Transportation Research Part E 92 (2016) 16–27

Contents lists available at ScienceDirect

Transportation Research Part E

journal homepage: www.elsevier.com/locate/tre

A quality function deployment approach to improve maritime supply chain resilience

Jasmine Siu Lee Lam *, Xiwen Bai

School of Civil and Environmental Engineering, Nanyang Technological University, Singapore

ARTICLE INFO

Article history:
Received 1 October 2015
Received in revised form 11 January 2016
Accepted 25 January 2016
Available online 7 April 2016

Keywords:
Maritime supply chain
Maritime logistics
Supply chain resilience
Maritime risk
Shipping line
Quality function deployment (QFD)

ABSTRACT

Being international and involving numerous organizations as the basic nature, maritime supply chains are exposed to various natural and man-made risks. This paper aims to develop an original quality function deployment approach to enhance maritime supply chain resilience, taking both customer requirements and maritime risks into consideration. The empirical analysis is carried out through in-depth studies of three major shipping lines and their respective major shippers. The top three resilience measures are contingency plan, monitoring and maintenance, and supply chain relationship management. The study also unveils the relatively low visibility and integration in maritime supply chains.

1. Introduction

In today's global economy, organizations are required to work together in networks, instead of competing as isolated entities (Carvalho et al., 2012). Being international and involving numerous organizations as the very basic nature, maritime supply chains (MSCs) are exposed to various natural and man-made risks (Lam, 2012). The current increasing interdependency between organizations, coupled with fierce market competition and growing requirements from shippers, has made modern MSCs more vulnerable and augmented the potential effects of disruptions to be proliferated throughout the supply chains (SCs). Once a SC is affected by a disturbance, the SC performance would be jeopardized, in terms of profitability, cost structure and inventories among others (Carvalho et al., 2012). In addition, SC disturbances also affect the overall satisfaction rate of its downstream firms and end-customers (Ji and Zhu, 2008). To survive, the SC needs to be resilient. SC resilience is about the ability of SCs to return to its original state or to a more desirable state after a disturbance and to avoid the occurrence of failure modes (Azevedo et al., 2008). SC resilience empowers companies' proactive response to changing market demand and disruption ahead of their competitors (Sheffi, 2006). However, the literature focuses more on operations and has not incorporated the voice of customers in the study of SC resilience, even customers are crucial users and income generators of a SC. Furthermore, to the authors' knowledge, scientific literatures provide only few specific studies proposing a structured framework to implement SC resilient strategies. We also hardly find any contributions regarding MSC resilience.

In view of the importance of MSCs' resilience, this paper fills in the research gaps by adopting the quality function deployment (QFD) approach to prioritize resilience measures for shipping lines from a SC perspective, taking both customer requirements and maritime risks into consideration. Shipping lines are chosen as the main research object due to their

* Corresponding author. Tel.: +65 67905276.
E-mail address: sllam@ntu.edu.sg (J.S.L. Lam).

http://dx.doi.org/10.1016/j.tre.2016.01.012
1366-5545/

fundamental role as an actor connecting various parts of a MSC (Berle et al., 2011). QFD is a flexible system that could translate customer requirements (CRs) into company's design requirements (DRs) at each stage from product design and manufacturing to distribution (Bottani and Rizzi, 2006). The House of Quality (HoQ) is a commonly used tool in QFD and identifies the correlations between CRs and DRs. QFD originated in 1972 in Japan, put forwarded by Akao (1990) with the aim to evaluate new product design based on customer inputs, and was first applied in the shipbuilding industry for improving the design of new oil tankers for Mitsubishi Heavy Industry (Hauser and Clausing, 1988). Shortly, QFD gained increasing popularity and expanded its scope to manufacturing and service industries, including supply chains (Behara and Chase, 1993; Dursun and Karsak, 2013; Büyüközkan and Cifci, 2013; Liao and Kao, 2014; Lam and Dai, 2015a). The function of QFD has also broadened, from purely product design to now various applications, for example, to enhance customer service levels.

The objective of this study is to develop an original QFD approach to enhance MSC resilience, by identifying the major CRs of shipping lines, common risks that would affect the satisfaction of customers and then resilience measures to mitigate the risks. The aim is also to investigate the relationships between these three groups of variables and in the end prioritize resilience solutions for shipping lines. This study provides a practical contribution for shipping lines to implement a flexible and resilient MSC. The business and performance of other actors and stakeholders involved in a MSC are affected by its resilience level so they would also be interested in the results of this study. These actors and stakeholders include shippers as customers, ship supply agencies and port operators as service providers, and policy makers overseeing a country' trade facilitation.

After the introduction, the next section reviews the related literature and highlights the research gaps. Section 3 presents the methodology, while Section 4 explains the results and provides discussions. Section 5 is the last section which outlines the main conclusions and contributions of the study.

2. Literature review

Maritime logistics as an emerging discipline has gained more attention recently among researchers. Major research fields, as classified by Panayides and Song (2013), include (1) performance in maritime logistics, (2) maritime logistics networks, integration and risks, (3) quality and services in maritime logistics and (4) environmental performance and corporate social responsibility in maritime logistics. These fields are in fact interconnected, and we draw the link between services and risks in the current paper.

2.1. Quality and services in maritime logistics

The long-term goal of logistics strategic planning is to enhance customer satisfaction. Identification of proper CRs is essential for a firm to gain competitive advantage by improving customer satisfaction level and delivering quality services is about conformance to these CRs. A number of studies have investigated service attributes in the maritime context (e.g. Brooks, 1990; Lu, 2003; Celik et al., 2009; Lam and Zhang, 2014). Previously, cost was regarded as the most important criterion for selecting ocean carriers, followed by frequency of sailings, reputation, transit time, and directness of sailings (Brooks, 1985). At a later stage, the improvement in transit-time became the most important requirement of shippers (Brooks, 1990). More recently, the focus has gradually shifted to the quality of customer service. Requirements like courtesy of inquiry and prompt response to claim have appeared on the top of shippers' requirements for ocean carriers (Lu, 2003). In these studies, shippers are the customers. We also mean shippers when we mention customers in MSCs throughout this paper.

The list and classification of CRs vary among different researchers and there exists no standard classification. For example, Lam and Zhang (2014) include cost control, reliability, responsiveness, public image, and value-added services as shippers' major criteria. Liao and Kao (2014) list lead-time, flexibility, reliability, regularity, completeness, accuracy, fill rate, correctness, organization accessibility, and complaints management as key logistics requirements.

2.2. Maritime supply chain risks

Risk is an event that may adversely affect the enterprise. Many researchers have revealed that modern SCs are at greater risk than their SC managers could identify (Sheffi, 2006). Supply chain risk management related literatures are substantial (Harland et al., 2003; Azevedo et al., 2008; Ji and Zhu, 2008; Ivanov and Sokolov, 2013). The risk sources could include unfavorable weather conditions (storm, tornado, etc.), information technology breakdown or telecommunication systems and failure in service provided by an outsourcer, loss of talent/skills, civil unrest/conflict, industrial dispute, fire, and cyber-attack.

Nevertheless, literatures on supply chain risks in a maritime logistics context are limited. Chang et al. (2014) provide an inclusive analysis of the risks in container shipping operations that may cause maritime safety and security related damages. Among all the risk factors, Vilko and Hallikas (2012) conclude that employee strikes in ports, information systems, ice conditions in water, and fire are the most significant maritime risks, while Gurning and Cahoon (2011) rank port congestion, equipment breakdown, cleanliness, insufficient empty containers, and customs as the top five risks. Chang et al. (2014) point out the importance of risks associated with piracy and terrorist attacks and shipper hiding cargo information. Researchers