



# Designing a sustainable maritime supply chain: A hybrid QFD–ANP approach



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## ABSTRACT

This study aims to design a sustainable maritime supply chain by taking customer requirements as the focus. This is achieved by an analytical approach combining Quality Function Deployment (QFD) and Analytical Network Process (ANP) for guiding shipping companies' design. An analysis of a major container shipping line is conducted to illustrate and validate the approach. The four main customer requirements are: (1) Cost and Price Competitive, (2) Pollution Reduction, (3) Efficient Use of Fuel and Resources, and (4) Health, Safety, and Security. The Use of Green Design Ships, Engines and Machinery is found to be the most important design requirement.

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## 1. Introduction

The maritime industry plays an essential role in facilitating international trade and commerce in the global economic system. Shipping companies as carriers are indispensable actors in the system. In the era of global supply chain management (SCM), shipping companies face challenging circumstances with shippers demanding supply chain solutions whilst expecting lower freight rates. This leads to a higher degree of integration along the maritime transport chain, thus the birth of 'maritime supply chains'. With reference to Lam (2011, p. 366), a maritime supply chain in the context of container shipping is defined as 'the connected series of activities pertaining to shipping services which is concerned with planning, coordinating and controlling containerised cargoes from the point of origin to the point of destination'. A maritime supply chain aims to add value to the goods transported. By providing place and time utility, a maritime supply chain carries the goods from a place (point of origin) where the goods are valued at a lower level to a place (point of destination) where the goods are to be valued at a higher level. In the supply chain dimension, shipping companies have to coordinate cargo, information, and financial flows along the chain interfacing with various parties such as shippers and ports. This leads to a highly complex problem in managing maritime supply chains.

At the same time, another facet of complication facing the maritime industry is the quest for sustainable development. Shipping is generally acknowledged as an environmentally-friendly transport mode, but recent study shows that ship emissions can be a significant contributor to global anthropogenic emissions (Eyring et al., 2010). Shipping companies are increasingly facing many challenges from economic, social, and environmental factors which create significant impact on their performance and management, and even reshape the patterns of their businesses. Economic performance has always

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been a key concern for shipping companies and a popular subject studied by scholars. Owing to regulatory control and the need for fulfilling corporate social responsibility (CSR), shipping companies are also required to attain higher social and environmental standards (Lai et al., 2013b). Correspondingly, research addressing environmental issues has grown significantly in recent years (Sarkis et al., 2011). However, the social aspect is relatively under-researched. There is also little research addressing sustainability in shipping. Literature in sustainable maritime supply chains is even more limited, or almost non-existent.

In view of heightened challenges in this dynamic industry, how can a shipping company achieve sustainability and enhance its competitiveness? Lam and Van de Voorde (2011) suggested that customer focus is a significant attribute contributing to a maritime supply chain's total value. In this study, we postulate that actors in a maritime supply chain should adhere to customers' expectations in their efforts in devising social and ecological solutions for achieving economic performance concurrently. This study aims to design a sustainable maritime supply chain by taking customer requirements as the focus. This is achieved by a hybrid analytical approach combining Quality Function Deployment (QFD) and Analytical Network Process (ANP) for guiding shipping companies' design. An analysis of a major container shipping line is conducted to illustrate and validate the approach.

After the introduction, Sections 2 and 3 explain the conceptual development and methodology of this research respectively. Section 4 discusses the process of conducting the case of a container shipping line and the findings. Then research and managerial implications are provided in Section 5. Section 6 concludes the paper with some future research suggestions.

## 2. Conceptual development

Sustainability is regarded as achieving economic, social, and environmental performances simultaneously that support an organization for long-term competitiveness (Carter and Rogers, 2008). Hence, the three aspects of sustainability in the literature are examined for guiding the conceptual development. As noted above, due to the lack of research in sustainable maritime supply chains, this study takes reference from broader areas in sustainable SCM and related maritime research.

Economic performance has always been emphasized in the maritime industry. Liner shipping companies strive to achieve high levels of operational and financial efficiencies for survival (Bang et al., 2012). The thrust towards higher supply chain integration is putting increased demand on the container transport system. In the context of SCM, a sustainable supply chain has to be economically viable and, in particular, possess the capability to increase profitability (Pagell and Wu, 2009). Supply chain optimization is to maximize product values with minimum raw materials, inventory, and production costs in order to maximize profits (Büyükoçkan and Berkol, 2011). For a maritime supply chain, Lam and Van de Voorde (2011) also noted that the goal is to synchronise the processes and partners involved in achieving the maximum profits generated. The trend of higher supply chain integration in the maritime industry is largely driven by economic benefits. For example, for shipping lines investing in terminal operations, the major reasons include cost savings and an extra source of profit (Parola et al., 2014).

Nevertheless, attaining economic performance alone is insufficient for long-term sustainability. Environmental sustainability has become a popular topic among academics and the maritime industry in recent years. Enterprises are characterised with higher environmental awareness and they require their supply chain partners to attain eco-efficiency in delivering services (Lee and Lam, 2012). Green shipping practices (GSPs) are environmental management practices undertaken by shipping firms with an emphasis on waste reduction and resource preservation in handling and distributing cargoes (Lai et al., 2013a). Implementing GSP requires internal functional coordination within the shipping company as well as external integration with upstream shippers and downstream consignees in the physical cargo movement process. In essence, this is the concept of implementing GSP in maritime supply chains. As a part of the supply chain connecting customers and various parties in cargo flows, shipping firms increasingly undertake GSP in facilitating international trade in a more environmentally-sustainable way (Lai et al., 2013b). Yin et al. (2014) showed that slow steaming practised by liners contributes to both bunker cost savings and environmental protection. In a broader sense, Lirn et al. (2014) found that green shipping management capability not only improves container shipping firms' environmental performance, but also their financial performance.

The third aspect of sustainability is the social performance of a maritime supply chain. Social sustainability focuses on the needs of people and the requirement to implement CSR. For shipping companies, the rationales of being socially responsible include the improvement in employee's job satisfaction, customer loyalty, relationships with partners, community, and authorities, and financial performance (Fafaliou et al., 2006). Lu et al. (2009) found that CSR has positive effects on both financial and non-financial (e.g. customer satisfaction and competitive position) performances of container shipping companies in Taiwan. Thus, both Fafaliou et al. (2006) and Lu et al. (2009) derived that being socially responsible benefits people and also contributes to shipping companies' economic performance. However, both studies are limited by a sample of shipping companies of a particular country – Greece and Taiwan, respectively. More investigations on the social aspect are necessary. Furthermore, very limited literature can be found on how to enhance the social performance for sustainable development of the maritime sector. In the context of supply chains and logistics, social sustainability should incorporate the concerns addressed by organizational stakeholders. The concept of purchasing social responsibility asserts that the purchasing function of a company adopts social standards which can be transferred to suppliers, thereby generating a chain effect (Carter and Jennings, 2002; Ciliberti et al., 2008). This concept is extended in our study to the maritime supply chain domain particularly to address the importance of cooperation among supply chain members.

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