chain and effectively validated the assessment results. Recently, Azevedo *et al*. (2016) benchmarking the tool for improving the leanness, agility, resilience and greenness in an automotive supply chain by using Delphi technique. Their result has demonstrated that the usefulness and ease of application of LARG index in supply chain. This application makes possible to assess the LARG index for each company and corresponding supply chain; to rank the company's performance in each paradigm; and to enable LARG practices with higher level of application among the companies.

Based on the available research discussed above, most of LARG paradigm has been applied individually rather than collectively which comprises all components in a seaport supply chain operations. This indicates that inadequate works have attempted to apply the LARG integration into the seaport supply chain industry. Therefore, this research tends to focus on the application and extension of LARG paradigms in seaport supply chain operations as a result of its potential as a management paradigm for enhancing the business and environmental sustainability in seaport supply chain operations.

2.1 Lean Paradigm in Seaport Supply Chain Practice

Lean in supply chain is a concept on reducing wasteful activities while enhancing the supply chain to be more competitive. Lean embraces all the processes in the product life cycle, from raw materials until sales and from order until delivery to end customers (Anand & Kodali, 2008). The lean in port will focus on eliminating waste in the entire flow of material in the cargo-handling process identified as the delay time of equipment and transporters, lost and damaged cargo, equipment and transporter breakdowns (Ridwan, 2016). Several papers also discussed about the implication of lean paradigm in seaport. Marlow & Casaca (2003) suggest a set of new port performance indicators that measure lean port performance and sustain the subsequent development of agile ports and Olesen *et al*. (2015) investigates the application of lean practices to improve material flow within intermodal terminals and to develop an overarching framework for lean terminalization. Several lean practices that can be applied in the seaport supply chain are higher resource utilization rate, information spreading through network, Just-In-Time (JIT) practice and shorter lead time (Azevedo *et al.,* 2011a; 2011b; Carvalho & Machado, 2011; Carvalho *et al.,* 2011; Cabral *et al.,* 2012; Azevedo *et al.,* 2013; Ha *et al.,* 2017).

2.1.1 Higher resource utilization rate.

One of the lean principles is to maintain high average utilization rate (Vonderembse *at el.,* 2006). Resource utilization in port is referred to utilization of various equipment associated with the arrival time and arrival rate of container to be loaded on transport (Olesen *at el,* 2015). Utilization indicators measure how intensively port facilities are used i.e. percentage of actual use of resources and maximum possible use of those resources over a period of time (Mwasenga, 2012). The resources utilization in seaport will be berth occupancy ratio and yard utilization (Ha *et al.,* 2017; Salleh *et al.,* 2017; Salleh & Saharuddin, 2017). Ha (2015) listed berth occupancy revenue per ton per cargo as the financial performance indicators in revenue and cost category and in productivity category of efficiency and utilization. Meanwhile, yard utilization is the ratio of number of storage slots (number of containers on hand) to the number of available slots (terminal capacity) (Mwasenga, 2012). Maximum storage capacity for yard utilization is vary according to port (Ha, 2015).

2.1.2 Information spreading through network.

The growth of using information technology (IT) also has been improving the performance of an organization. The used of IT has allowed the development of faster, reliable, precisely time logistics strategy within the industry which information intensive transportation service is important (Janssens, 2011). Janssens (2011) stated the benefit of using EDI is it can allow a user to select any container and gain instant data on the container's location, weight, and identification number through electronic communications. Other than that, an automatic IT system is required to ensure a higher level of information sharing in ports (Olesen *et al.,* 2016). So, to measure about how information is spreading through network in seaport, the paper listed the IT system used at a seaport for example EDI for communication, IT system used in sharing data and the port latest IT system as suitable seaport practices under information spreading through network (Ha *et al.,* 2017).

2.1.3 Just-in-time (JIT) practice

JIT is a strategy in increasing efficiency while decreasing waste by receiving goods only when it is needed therefore the inventory cost will decrease (Singh & Ahuja, 2012; Kootanaee *et al.,* 2013; Franco *et al.,* 2017). The 'waste' can be identified in term of effort, material and time (Canel *et al.,* 2000). JIT practices can be applied on the container dwelling time at seaport. Minimizing container dwelling time is one of the main objectives from the perspective of the shippers in the port supply chain (Gaete *et al.,* 2017). Container dwelling time also is a factor that directly affects operational costs in the ports as it increases inventory levels and uncertainty in the dispatching process (Gaete *et al.,* 2017).

2.1.4 Shorter lead time

Lead time is the latency between the initiation and execution of a process (Muehlen & Shapiro, 2010). Several port activities that can be associated with lead time including truck turnaround time and ship turnaround time (Ha *et al.,* 2017). Ship turnaround time is total time spent by a ship in a port (Mwasenga, 2012). There are components of ship turnaround time which are waiting time, berthing/unberthing time and berth time or service time (Mwasenga, 2012). The berth time depends on the quantity of cargo a vessel has to load or discharge, the type and characteristics of a vessel, the type of equipment and other resources used at berth (Mwasenga, 2012). Truck turnaround time is the time between the vehicle's arrival at the terminal entrance gate and its departure from the terminal exit gate (Mwasenga, 2012). It measures the terminal's service quality to road transport operators.

2.2 Agile Paradigm in Seaport Supply Chain Practice

The agile supply chain is design to create the ability of the supply chain to respond rapidly to unpredictable change in markets and environment, in term of value and variety (Agarwal *et al.,* 2007). Agile paradigm identified criteria are excess buffer capacity, quick respond to customer need/claim, total market place visibility and dynamic alliance (Azevedo *et al.,* 2011a; 2011b; Carvalho & Machado, 2011; Carvalho *et al.,* 2011; Cabral *et al.,* 2012; Azevedo *et al.,* 2013).

2.2.1 Excess buffer capacity.

Buffering concept refer to maintaining enough supply to make sure the operations does not halted (Watson, 2013). Watson (2013) stressed buffer can be in term on inventory, capacity and time buffer. In port supply chain, port can supply buffer capacity is by supplying enough buffer capacities for yard, berth and equipment if there is any unpredictable change in demand. Jawaharlal Nehru Port Trust there is buffer yard that is managed, maintained and operated by Speedy Multimodes Limited. This buffer yard has a segregated 14 acre area adjacent to the main yard used to manage container waiting for customs clearance.

2.2.2 Quick respond to customer need/claim.

One situation where port must be quick in their respond is in their responsiveness to customer claim. Accidents and unnecessary events happened at port which resulted in damage at port and customers' goods. Customers will do claims for the damage done and port needs to necessary respond for their request. Ha (2016) list responsiveness to special request as one of the service fulfilment indicator which will reflect on the service quality and customer satisfaction. Respond speed also has a positive effect on satisfaction and intentions to service repurchase (Davidow, 2003).

2.2.3 Market place visibility.

Visibility means the ability to see the problem before they occur (Silva *et al.,* 2017). Port must be able to predict the change of their throughput in future. Ideally, the TEUs that port receives will increase year by year. Port must be able to visible in predicting the growth of TEUs and demand in future so that they will able to cattle bigger demand and goods since problem like congestion will occur (Shahjahan, 2000).

2.2.4 Dynamic alliance.

Collaboration with members in a seaport supply chain is important for data and system effectiveness. Variety of cooperation forms are connected in the advancement of global supply chains, showing that integration has recently become an important ideology in the maritime literature (Panayides, 2006). Cooperation between container terminal operators may be necessary in the port supply chain for the whole information network (UNESCAP, 2005). An information gap at one point in a port has a negative impact on a whole port system and each port supply chain member (Seo, 2014). In the shipping industry, cooperation between shipping lines has been common through the form of strategic alliances (Seo, 2014).

2.3 Resilience Paradigm in Seaport Supply Chain Practice

Resilience is the ability of the supply chain to cope with unexpected disturbances (Carvalho & Machado, 2011). It is how a system able to return to its normal state or form a better state after a disturbance and obviate the occurrence of the failure (Carvalho & Machado, 2011; Shaw *et al.,* 2016). Rice and Canito (2003) refer the ability to recover from occurrence of a disturbance is connected to the development of responsiveness capabilities through flexibility and redundancy.

Several papers have discussed the implication of resilience paradigm in supply chain and seaport. Grainger & Achutan (2014) discussed about the vulnerabilities and resiliency of UK ports, Datta (2016) elaborate on the literature of the supply chain resilience for identifying the supply chain practices adopted for securing resilience in given uncertain event and Shaw *et al.*(2017) used a multi-level case study on the UK's system of ports to propose an approach related to information sharing that uses the subjectivity of information from a supplier's perspective and from a user's perspective to reduce barriers of complexity, confidentiality and political sensitivity. Mandal (2014) found that though several conceptual to few empirical works been done on supply chain resilience in recent years, there is large scope for research to address the issues in risk management, supply chain design, sourcing strategies, green practices, sustainable competitive advantage, supply chain security, supply chain performance and supply chain resilience.

There are several identified resilience paradigms which are strategic inventory or equipment resiliency, demand visibility, responsiveness, risk sharing and flexible transportation (Azevedo *et al.,* 2011a; 2011b;

Carvalho & Machado, 2011; Carvalho *et al.,* 2011; Cabral *et al.,* 2012; Azevedo *et al.,* 2013).

2.3.1 Strategic inventory or equipment resiliency

Strategic inventory or equipment resiliency is the organization ability in adapting and organizing required elements as preparation in facing disruption (Petit & Beresford, 2018). A port should prepare some inventory or equipment that specialized for used while facing disruption in order to ensure business continuity, avoiding congestions and minimizing lost (Shahjahan, 2000).

2.3.2 Demand visibility.

Visibility means the ability to predict a problem before they occur (Silva *et al.,* 2017). Demand visibility in port resiliency is a developing processes and capabilities of port in maintaining crucial equipment functionality and business continuity when disruptions hit (Petit & Beresford, 2018). Bigger demand in the future is one type of visible disruption (Shahjahan, 2000). A port must be able to forecast its future demand as demand will always grew. Bigger demand can lead to operation halted, delay and even deviation of operation because the port may unable to cater them with limited equipment and resources (Shahjahan, 2000).

2.3.3 Responsiveness in resilience

Responsiveness in resilience is about the port ability in returning to and recovering its normal state or a new one within tolerable time period, at acceptable cost and a minimum service loss within sustainable use of resources (Petit & Beresford, 2017). As mention before, respond speed also has a positive effect on satisfaction and intentions to service repurchase (Davidow, 2003).

2.3.4 Risk sharing

Risk sharing in port may be designed to the port authority, the state, or other public authorities' possible based on those parties that can carry the risk at the least negative impact. Supply chain risk management work best when company had forecast possible disruptions in future. Early warning makes it possible for companies to prepare and coping with disturbance to return to normal state operation (Brown and Williams, 2015; Tiernan *et al.,* 2019).

2.3.5 Reliability for multimodal transportation

Reliability for multimodal transportation is important in facing disturbance. If a container usually will be trucked to end customers, however if the trucking service is unavailable; the container can be send to the customer using other alternative which is rail. For a strategic handling and most efficient way of handling and delivering container, the reliance over modal shift of the transportation should be on road-rail-port. In order to attract a greater share of freight, therefore, the quality and reliability of service must be improved, and the punctuality of freight services must be maintained and order to promote intermodal transport, it is essential to improve transport links such as highways, railway networks, and inland waterways (Regmi and Hanaoka, 2011). Modal shift is important since it made the transport less costly and higher average value of the cargo being carried since intermodal transportation is linked with more complex and sophisticated commodity chains (Rodrigue and Slack, 2013).

2.4 Green Paradigm in Seaport Supply Chain Practice

The environmental issues have been an important key in port development which makes ports under pressure to adapt the green initiative in their operations. The purpose of green supply chain management is to integrate green into supply chain management (Chin *et al*., 2015). Green is a philosophy of an organization to achieve corporate profit and market share objectives by reducing environmental risks and impacts while improving ecological efficiency of these organizations and their partners (Rao *et al*., 2005; Zhu *et al.,* 2008; Carvalho & Machado, 2011).

Several papers have discussed about the implication of green paradigm in supply chain and seaport. Lirn *et al.* (2013) find that avoiding pollutants during cargo handling and port maintenance, noise control, and sewage treatment are the three most critical indicators in achieving sustainable green ports in Asia and Chin *et al. (*2015) focus on the environmental collaboration, which has been seen as a key relational capability to facilitate the Green Supply Chain Management (GSCM) strategic formulation and execution.

The selected criteria for green paradigm in the performance model are waste minimization, waste recycling, renewable energy or initiative and environmental risk sharing (Azevedo *et al.,* 2011a; 2011b; Carvalho & Machado, 2011; Carvalho *et al.,* 2011; Cabral *et al.,* 2012; Azevedo *et al.,* 2013; Ha *et al.,* 2017).

2.4.1 Waste minimization and waste recycling.

Avoiding waste refers to any practice or process that avoids, eliminates or minimizes waste at source (Husin *et al.,* 2016). Reusing and recycling waste can reduce the volume of waste material to be disposed or discharge to the environment (Husin *et al.,* 2016). Waste minimization also will support the green supply chain that aims to minimize wastage such as hazardous chemical, emissions, energy and solid waste along the supply chain (Chin *et al.,* 2015). The significant of waste minimization is to make sure high quality of life, clean environment, health and safety (Ahmad *et al.,* 2014).

2.4.2 Using renewable energy or initiative

Using renewable energy or initiative can help to protect the electricity producers and consumers from the cost adding, increased reliability & power quality, avoided risk and improved fuel and energy security (United State Climate Protection Partnerships Division, 2011). For example, the green initiative also has been in rise in Asian ports as the region is trying to curb shipping related pollution. The Port of Tanjung Pelepas (PTP) has been installed a new cable reel technology to provide electrical power for high reach ship to ship (STS) crane. The eight reels will boost green efficiency by optimizing productivity and reducing the environmental impact of handling operations.

2.4.3 Risk sharing

Risk sharing can minimize the supply chain disruption risk (Kim & Chai, 2017). Bowen *et al.* (2001) state that the green supply chain practices in advanced green supply must include the use of environmental criteria in risk sharing.

3.0 Compatibility Analysis for the Development of LARG Model

This section will describe the methods to analyse the compatibility between the LARG paradigm criteria and seaport supply chain practices in order to build the LARG model. The criteria and practices of LARG paradigm and seaport supply chain operation are first identified from the secondary data (literature review) as explained before and supported by primary data (experts' reviews) in the seaport operation. Experts (focus group validation) also answered the designed questionnaires by evaluating the compatibility between the LARG paradigm criteria and seaport supply chain operation practices in a five points Likert scale. The pairs are then filtered by choosing them with 3.5 average value and above. The pairs which are lower score than 3.5 will be exempted. Four steps are followed to achieve the purpose of the paper as illustrated in Figure 1.

Step 1: Each LARG paradigm criteria were identified using literature review and experts' consultation and finalised.

Step 2: Possible seaport supply chain operation practices is then critically identified for each LARG criteria using literature review and experts' consultation and finalised.

Step 3: The compatibility between each LARG paradigm criteria and seaport supply chain operation practices are then supported by focus group validation using five points Likert scale.

Step 4: The selected criteria and practices are then finalised.

3.1 Identification of LARG Paradigm Criteria and Seaport Supply Chain Practices (Step 1 and 2)

The process of identifying the LARG paradigm criteria and seaport supply chain operation practices will be conducted by listing all the potential practices for each paradigm criteria. Literature review that has been discussed in section 2.0 is supported by expert consultations and reviews (academic experts and industry experts). About 20 questionnaires have been distributed but only 11 experts have answered the questionnaire completely which consist of seven experts from maritime industry and four experts from related maritime academic institutes. All experts have more than 5 years of experience in the related field. About 17 LARG paradigm practices and 23 seaport supply chain operation practices have been finalised as listed in Table 2 and Table 4. It is important to mention that the identified criteria and practices can be modified and adjusted based on the preferences of the other decision makers.

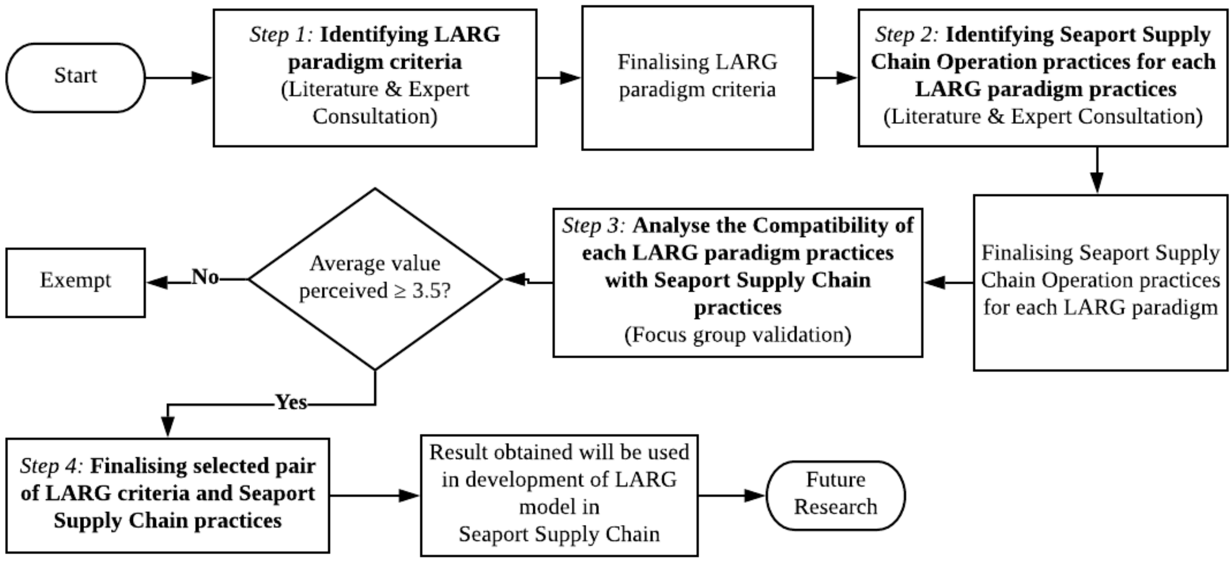

Figure 1 Proposed Framework for Analyzing the Compatibility of LARG Paradigm

Table 2 LARG Paradigm Criteria

LARG Paradigm Criteria		References
Lean	Higher resource utilization rate	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013), Ha (2016)
	Information spreading through the network	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013)
	Just-in-time (JIT) practice	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013), Wu (2009)
	Shorter lead time	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013), Ugochukwu *et al.,* (2012)
Agile	Excess buffer capacity	Azevedo *et al.* (2011a)(2011b); Remigio & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013)
	Quick respond to customer need / claim	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013), Salleh (2015)
	Total market place visibility	Shahjahan (2000), Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013)
	Dynamic alliance	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013)
Resilience	Strategic inventory / equipment resiliency	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013)
	Demand visibility	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013)
	Responsiveness	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013), Ha (2016)
	Risk sharing	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013)
	Flexible transportation	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); v Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013)
Green	Environmental risk sharing	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013), Ha (2016)
	Waste minimization	Azevedo *et al.* (2011a)(2011b); Carvalho & Machado (2011); Carvalho *et al.* (2011); Cabral *et al.* (2012); Azevedo *et al.* (2013)
	Renewable energy / initiative	Ha (2016), Ha *et al.* (2017)
	Waste recycling	Ha (2016), Ha *et al.* (2017)

3.2 Analysing and finalising the Compatibility of LARG Paradigm Criteria with Seaport Supply Chain Practices (Step 3 and 4)

After all potentials LARG paradigm criteria listed, the compatibility of each seaport supply chain operation practices with each LARG paradigm criteria will be finalised. Focus group validation (i.e. academic expert, port authorities and port operators) are conducted to strengthen the pairs between LARG paradigm criteria and seaport supply chain practice. Focus group is purposely used to the interaction which distinguishes them from other group in order to generate data (McLafferty, 2004). A focus group is generally understood to be a group of 6–12 participants, with an interviewer, or moderator, asking questions about a particular topic (Smithson, 2007). The advantage of using focus groups is they permit researchers to observe a large amount of interaction on a specific topic in a short time or a quick and easy way to gather data (Smithson, 2007). Stewart & Shamdasani (1990) suggest no optimal number to focus group. A group should consist of six to 10 peoples (Howard *et al.* 1989), four to eight (Kitzinger, 1996) or four to five (Twinn, 1998). Greenbaum (1998) identified three different types of focus group which are full group (10-12 participants), mini groups (4-6 participants) and telephone groups. As a result, this paper employed 11 experts to assess the compatibility between the LARG paradigm practices and seaport supply chain operation indicators to support the literature review in the section 2.0. The focus group undergo a filtration process to meet the focus requirement.

Total of 20 questionnaires consist of five Likert scale options were distributed to experts however there are only 11 answered questionnaire. This paper employed five linguistic terms (5: strongly agree, 4: agree, 3: neutral, 2: disagree and 1: strongly disagree) by means of the effective channel capacity is between five and nine equally errorless choice (Miller, 1956; Salleh, 2015).

The compatibility of each practices then analyse by using a descriptive statistics technique on the 11 completed answered questionnaires. This method has been adopted by Lirn *et al.* (2013) that used 5 Likert-scale questions to determine average value of importance of an indicator as a descriptive statistics in determining the port performance criteria that suitable for green port. If an average value of importance of an indicator was perceived to be less than 3, then the indicator was removed (Lirn *et al.,* 2013). However, to strengthen the compatibility of each listed criteria and practices in this paper, only criteria and practices that score of 3.5 and above are elected while score of 3.5 and below is exempted from the list. All of the possible pairs of LARG paradigm criteria and seaport supply chain operation practice scored average value more than 3.5 will be accepted to be incorporated into the LARG performance model for seaport supply chain operation.

The average value can be calculated by using Equation 1.

$$\bar{x} = \frac{\Sigma f x}{\Sigma f} \qquad (1)$$

Where
$\bar{x}$ is the average value,
f is the number of occurrences,
$\Sigma f x$ is the sum of the product fx
Σf is the total number of occurrences.

For example, by using the equation and the result from expert feedback (e.g. Table 3), the average value for lean practice of information spreading through the network and seaport practice of EDI for telecommunication is calculated as follows:

Table 3 Expert feedback for EDI for telecommunication

Information Spreading Through Network	Integrated Data Interchange (EDI) for telecommunication
Experts	Answer
1	5
2	5
3	5
4	5
5	5
6	5
7	4
8	4
9	5
10	5
11	4
Average value	4.7272

The average value then calculated as follows:

$$\frac{5+5+5+5+5+5+4+4+5+5+4}{11} = 4.7272$$

The obtained average value is 4.7272, thus it will incorporated in the LARG performance model. Using the equation (1), the obtained result for other pairs are shown in Table 4. Based on the result, the criteria with lowest score are container closing date and responsiveness to disturbance which scored average value of 3.909 while the highest average value is 4.7272 scored by integrated EDI for telecommunication. However, based on the obtained result, all of the pairs between LARG criteria and seaport supply chain practices scored average value above 3.5 thus all the pair are accepted to be incorporated in the LARG model for the seaport supply chain operation.

Table 4 Selected LARG criteria and seaport supply chain with average value for each criterion

	LARG Criteria	Seaport Supply Chain Practices	Average value
Lean	Higher resource utilization rate	Berth occupancy ratio	4.5455
		Yard utilization	4.4545
	Information spreading through the network	Integrated EDI for communication	4.7272
		Integrated IT to share data	4.5455
		Latest port IT system	4.4545
	Just-in-time (JIT) practice	Container closing date	3.909
		Container dwell time	4.1818
	Shorter lead time	Truck turnaround time	4.4545
		Ship turnaround time	4.6364
Agile	Excess buffer capacity	Ability to supply an enough buffer capacities for yard. berth and equipment for unpredictable change in demand	4.0909
	Quick respond to customer need / claim	Responsiveness to special request / claim responsiveness	4.2727
	Total market place visibility	Ability to forecast / predict demand of TEUs for monthly / yearly base (throughput growth)	4.5455
	Dynamic alliance	Collaboration with channel members for data / system effectiveness	4.5455
		The ability of port to collaborate with alliances	4.5455
Resilience	Strategic inventory / equipment resiliency	Inventory / equipment preparation in facing disturbance	4
	Demand visibility	Readiness for bigger demand in future	4.1818
	Responsiveness	Responsiveness to disturbance	3.909
	Risk sharing	Risk sharing among authorities	4.2727
	Flexible transportation	Reliability for multimodal operations	4.3636
Green	Waste minimization	Solid waste dumping management	4.3636
	Renewable energy / initiative	Renewable energy/initiative in port	4.3636
	Waste recycling	Waste recycling activities in port	4.1818
	Environmental risk sharing	Environment management programme	4.2727

4.0 Conclusion & Future Research

Improving an SCM system is a crucial task in order to ensure a long term competitiveness of a supply chain (Bartlett *et al.,* 2007). Azevado *et al*. (2011a) suggested that the simultaneous integration between lean, agile, resilience and green (LARG) paradigms will improve an SCM system to be more efficient, streamlined and sustainable. 17 LARG paradigm criteria which compatible 23 seaport supply chain operation practices are then finalized and will be used in modelling the LARG performance model. However, the study has certain limitation where the LARG criteria listed can be vary according to the industry. As mention before, it is noteworthy to mention that the identified criteria and practices can be modified and adjusted. The selected criteria of seaport supply chain also is still limited and does not cover all the seaport supply chain practices as the area of activities in port is huge, the nature of port operation is rigid as well as the nature of maritime trade is dynamic and keep changing from time to time.

The finding of this research was expected to be incorporated in the study about modelling LARG performance in seaport supply chain operation. This study also will be the literature for future research incorporated with LARG topic especially regarding the LARG influence on seaport. As the extension of this research, the conditional probability of each LARG paradigm criteria and seaport supply chain practices will be assessed by using Analytical Hierarchy Process (AHP) and will be the used as parent node in assessing LARG model in seaport supply chain at selected port using Bayesian Belief Network model. This will allows the decision-makers to objectify and formalized their decision through pairwise comparison of the LARG paradigm. This shall apply to assess the level of lean, agile, resilience and green of the seaport in more comprehensive perspective. Moreover, the identified LARG practices and seaport supply chain also can be more diverse and expand in future studies based on the preferences of the other decision makers.

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