Transport Policy xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Transport Policy

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

Innovative solutions for enhancing customer value in liner shipping

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ARTICLE INFO

Keywords:
Customer value
Innovation
Liner shipping
Container shipping
Fuzzy quality function deployment

ABSTRACT

In liner shipping, business conditions have become tougher in recent years in an already very competitive industry. Retaining customers and trying to attract new customers are crucial for liner companies' survival. Thus, it is vital for liner companies to deliver superior customer value with limited resources. This study aims to introduce 7 innovative solutions as design requirements (DRs) and examine to what extent these 7 solutions facilitate to enhance 5 proposed customer values (CVs) in liner shipping. CVs and DRs are identified based on literature analysis and then validated by interviewing academic and industry professionals. A case study of K Line provides insight of the relationship between the CVs and DRs. The Fuzzy QFD approach is deployed to analyze the relative importance of each DR. The results reveal that "Use of Eco Ship and Eco Container Technology", "Big Data Solution for Ship Information Management" and "Automation and Digitalization of System" are the three most effective innovative solutions for enhancing customer value in liner shipping.

1. Introduction

In this 21st century, value-based strategy is one of the key elements in gaining organizational competitive advantage (Woodruff, 1997; Wyner, 1996; Laitamaki and Kordupleski, 1997). In order to ensure the success of value-based strategies, one must fully comprehend the concept of value (Woodruff, 1997). According to Reichheld (1994), values can be divided into shareholder value, stakeholder value, and customer value. Out of these three values, customer value is the predominant one and is deemed as the source of all other values (Heskett et al., 2008).

Recently, the demand for liner shipping has been deteriorating due to slower economic growth. On the supply side, overcapacity of ships has existed for years and the situation is not getting much better in the near future (BIMCO, 2017). Business conditions have become tougher in an already very competitive industry. Retaining customers and trying to attract new customers are crucial for liner companies' survival. Thus, it is vital for liner companies to deliver superior customer value with limited resources (Zhang and Lam, 2018). However, little research has been conducted to enhance customer value for shipping companies and the maritime industry as a whole. Importantly, the literature has not defined customer value at the first place, and the literature has not mentioned customer value and value creation explicitly, while the focus is mostly on service quality. The limited research available in this area merely proposes measurements for shipping companies to evaluate the customer value they delivered (Ding, 2009). The way to create and enhance customer value in liner shipping has not been investigated explicitly. To find out the answer, this study performs an original attempt to propose innovative solutions for liner companies. Looking from the innovative prospective, Flint et al. (2008) suggest the role of innovation in developing customer value insight in the supply chain domain. Therefore, we develop innovative solutions for liner shipping and analyze the role they play in capturing competitive advantage for liner shipping companies.

This research serves to bridge the gap by proposing innovative solutions and investigate the relationship between the customer values and innovative solutions by utilizing Fuzzy Quality Function Deployment (QFD). QFD serves as a cross-functional tool to optimize customer satisfaction, in this case, the customer value, due to its framework of transforming customer demand into product or service specification (Erginel, 2010; Sireli et al., 2007). The fuzzy approach was introduced in addition to QFD to translate linguistic data to numeric precision (Kahraman et al., 2006). The remainder of the paper is structured into 5 sections. Previous studies related to customer value and innovative solutions in liner shipping are reviewed in Section 2. The research process and fuzzy QFD approach are introduced in the methodology section while the application of the methodology is illustrated in Section 4. Section 5 draws research and practical implications from the results and Section 6 concludes.

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https://doi.org/10.1016/j.tranpol.2018.09.001
Received 15 August 2017; Received in revised form 31 May 2018; Accepted 1 September 2018

2. Customer value and innovative solutions

2.1. Customer value

A previous study by Reichheld (1994) has shown that value in business can be categorized into shareholder value, customer value, and stakeholder value. However, it is customer value that plays a vital role in most business strategy models (Cravens et al., 1997). According to Kotler and Armstrong (1994), customer value can be defined as customer delivered value, which is the difference between total customer benefits and total customer cost, while the study by (Lepak et al., 2007) defines customer value as the benefits and satisfaction that a firm can deliver to its customer. In general, customer value can be grouped into three models which differ from each other: Customer value in exchange, Customer value buildup, and Customer value dynamics (Khalifa, 2004). Khalifa (2004) emphasizes that all three models are not mutually exclusive and should be utilized to build an integrative configuration of the customer value concept. In order to build value added creation, Berghman et al. (2006) state that three competences are required, namely marketing practices for external knowledge absorption, general organizational competencies and competences embedded in supply chain.

2.2. Customer value and value creation in the maritime industry

While customer value is recognized as a key concept in the general business and management literature, it is barely touched on in the maritime field. This sub-section widens the search to related prior studies.

Customer perceived value plays a dominant role in developing liner shipping companies' competitive advantages (Ding, 2009). Johansson (1993) has identified service, quality, cost and cycle time as the four main value metrics that contribute to customer value criteria. Furthermore, the result in a recent study by Lam and Bai (2016) indicates reliability and speed as the main customer requirements in liner shipping. According to Yuen and Thai (2015), reliability can be defined as the overall consistency in providing customer service while speed refers to transit time of transportation services, frequency of transportation services and responsive services. Tseng and Liao (2015) opine that integrated service operation in areas such as container shipping is also playing a predominant role in organizational performance due to customers' need for a wider array of global services.

Based on literature analysis and investigating the mission and vision statements of the top 15 liner companies (as listed in Appendix I), 5 key customer values are proposed as follows: Responsive service (CV1), Service reliability (CV2), Service customization (CV3), Cost and Price Competitiveness (CV4), and Corporate branding (CV5). Interviews were conducted with academic and industrial experts to verify the list. The detailed process will be explained in sections 3 and 4. All 5 customer values are discussed in the following subsections.

2.2.1. Responsive service (CV1)

The capability to provide services in a fast manner is valued by liner companies' customers (Lam and Bai, 2016). As compared to the tramp shipping sector, Meixell and Norbis (2008) report that liner shippers tend to value time-related service attributes such as transit time and frequency of liner service over the freight cost. This is because by improving the responsiveness of the service, the overall logistic cost will be reduced. Along a similar rationale, Acciaro (2011) proposes liner service differentiation and express services. Thus, Responsive Service is introduced as one of the components in measuring customer value.

2.2.2. Service reliability (CV2)

Reliability is a conventional measurement of customer satisfaction together with speed, responsiveness and value (Yuen and Thai, 2015). It is reflected by overall consistency in providing customer service, error-free documentation and the transportation itself (Yuen and Thai, 2015). According to Lam et al. (2018), besides speed and value, safety is a top attribute to ensure the quality of shipping. By improving schedule reliability, it is found that the inventory cost of cargo will be reduced, which in turn will benefit the customers (Zhang and Lam, 2015). Hence, service reliability is deemed as one of the key value metrics in measuring customer value.

2.2.3. Service customization (CV3)

Scholars' attention has slowly shifted to marketing strategy of customization over the past years (Dellaert and Stremersch, 2005). Mass customization capability, for example, is the ability to design a system capable of producing a range of products efficiently by collecting and processing various product requirements from the customer (Mccarthy, 2004). Thus, by referring to the successful adoption of mass customization in manufacturing industry, service customization could be one of the key components in quantifying customer value of liner shipping.

2.2.4. Cost and price competitiveness (CV4)

Based on Ding (2010), cost of logistics can be measured by the reasonableness of price related operating costs of shipments and related overhead, charges and fees. Since company's cash flow and profit are of utmost important to ensure corporate sustainability, catering liner service at a competitive price is a common industry practice in a competitive business environment for example the maritime industry (Lam and Wong, 2018). Therefore, cost and price competitiveness is another important criterion for evaluating customer value.

2.2.5. Corporate branding (CV5)

Brand can be defined as a sign for recognition, as a set of attributes or values, and as an experience by consumers (Rowley, 2004). According to Rundh (2011), branding is one of the key drivers to boost customer value and to determine business sustainability in the future. Therefore, in this paper, corporate branding is proposed as a key metric of customer value in the liner industry.

2.3. Innovative solutions

Innovative solutions and differentiated services are vital by helping liner companies to gain organizational competitive advantage. In this study, 11 innovative solutions (as listed in Appendix II) were summarized by reviewing top 15 liner companies' website, annual reports, corporate news, and related information that can be found from public sources. The list was analyzed with reference to the literature. These innovative solutions were categorized into 2 groups, namely Process Innovation (PI) and Service Innovation (SI). Similar to customer values, these 11 innovative solutions were examined by one academic and four industrial professionals and consolidated into the 7 solutions as follows.

2.3.1. Process Innovation (PI)

2.3.1.1. Use of Eco-Ship and Eco-Container technology (PI1). Given the rising concern of environment sustainability, the research by Lam and Lai (2015) has shown that the use of green design ships, engines and machinery is the most crucial measure in the process design of environmental sustainability. Besides, efficient ballast water system and LNG-fuelled ship are also good examples of innovative solutions adopted by liner companies in building an Eco-Ship.

On the other hand, the utilization of Eco-Container in the maritime industry benefits liner companies by helping to reduce carbon footprint and operational cost. For example, container with bamboo floor developed by CMA CGM and Steel Floor Container introduced by Hapag-Lloyd are fully recyclable.

2.3.1.2. Big Data Solution for Ship Information Management (PI2). In tradition, big data is commonly used to improve medical practice, modernize public policy, and inform business decision making (Mayer-

schönberger and Cukier, 2013; Tichavska et al., 2017). However, Waller and Fawcett (2013) believe that big data has the potential to improve and boost the business process of a supply chain. Ship Information Management System (SIMS) has been launched by NYK Line and employing SIMS on vessels enables the timely data exchange between on-board crew and land-based operation stuff. Thus, Big Data Solution would lead to more efficient vessel operations which will benefit the company and its customers.

2.3.1.3. 3D printing in the maritime industry (PI3). 3D printing is a breakthrough technology that would refine the entire shipbuilding industry. According to Garg and Lam (2015), 3D printing technology uses the polymer PLA (Polyactic acid) as a material, which is biodegradable, and saves fuel and reduces waste when fabricating prototypes. This results in a greener shipping practice with lower carbon emission and transportation cost. Although 3D printing is still relatively new in the maritime industry, it has a potential to bring ship building and supplies to a completely new level.

2.3.1.4. Automation and Digitalization of System (PI4). Past researches have shown that the design of the ship automation system consists of power, freezing, air-conditioning, auxiliary installation, navigation, rolling stabilizer, steam production, and loading systems (Kowalski et al., 2001; Lee and Lee, 1999). Another industrial example is the Watchdog Program launched by Hapag-Lloyd, which helps to detect incorrectly declared or dangerous goods. These measures and ship designs have successfully transformed the on-board operations by automating and digitizing the system.

2.3.2. Service Innovation (SI)

2.3.2.1. Integrated and Extensive Online Shipping Service (SI1). Living in this information age, a firm should integrate both the information technology (IT) and strategy with important partners (Kim et al., 2013). This shows the significance of an extensive IT service in enhancing customer value. Developing mobile application and providing all-in-one internet shipping service are good instances of IT services aimed to improve user experience provided by liner companies UASC and APL, respectively.

2.3.2.2. Specialized cargo service and technology (SI2). With the invention of containerized transport systems, a wide range of commodities can be transported with container vessels instead of employing technologically specialized vessels (Woxenius, 2012). This has led to the launching of new services and technology by liner companies. For example, Garment on Hanger service and XtendFRESH™ Technology facilitate to improve the food quality of reefer cargo by removing ethylene. Hence, providing specialized cargo service and technology may be a differentiation strategy for liner companies to distinguish themselves from their competitors.

2.3.2.3. Customized carbon footprint report (SI3). According to Rugani et al. (2013), carbon footprint (CF) serves as a tool to identify areas of emissions reduction and as the driver to improve the eco-profile of products and the socio-environmental awareness and responsibility of people and organizations. For this reason, French giant CMA CGM took the initiative to send a customized carbon footprint report to every customer which enables them to trace their own carbon footprint per year, per maritime line, and by booking. This measure is believed to improve the customer experience and at the same time increase environmental awareness of customers.

3. Methodology

In this research paper, Fuzzy Quality Function Deployment (QFD) was selected as the research methodology due to its distinctive capability of translating user demands into technical requirements (Chen and Ko, 2009). Since this study focuses on customer value, the customer requirement planning matrix in QFD will be the main tool applied in this research. The customer requirement planning matrix is also called the 'house of quality' (HOQ), which assesses the impact of customer requirements (CRs) (the WHATs) on design requirements (DRs) (the HOWs). However, in this study, we replaced CRs with customer value (CVs) and design requirements with innovative solutions in order to be aligned with our aim of this study which is to investigate the relationship between CVs and DRs.

In addition, fuzzy approach was deployed to translate linguistic data to numeric precision (Kahraman et al., 2006). This is because most of the time, natural language was used by customers to express their expectations on services and products which will cause ambiguities (Mohammad and Mohsen, 2013). Hence, Fuzzy QFD is a more suitable approach to tackle the objective of this study.

Drawing reference from Bottani (2009) and Yang et al. (2013), we developed the Fuzzy QFD approach which has the following steps:

Step 1 – Identify and verify the list of CVs: In general, the first step involves literature analysis and information collection. CVs are listed in rows in the HOQ.

Step 2 - Assess the relative importance of CVs: Customer values are weighted in order to express their relative importance. The weight of each CV, W_i $(i = 1, ..., n)$ is inserted in a column in the matrix.

Step 3 - Identify and verify Innovative Solutions (DRs): Innovative solutions that would enhance customer value of liner firms have to be identified and listed in columns in the HOQ.

Step 4 - Construct the central relationship matrix: The relationship matrix $R_{ij}(i = 1, ..., n,\ j = 1, ..., m)$ is the core element of the HOQ. To complete this part, the relationships between customer values and the innovative solutions have to be determined.

Step 5 – Calculate relative importance of each innovative solution: The output of the matrix is the ranking of DRs in descending order of importance. The relative importance of each innovative solution against customer value has to be quantitatively evaluated applying the following equation:

$$RI_j = \sum_{i=1}^{n} W_i \otimes R_{ij},\ j = 1,\ ..., m \tag{1}$$

Where W_i is the fuzzy weighted importance of i-th customer value, while R_{ij} is the fuzzy number expressing the impact of the j-th innovative solution on the i-th customer value.

Both W_i and R_{ij} are fuzzy numbers and Eq. (1) describes an operation between fuzzy numbers, thus the result RI_j is a fuzzy number. Therefore defuzzified values should be computed to make the importance of DRs comparable in order to rank the results.

Yager (1981)'s method is adopted to obtain final crisp relative importance of each innovative solution since it is a simple yet suitable tool to order fuzzy subsets of the unit interval. The equation to convert a fuzzy triangular number $\alpha(l,\ m,\ u)$ into a crisp number is shown below.

$$\frac{l + 2m + u}{4} \tag{2}$$

Innovative solutions can be finally ranked due to their impact once the crisp values have been computed. According to Trappey and Trappey (1996), the higher the crisp RI_j, the more effective the innovative solution could enhance the customer value of the liner companies. The structure of the HOQ is shown in Fig. 1.

4. Application

In this section, a numerical example is provided to illustrate the application of the proposed methodology.

Step 1: Identify and verify list of customer value (CVs).

The process is explained here. By integrating the finding of past

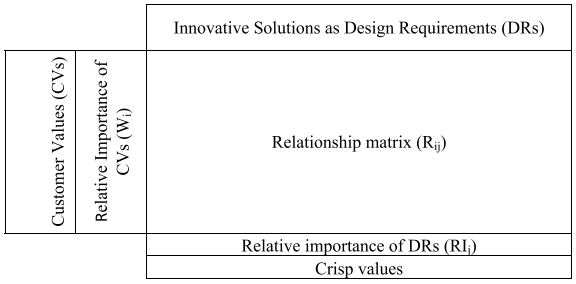

Fig. 1. Structure of house of quality.

Table 1
List of CVs.

Notations	Customer Value
CV1 RS	Responsive Service
CV2 SC	Service Customization
CV3 SR	Service Reliability
CV4 CPC	Cost and Price Competitive
CV5 CB	Corporate Branding

researches as discussed in the literature review above and analyzing the mission and vision statements of the top 15 liner companies (Appendix I), the five key customer values are proposed. Specifically, content analysis was conducted to classify and extract information from these companies. To enhance the research's practicality, interviews were conducted with one academic and four industry experts to obtain first-hand opinion and information for verifying the list of CVs. Among the four industry experts, two are from liner companies (representing the subject domain), one is from a freight forwarder (representing customer's view), and one comes from a maritime consultancy firm (representing a third-party opinion) who are all in management positions. These interviewees were chosen due to their immense expertise and experience in liner shipping. Through the verification process, there were indeed changes made to the original list of CVs. Service Customization with High Reliability was initially proposed as one of the customer values. Later, this CV was split into two after taking up the suggestion of interviewees. Besides, it was suggested that corporate identity shall be removed from the list of CV. Thus, we updated CV5 from “Corporate Branding and Identity” to “Corporate Branding”. Five service attributes were identified as the customer values as shown in Table 1.

Step 2: Assess the relative importance of CVs.

In this paper, fuzzy linguistic scales are adopted to calculate the importance of CVs, investigate the relationship between CVs and DRs and correlations between DRs by following the example of Bottani and Rizzi (2006). A survey was conducted to obtain the relative importance of CVs based on a normalized 4-point fuzzy linguistic scale, ranging from “very low” (VL) to “very high” (VH), as shown in Table 2.

After attaining the data, ranking of CVs are assigned based on their importance weight, W_i where $i = 1, \ldots,5$ as shown in Table 2.

For data collection to determine the importance of each CV, a total of 159 professionals were approached to conduct a survey to rate the CVs' importance. These professionals include ship managers and marine surveyors from shipping companies, as well as shippers/forwarders

Table 2
Degree of importance and fuzzy number.

Degree of Importance	Fuzzy Number
Very High (VH)	(0.7; 1; 1)
High (H)	(0.5; 0.7; 1)
Low (L)	(0; 0.3; 0.5)
Very Low (VL)	(0; 0; 0.3)

Table 3
List of DRs.

Notations	Innovative Solutions
PI1 UESECT	Use of Eco Ship and Eco Container Technology
PI2 BDS-SIM	Big Data Solution for Ship Information Management
PI3 3DP	3D Printing in Maritime Industry
PI4 ADS	Automation and Digitalization of System
SI1 IEOSS	Integrated and Extensive Online Shipping Service
SI2 SCST	Specialized Cargo Services and Technology
SI3 CCFR	Customized Carbon Footprint Report

such as directors from major logistics companies and manufacturers. Their job scope covers operational, market, logistics, technical and other aspects, hence a comprehensive understanding of CV can be obtained. Out of these 159 professionals, 63 of them have responded. The average years of working experience of the respondents are 9.1 years. The profile of the participants is similar to the expert panel which helped to review and comment on our CV and DR lists. Forty-eight participants (76%) are from liner companies, which present the service providers of the innovative solutions. The rest fifteen respondents (24%) are from freight forwarders and third-party logistics firms, which present the customers’ perspective. The diversified expertise pool ensures that the opinions are captured from different perspectives. The answers from the two groups of survey participants (service providers and customers) are similar and do not show significant differences.

Step 3: Identify and verify Innovative Solutions (DRs).

Seven innovative solutions were obtained based on the analysis of several reputable journal publications (Johansson, 1993; Kowalski et al., 2001; Woxenius, 2012; Kim et al., 2013; Mayer-schönberger and Cukier, 2013; Rugani et al., 2013; Garg and Lam, 2015; Lam and Lai, 2015) and content analysis of top 15 liner companies’ website, annual reports, and news. The list was verified by the same interviewees who commented on the CVs. Details have been given in step 1 above. The DRs list is shown in Table 3.

Step 4: Construct the central fuzzy relationship matrix.

The purpose of constructing a central fuzzy relationship matrix is to link innovative solutions (Table 3) and customer value (Table 1) in a fuzzy decision environment. The relationships matrix $R_{ij}(i = 1, \ldots,n, j = 1, \ldots,m)$ of the HOQ is a matrix the generic entry (i, j) of which assesses how the j-th innovation solutions contributes to the i-th customer values. In this study, we relate between the degree of contribution of each innovative solution to each customer value and corresponding fuzzy numbers due to the nature of study which requires human judgement. Instead of traditional graphic symbol, we applied a five-point linguistics scale (as shown in Table 4) to increase the accuracy.

For the data collection of this section, a case study of K Line Pte Ltd was conducted through a focus group meeting of four managerial staff. These four managers from K Line have the experience and knowledge to represent the company and provide professional opinion. They are familiar with both the operations within liner business and the customer requirements.

Step 5: Calculate relative importance of each innovative solution.

The purpose of calculating relative importance of each innovative solution is to determine innovative solutions that have greater impact

Table 4
Degree of significance and corresponding fuzzy numbers.

Degree of Significance	Fuzzy Number
Very Significant (VS)	(0.7, 1,1)
Fairly Significant (FS)	(0.5, 0.7, 1)
Neutral (N)	(0.3, 0.5, 0.7)
Not Significant (NS)	(0, 0.3, 0.5)
Trivial (T)	(0, 0, 0.3)

		Process Innovations				Service Innovations		
	W_i	UESECT (PI1)	BDS-SIM (PI2)	3DP (PI3)	ADS (PI4)	IEOSS (SI1)	SCST (SI2)	CCFR (SI3)
CV1 RS	(0.56; 0.82; 0.96)	VS	FS	N	FS	FS	NS	NS
CV2 SC	(0.47; 0.69; 0.93)	VS	FS	N	FS	NS	NS	NS
CV3 SR	(0.63; 0.90; 0.99)	VS	FS	N	FS	NS	NS	NS
CV4 CPC	(0.60; 0.86; 0.98)	VS	FS	N	FS	FS	FS	N
CV5 CB	(0.33; 0.56; 0.78)	FS	FS	N	FS	FS	NS	VS
RI_j		(1.75; 3.67; 4.65)	(1.29; 2.69; 4.65)	(0.78; 1.92; 3.26)	(1.29; 2.69; 4.65)	(0.74; 2.05; 3.69)	(0.30; 1.50; 2.82)	(0.41; 1.72; 2.91)
Crisp Values		3.44	2.83	1.97	2.83	2.13	1.53	1.69

Fig. 2. HOQ based on survey and interview results.

on customer values so that they can be implemented by liner companies for customer value creation. Relative importance RI_j , $j = 1, \ldots, m$ was calculated before it was defuzzified to crisp values by deploying Yager (1981)'s method. Based on previous study (Trappey and Trappey, 1996), the higher the crisp RI_j, the more effective the innovative solution could boost the customer value of the liner companies. The output is shown in Fig. 2.

5. Results and implications

Due to the competitive business environment of container line, liner companies have been attempting to capture the customers by delivering high customer value and providing innovative solutions in order to gain competitive advantage. The Fuzzy QFD method is a systematic tool that evaluates the importance of customer values and enables the users to identify design requirements which will boost the customer values. Hence, this study mainly focuses on examining the “WHATs” and the “HOWs” and their relationships for the purpose of enhancing the customer values.

Five CVs important for gaining competitive advantage in container shipping are newly identified in this study. These 5 CVs serve as measurements for liner companies to enhance customer satisfactory level and therefore gain competitive advantage. The “HOWs” list is also an original contribution for liner shipping's practical reference. It consists of seven innovative solutions which aim to enhance the customer value of liner companies. This would give companies some ideas on the latest projects developed by other companies.

Based on the results of K Line as shown in Fig. 2, Use of Eco Ship and Eco Container Technology (PI1) emerges as the top innovative solution for enhancing the customer value followed by Big Data Solution for Ship Information Management (PI2) and Automation and Digitalization of System (PI4) both with a crisp value of 2.83. Besides, Specialized Cargo Services and Technology (SI2) and Customized Carbon Footprint Report (SI3) are the less effective solutions to improve customer value with only 1.53 and 1.69 crisp value, respectively.

The ranking of innovative solutions indicates that Process Innovation (PI) plays a more significant role than Service Innovation (SI) in enhancing customer value of liner companies. PI could be seen as a more fundamental type of innovative solution that affects various dimensions of customers’ businesses. The effect of PI could be more disruptive and long-lasting when compared to SI. In the case study, the Use of Eco Ship and Eco Container Technology (PI1) is viewed as the most effective solution due to the use of green technology. Results reveal that utilizing the green technology can achieve more responsive service and higher reliability with lower cost which benefits both the customers and liner companies. Furthermore, by launching eco ship and green technology, liner companies can demonstrate their environmental consciousness which will enhance the corporate image. It is not just a new service but a paradigm shift which advances the technology of container ship and container box. Therefore, this kind of innovative solution in effect establishes new standards and is likely to urge other liner companies to advance their pace of innovation when they strive to stay competitive in the liner shipping market. As an example, Eco Ship and Eco Container Technology is more prevalent in practice. In addition to K-Line, companies such as Maersk, CMA-CGM, and OOCL also adopts this innovation.

Based on the above finding and discussion, policy makers overseeing research and technology development of shipping and the maritime industry in a country such as those in national research councils could consider promoting more research in PI. In these years, we see the rapid development of PI, including the 3 key innovative solutions: Use of Eco Ship and Eco Container Technology (PI1), Big Data Solution for Ship Information Management (PI2), and Automation and Digitalization of System (PI4). Eco technology and information technology would be the twin drivers bringing the maritime industry to the next level of service quality.

Although Specialized Cargo Services and Technology (SI2) ranked the last among 7 innovative solutions, it depends on the case in point to judge the role of this solution in enhancing customer value. Specialized cargo services such as Garment on Hanger service and XtendFRESH™ Technology may serve as a differentiated strategy which can help a liner firm to gain a competitive edge over its rivals. Essentially, the major purpose of this research is to use innovative solutions for enhancing customer value of liner shipping companies. A company's customers/customer segments are different from other companies, so correspondingly the importance ranking of customer values and innovative solutions may be different. The case application has illustrated that the Fuzzy QFD model is a systematic tool for liner companies to serve the intended objective of enhancing customer value.

Furthermore, referring to the results of the Fuzzy QFD model, liner companies will be able to concentrate their resources on developing those innovative solutions that are more effective in enhancing customer value. It is important to prioritize resources because innovation may involve heavy investment. Also, return or outcome may be seen only in the mid to long term. Due to the level of commitment and specialization required, it is recommended to set up a dedicated team to develop an identified innovative solution. The Fuzzy QFD approach serves as an analytical and planning tool. To ensure the success of an innovation, meticulous efforts in development and implementation will be required after the planning stage.

6. Conclusion

This paper has presented an original research work of innovative solutions for liner shipping and examined their relative impacts on customer values by deploying the Fuzzy QFD method. A HOQ is constructed to show the relationships between the “WHATs” and “HOWs” aspects of the QFD problem. In the HOQ, Customer Requirements (CRs) are replaced by Customer Values (CVs) to form the “WHATs” in order to be aligned with the topic of research. To overcome the ambiguous and imprecise decision-making environment generated by the traditional QFD approach (Yang et al., 2013), the Fuzzy QFD method is employed to improve accuracy of the analysis and decision-making.

By utilizing the Fuzzy QFD approach, the innovative solutions are ranked according to their impact on enhancing customer value for liner companies. The top five innovative solutions are “Use of Eco Ship and Eco Container Technology (PI1)”, “Big Data Solution for Ship Information Management (PI2)” “Automation and Digitalization of System (PI4)”, “Integrated and Extensive Online Shipping Service (SI1)” and “3D Printing in Maritime Industry (PI3)” in descending order. Four

out of these five solutions are from Process Innovation (PI), this shows that customer value is more sensitive to Process Innovation (PI) than Service Innovation (SI).

Although other solutions are not as effective as the top five, many are still closely related to the improvement of customer value and should not be ignored. The empirical case study has a limitation that the results should not be generalized. As discussed in section 5, each company's situation is different. However, the case of K Line as a major liner company would be a useful reference. This paper provides a good avenue for further investigating the innovative solutions, including how to implement them effectively.

Acknowledgement

We would like to thank all our interviewees and survey's participants for their contributions which helped to form part of this research. Also, the anonymous reviewers are appreciated for their valuable comments on the earlier version of the manuscript.

Appendix I. List of Top 15 Liner Shipping Companies based on ranking in 2016 and their Innovations

Company	Innovative Solutions	Website
Maersk Line	Standardization, Automation and Digitalization of Business Process	https://www.maersk.com/press/press-release-archive/maersk-and-ibm-to-form-joint-venture
	Onboard Watchdog System together with the Hapag-Lloyd FIS (Freight Information System)	https://www.hapag-lloyd.com/en/press_and_media/press_release_page_43375.html
	3D printing (Green Ship of Future)	http://www.greenship.org/lowemissionconceptstudy/ecaretrofitstudy/
	Enabling Global Trade, growth and development of communities	http://www.maerskline.com/～/media/maersk-line/Countries/int/Images/Sustainability/maerskline-sustainability-2014-enabling-trade.pdf
	UV-based system ballast water treatment system	http://www.maersktechnology.com/en/all-stories/ballast-water-management
MSC Shipping Co.	Ban on shark fin consignments	http://www.hellenicshippingnews.com/msc-places-embargo-on-shipments-of-shark-related-products/
	Launched a new global website which operates across 157 countries in eleven languages	http://www.thedrum.com/news/2015/07/27/mediterranean-shipping-company-launches-new-global-website-crafted
CMA CGM	In-built connected container technology - TRAXENS technology	https://www.cma-cgm.com/news/962/worldwide-innovation-the-cma-cgm-bougainville-is-the-first-container-ship-ever-to-have-in-built-connected-container-technology-thanks-to-the-group-s-partnership-with-traxens
	Eco-vessel & Eco-Container	https://www.cma-cgm.com/media/magazine-article/27/group-life-sustainable-development-driving-innovation
	Custom Report on carbon footprint	https://www.cma-cgm.com/the-group/corporate-social-responsibility/environment/innovation-eco-solutions
Hapag-Lloyd	Watchdog Program	https://www.hapag-lloyd.com/en/products_and_services/dg_watchdog.html
	Eco Calculator	https://www.hapag-lloyd.com/en/about_us/environment_eco_calc.html
	Steel floor container	https://www.hapag-lloyd.com/en/press_and_media/press_release_page_40522.html
	Extensive e-business solution	https://www.hapag-lloyd.com/en/products_and_services/overview_ebusiness.html
Evergreen Line	Minimum ballast, slow steaming, Ballast water treatment plant, frequency control sea water pump, HT47 higher tensile steel and green passport (L-typed Green Ship)	http://www.evergreen-line.com/tbi1/jsp/TBI1_Index.jsp#
COSCO & CSCL	NIL	
Hamburg Sud	XtendFRESH™ Technology- manages oxygen and carbon dioxide levels and removes ethylene	http://www.hellenicshippingnews.com/hamburg-sud-adds-carrier-transicold-xtendfresh-technology-to-maintain-optimal-quality-of-shipped-produce/
OOCL	Green Terminal- Middle Harbour Redevelopment Project (MHRP) at Port of Long Beach	http://www.oocl.com/eng/resourcecenter/ebrochures/Documents/OOCL%20Leaflet_2015%20Eng.pdf
	Green Container- tin free paint	http://www.oocl.com/eng/resourcecenter/ebrochures/Documents/OOCL%20Leaflet_2015%20Eng.pdf
MOL Line	Introduces Tablet Computer System for Onboard Inspection	http://www.mol.co.jp/en/pr/2015/15069.html
	Next-generation condition-based engine monitoring system -" CMAXS e-GICSX″	http://www.mol.co.jp/en/pr/2015/15065.html

YangMing	NIL	
APL	HomePort- All-in-one internet shipping service	https://www.apl.com/wps/portal/apl/etools/homeport
	Garment on Hanger Services	https://www.apl.com/wps/portal/apl/apl-home/services/value-added-services/garments-on-hanger
UASC	Launched New Mobile Application to improve customer experience	http://www.uasc.net/en/news/151105/uasc-launches-new-mobile-application
	First LNG Ready ULCC- MV ″ Sajir"	http://www.uasc.net/en/news/141127/uasc-names-first-ever-lng-ready-ultra-large-container-vessel-hhi-shipyard-ulsan
NYK Lines	Launch Medium-term management plan, “More Than Shipping 2018 —Stage 2 leveraged by Creative Solutions-”	http://www.nyk.com/english/profile/plan/
	SIMS (Ship Information Management System), which makes use of Big Data	http://www.nyk.com/english/release/3710/004037.html
	“Kirari NINJA,” a device that can automatically photograph the inside of a vessel engine	http://www.nyk.com/english/release/3710/004048.html
	Development of electronic UMS (Unmanned Machinery Space) check system	http://www.nyk.com/english/release/3710/003973.html
	“Honesty,” an efficient sounding device for vessel tanks	http://www.nyk.com/english/release/3710/003859.html
K Line	Drive green project	https://www.kline.co.jp/en/feature02.html

Note: Hanjin discontinued in 2016 so was removed from the list.

Appendix II. Initial Identified Innovative Solutions

1) Use of Green Technology	Website
Eco-Container	https://www.cma-cgm.com/media/magazine-article/27/group-life-sustainable-development-driving-innovation
Eco Calculator	https://www.hapag-lloyd.com/en/about_us/environment_eco_calc.html
UV-based system ballast water treatment system	http://www.maersktechnology.com/en/all-stories/ballast-water-management
Green Terminal- Middle Harbour Redevelopment Project (MHRP) at Port of Long Beach	http://www.oocl.com/eng/resourcecenter/ebrochures/Documents/OOCL%20Leaflet_2015%20Eng.pdf
First LNG Ready ULCC- MV ″ Sajir"	http://www.uasc.net/en/news/141127/uasc-names-first-ever-lng-ready-ultra-large-container-vessel-hhi-shipyard-ulsan
2) Big Data Solution	**Website**
Introduces Tablet Computer System for Onboard Inspection	http://www.mol.co.jp/en/pr/2015/15069.html
SIMS (Ship Information Management System), which makes use of Big Data	http://www.nyk.com/english/release/3710/004037.html
3) Corporate Social Responsibility	**Website**
Enabling Global Trade, growth and development of communities-Maersk	http://www.maerskline.com/～/media/maersk-line/Countries/int/Images/Sustainability/maerskline-sustainability-2014-enabling-trade.pdf
Ban on shark fin consignments	http://www.hellenicshippingnews.com/msc-places-embargo-on-shipments-of-shark-related-products/
4) 3D printing in Maritime Industry	**Website**
Green Ship of Future - Maersk	http://www.greenship.org/greenshipofthefuture/teksttiltemaerne/3dprintinthemaritimeindustry.html
5) Cargo-detection Software	**Website**
Watchdog - Hapag-Lloyd	https://www.hapag-lloyd.com/en/products_and_services/dg_watchdog.html
6) Automation and Digitalization of System	**Website**
Development of electronic UMS (Unmanned Machinery Space) check system	http://www.nyk.com/english/release/3710/003973.html
“Kirari NINJA,” a device that can automatically photograph the inside of a vessel engine	http://www.nyk.com/english/release/3710/004048.html
Standardization, Automation and Digitalization of Business Process	https://www.maersk.com/press/press-release-archive/maersk-and-ibm-to-form-joint-venture
Next-generation condition-based engine monitoring system -" CMAXS e-GICSX″	http://www.mol.co.jp/en/pr/2015/15065.html
7) Strategic Management Plan	**Website**
“More Than Shipping 2018 —Stage 2 leveraged by Creative Solutions-”	http://www.nyk.com/english/profile/plan/

STEER FOR 2020	http://www.mol.co.jp/en/pr/2014/14017.html
8) Integrated and Extensive Online Shipping Service	**Website**
HomePort- All-in-one internet shipping service	https://www.apl.com/wps/portal/apl/etools/homeport
Launched New Mobile Application to improve customer experience	http://www.uasc.net/en/news/151105/uasc-launches-new-mobile-application
launched a new global website which operates across 157 countries in eleven languages	http://www.thedrum.com/news/2015/07/27/mediterranean-shipping-company-launches-new-global-website-crafted
Extensive e-business solution	https://www.hapag-lloyd.com/en/products_and_services/overview_ebusiness.html
9) Specialized Cargo Services and Technology	**Website**
XtendFRESH™ Technology- manages oxygen and carbon dioxide levels and removes ethylene	http://www.hellenicshippingnews.com/hamburg-sud-adds-carrier-transicold-xtendfresh-technology-to-maintain-optimal-quality-of-shipped-produce/
"Honesty," an efficient sounding device for vessel tanks	http://www.nyk.com/english/release/3710/003859.html
10) Garment on Hanger Services	**Website**
	https://www.apl.com/wps/portal/apl/apl-home/services/value-added-services/garments-on-hanger
11) Customized Carbon Print Report	**Website**
	https://www.cma-cgm.com/the-group/corporate-social-responsibility/environment/innovation-eco-solutions

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