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KEY INFLUENCE FACTORS FOR OCEAN FREIGHT FORWARDERS SELECTING CONTAINER SHIPPING LINES USING THE REVISED DEMATEL APPROACH

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Key words: sea transport, maritime marketing, container shipping lines (CSLs), ocean freight forwarders (OFFs).

ABSTRACT

More than 80% of container traffic in the global container shipping market in recent years is derived from ocean freight forwarders (OFFs). It raises concern about the OFFs' role in coordinating the services between container shipping lines (CSLs) and shippers. Most previous studies did not distinguish the identity of shippers among OFFs, direct shippers, and routing order exporters. There have been some studies examining the factors for OFFs selecting CSLs by the method of decision-making trial and evaluation laboratory analysis (DEMATEL), but the initial direct relationship matrix may not have convergence to zero in the original version of DEMATEL. Moreover, none of the previous studies applied the Revised DEMATEL analysis to evaluate the key influence factors for OFFs selecting CSLs. This paper implemented a questionnaire survey of 30 experts from 15 major Taiwanese OFFs. The survey considered marketing 4C frameworks of customer needs, customer costs, customer communication, and customer convenience. The influence factors of maritime service for CSLs were constructed; the Modified Delphi Method (MDM) and the Revised DEMATEL were used to define the suitability of key factors and to compare the different relations among factors for OFFs in selecting CSLs to provide shipping services. In particular, the result of research on the key factors of the selection of CSLs by OFFs confirms that the Revised DEMATEL could improve the shortcomings of DEMATEL. In conclusion, 12 key factors are proposed, and 'integrated logistics' and 'timely delivery' are the main influencing and consequence factors respectively.

I. INTRODUCTION

Since the development of container transport in the 1960s, the environment of global container transport business has become increasingly competitive because of economic globalization and various trends in trade. Market uncertainty and unpredictable shipping changes have thus become the main factors behind the impact of the choice of ocean freight forwarders (OFFs) on container shipping lines (CSLs). However, after 1995 due to technological advances in shipbuilding, there was excess space and supply shortage due to the development of mega-ships for global container shipping. Since then, the environment of global container transport business has become highly competitive due to the financial crises of 2008 and 2012, and with the slowing of China's economic growth since 2015; CSLs are facing new challenges in the current global economy. To counteract this, through the concept of market segmentation, CSLs should better understand the needs of shippers in order to enhance their satisfaction and operational performance (Wen and Lin, 2016).

In practice, shippers can be divided into OFFs, direct shippers, and routing order exporters. In the related research on choice of CSLs for Taiwanese shippers, most previous studies found that shippers were unable to distinguish their identity (Krapfel and Mentzer, 1982; Brooks, 1985; Brooks, 1990, 1991; Murphy and Hall, 1995; Tiwari et al., 2003; Yen and Chen, 2004; Douglas et al., 2006; Salleh, 2007; Zsidisin et al., 2007; Brooks and Trifts, 2008; Rogerson et al., 2014). Chen et al. (2009) showed that more than 80% of the container traffic in the global container shipping market was from OFFs, and it has aroused concern about who being in charge of the service between CSLs and shippers. In addition, OFFs' subjective response in the quality services of CSLs is less effective than that of direct shippers.

The current study points out those better shipment of goods, accompanying more satisfaction of OFFs, could strengthen the

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partnership between CSLs and OFFs. Therefore, it leads to better applications in shipping business. In principle, freight tariffs are the most important consideration for OFFs in choosing a carrier (McGinnis, 1990). In addition to considering freight tariff, OFFs also consider service quality of sailing accuracy (Yang et al., 2014), shipping security, cargo tracing system and transferal of transports (Wong et al., 2008; Chung et al., 2011). As CSLs are mostly based on OFF's orientation, they should understand the shipping market changes and shippers' needs. If CSLs can better understand the dynamic changes of customer needs, as well as ways to reduce customer cost, improve customer communications and provide more convenient services, they can improve the operation performance in the uncertain shipping market.

The Delphi technique is a method for establishing a group communication process, allowing a group of individuals, as a whole, to deal with a complex problem. This structured communication is accomplished through various feedbacks, including individual contributions of information and knowledge. It consists of assessment of the group judgments or views, opportunities for individuals to revise views, and a degree of anonymity for the individual responses (Linston and Turoff, 1975). The modified Delphi Method (MDM) retains the spirit and advantages of original Delphi method, and also makes two further improvements. First, it develops a structured questionnaire to replace the complicated survey used in the traditional Delphi open-ended questionnaire, allowing the experts to focus on the research topics and improve the overall response rate. Secondly, it uses statistical analysis and systematic data processing to integrate the experts' opinions and reach a consensus of these views. Subsequently, the decision-making trial and evaluation laboratory (DEMATEL) has been applied in many fields, such as marketing strategies, control systems, safety problems, developing the competencies of global managers and group decision making. However, this method, raising the initial relation matrix to the power of infinity, may not yield a convergence to zero and hence total influence may not converge, though the Revised DEMATEL can improve on this shortage (Lee et al., 2013).

As mentioned above, the current study applies more stringent subcriteria for the selection process by using the MDM and Revised DEMATEL, not only to define the suitability and relevance of key factors and affecting factors, but also to adopt the 4Cs criteria of customer orientation to compare OFFs selections of CSLs. The rest of this paper is organized as follows. Section 2 reviews the related literature on the choice of OFFs for CSLs and their proposed consolidation. Section 3 explores methods and the assessment framework. Section 4 provided an empirical analysis of OFFs' choices for CSLs. Finally, conclusions and recommendations are presented in section 5.

II. LITERATURE REVIEW

This section reviews attributes related to maritime service and discusses the impact of various factors on choosing CSLs. It also reviews the related literature on research methods and provides a comprehensive discussion.

1. Attributes of Maritime Service for Container Shipping Lines

Collison (1984) considered delivery speed, reliable schedules, freight tariff, and cargo damage claims as the primary service factors for studying the choice of OFFs for CSLs. The freight charges did not vary greatly between different carriers during the 1980s, carrier reputation (Brooks, 1985) and customs clearance efficiency (Slack, 1985) were the main determining factors for the choice of OFFs for CSLs at that time. Subsequently Brooks (1990, 1991) showed that the importance of the transit time was greater than carrier reputation in the early 1990s. Also in that decade, companies' financial key performance indicator (KPI) reports, together with an increasing trend to use branch offices and commission agents, generated an expanded scope of services, and providing higher quality service became an important feature for OFFs (McGinnis, 1990).

Freight tariffs have been the highest priority consideration since 2000, because CSLs had greater room for bargaining over price, this will increase an OFF's intention to use that CSL for shipment (Shry and Chu, 2005). With the vigorous developments in the logistics industry, CSLs needed to integrate their services vertically, and increase the efficiency of transport processes (Douglas et al., 2006). It has been noted that CSLs can enhance their market competitiveness by integrating their logistics operations (Tiwari et al., 2003; Huang, 2014; Yang et al., 2014). Furthermore, considering the need of OFFs for logistics operations, the efficiency of pier operations and fees are also key factors considered by shippers (Tongzon, 2009).

Under the pressure of intensive global competition, supported by the use of e-commerce, the container shipping lines can provide benefits for customers with more value-added services (Penaloza et al., 2007). The increased effectiveness from providing e-tracking systems, rapid response, reduction of cargo damage, and enhancement of transport safety (Liang et al., 2007) can increase the loyalty of their shippers. According to Wong et al. (2008), voyage reliability and communication skills are more important than freight tariffs because transport delay and inefficient staff are the most frequently encountered problems. Hence, service attitude and maintaining relationships are also key factors for the choice of OFFs by CSLs.

As transport providers are part of the service industry, it is necessary for CSLs to understand the different needs of OFFs in order to provide satisfactory service. In addition to reliable transport, CSLs should consider transport safety, lower costs, expertise, company reputation, transit time (Brooks and Trifts, 2008), service scope, integrated logistics (Krapfel and Mentzer, 1982; Yeung, 2006), intensive sailing frequencies (Notteboom, 2006), and implementation of e-commerce (Wen and Lin, 2016). In addition, other aspects such as container types, sizes, convenient capacity and accurate documentation are also key influencing factors for OFFs to choose CSLs (Yen and Chen, 2004; Chung et al., 2011).

In the research on how shippers choose CSLs, most previous

studies were unable to distinguish the types of shippers, i.e., OFFs, direct shippers, and routing order exporters, for evaluation criteria. Wen and Huang (2007) and Wen and Lin (2016) studied on OFFs to selecting CSLs, but there was a lack of theoretical support for the criteria. Kannan (2010) and Kannan et al. (2011) used SERVQUAL framework, factor analysis (FA) and an analytic hierarchy process (AHP) approach to analyze ocean carriers' strengths and weaknesses in India, though they did not analyze the relevance of subcriteria. Chung et al. (2011) used 7Ps and DEMATEL to assess the key factors of Taiwanese OFFs selection of CSLs. However, the initial relation matrix, raised to the power of infinity, may not converge to zero. Moreover, since the total influence may not converge, the results will probably be unable to effectively present the correlations between subcriteria. Briefly, previous studies have not been able to comprehensively consider OFFs' and the theoretical basis of criteria is lacking. Since it is difficult to comprehensively analyze the current situation of the container shipping market, this leads to ineffectively applying value on the basis of evaluation criteria and shipping management that are incompletely understood. In order to compensate for shortcomings in previous studies, this study includes customer needs, customer costs, customer communication and customer convenience as the influence factors for analyzing OFFs selection of CSLs. This provides a more complete understanding of the relevance of influence factors for OFFs selecting CSLs in Taiwan.

2. Related Literature and Research Methods

The Delphi method, proposed by Dalkey and Helmer in 1960, is a systematic method to expedite decisions of expert group. Murry and Hammons (1995) suggested that the Delphi method should adopt an anonymous decision-making technique to obtain input from a group of experts. Although this can effectively collect opinions, but it is difficult to control research progress and there is a low rate of survey returns. The MDM was then proposed to resolve these problems. In the MDM, relevant literature can be considered to modify the speculation that occurs in traditional open-ended Delphi questionnaires and allow experts to focus more clearly on the research topics. The MDM has been extensively applied, based on the expert group's work experiences and knowledge as expressed in the questionnaires. For practical applications, Lirn et al. (2004) proposed developing evaluation criteria for influence transshipment factors using the MDM. Hsu (2010) applied the MDM to help investors effectively select an optimal location for an international business center in China, a case that is highly relevant for both academic and commercial implications. Lin et al. (2011) explored the best option for the location of an international exhibition, and established evaluation criteria and subcriteria.

Subsequently, the Battelle Memorial Institute of the Geneva Research Centre between 1972 and 1976 developed the DEMATEL approach. An initial direct relation matrix was established to observe the degree of interaction between factors. By applying it, the matrix and related mathematical theory can be used to calculate the causal relationship between influence degrees of all factors, thereby clarifying the complex causal relationship between the evaluation criteria and the decision-making goal. It has been used to solve sophisticated problems by improving the understanding of them (Tzeng et al., 2007). Using mutual relations between the factors of comparison to calculate the direct, indirect, and combined effects, this method helps clarify the nature of problems and resolve related issues (Liu and Lin, 2005). Since the initial direct relationship matrix may not have convergence to zero in the original version of DEMATEL, the Revised DEMATEL improves on this shortage (Lee et al., 2013). Yang (2013) used the Revised DEMATEL to analyze directly and indirectly, and combined factors for choosing a ship's registration, which provides an effective strategy for CSLs.

In place of DEMATEL, this study adopts Revised DEMATEL, supplemented by MDM to survey the optimum subcriteria effectively and objectively. This study focuses on senior manager's opinion from 15 major Taiwanese OFFs to select appropriate evaluation subcriteria, to establish the influence factors for OFFs selecting CSLs, and to provide shipping companies practical value as well as a reference for future research. The results of research into the key factors of the selection of CSLs by OFFs confirm that the Revised DEMATEL can improve the shortcomings of DEMATEL.

3. Comprehensive Discussions

Although previous studies have considered the influencing factors for OFFs to choose CSLs, their needs will vary according to conditions, and CSLs need to understand this in order to maintain existing customers and develop new ones (Chung et al., 2011). Relevant evaluation of subcriteria and descriptions of influencing factors in maritime services for CSLs are shown in Table 1.

In conclusion, for the optimal transport conditions, CSLs should understand how attributes of OFFs differentiate the needs and affect the strategies for shipping services. Moreover, because DEMATEL models the influences of components of a system with an initial direct relation matrix, so the influences of components can transitively affect other components; and this is modeled by raising the initial direct relation matrix to powers. The total influence is computed by summing up the matrices of all powers based on the assumption that the matrix raised to the power of infinity would converge to zero. Lee et al. (2013) indicated that if the initial relation matrix, raised to the power of infinity, does not converge to zero, then the total influence may not converge.

This study is based on customer orientation, considering the relevant literature on how OFFs choose CSLs, and this paper effectively improves the evaluation subcriteria for CSLs. MDM is used to develop stringent selection subcriteria and to gain valuable and objective data information through expert groups' relevant work experiences and knowledge. Based on this, the Revised DEMATEL ensures that the initial direct-relation matrix to infinite power will converge to zero, and thereby defines the suitability and relevance of key factors for CSLs to create operating strategies.

Table 1. Relevant subcriteria of influence factors in maritime service for CSLs.

Influencing factors	Definitions	Sources
Financial KPI report	Used to measure the capacity of CSLs to make a profit in a particular period, such as concerning yielding rate, return on assets, total assets turnover, return on equity, current ratio, debt ratio, etc.	McGinnis (1990)
Indirect access network	CSLs advertise transport services through the intermediate trader, such as OFFs or brokers	Chung et al. (2011); Yeung (2006)
Dedicated dock	Participate in port investment and harbor leasing to meet CSLs' needs, pre-scheduling to improve efficiency in using dock machinery and equipment and to ensure shipment stability	Yang et al. (2014); Chung et al. (2011); Tongzon (2009); Vernimmen et al. (2007); Notteboom (2006)
Document fee	Processing costs for receiving, amending and surrendering certificates of origin and other documents	Chung et al. (2011)
Types and condition of Container	Providing different sizes and functions of container to meet shippers' various needs. Containers structure should conform to be standard and internally clean to ensure transport safety	Wen and Lin (2016); Chung et al. (2011); Wong et al. (2008); Wen and Huang (2007); Yen and Chen (2004); Brooks (1995)
Mega container ships	High-speed and automated mega container ships, reduce the unit cost of container transport and increase the convenience of shippers to utilize space	Yang et al. (2014); Chung et al. (2011); Mentzer et al. (1999)
Document accuracy	CSLs should seek to document accuracy to shorten the time taken between CSLs and shippers	Wen and Lin (2016); Chung et al. (2011); Wen and Huang (2007); Yen and Chen (2004); Brooks (1995)
Equipment obtained conveniently	Including the withdrawal of general and special containers, as well as conveniently obtaining spaces	Wen and Lin (2016); Wong et al. (2008); Liang et al. (2007); Wen and Huang (2007); Shry and Chu (2005); Yen and Chen (2004); Brooks (1995)
E-commerce system	Shippers can use online booking and tracking to monitor the flow of goods via the internet	Wen and Lin (2016); Chung et al. (2011); Kannan et al. (2011); Kannan (2010); Wong et al. (2008); Penaloza et al. (2007); Yen and Chen (2004)
Service attitude	Timely solution of problems with patience and a helpful attitude	Chung et al. (2011); Kannan et al. (2011); Kannan (2010); Wong et al. (2008); Wen and Huang (2007)
Convenient shipping	Booking, shipping, issuance documents and withdrawal of cargo are simple and convenient	Yang et al. (2014); Chung et al. (2011); Liang et al. (2007); Yen and Chen (2004)
Relationships maintaining	Regularly visit responsible shippers, establish business relationships, solve problem during the implementation	Wen and Lin (2016); Yang et al. (2014); Chung et al. (2011); Wen and Huang (2007); Yen and Chen (2004); Tiwari et al. (2003)
Direct access network	CSLs set up branches abroad in order to facilitate direct shipper inquiry for transport services	Chung et al. (2011); Yen and Chen (2004)
Sailing schedule advertisement	Intensive use of print media, including published shipment advertising transport services to targeted customers	Chung et al. (2011)
Freight tariffs	Shippers pay the freight costs to CSLs for ocean transport	Wen and Lin (2016); Rogerson et al. (2014); Chung et al. (2011); Kannan et al. (2011); Kannan (2010); Wong et al. (2008); Liang et al. (2007); Salleh (2007); Wen and Huang (2007); Douglas et al. (2006); Shry and Chu (2005); Mentzer et al. (1999); Brooks (1995); Murphy and Hall (1995); Brooks (1990); Brooks (1985); Krapfel and Mentzer (1982)
Timely delivery	Due to increased transport services, excess delivery time will cause an excessive increase of downstream industry demand conditions, and will also affect the willingness of importers to order from exporters	Wong et al. (2008); Liang et al. (2007); Penaloza et al. (2007); Salleh (2007); Vernimmen et al. (2007); Douglas et al. (2006); Notteboom (2006); Shry and Chu (2005); Liao et al. (2004)
Transport reliability	The reliability and accuracy of time and shipment for transport services. Scheduled time, timetable stability, arrival and estimated arrival time are consistent	Wen and Lin (2016); Chung et al. (2011); Kannan et al. (2011); Kannan (2010); Brooks and Trifts (2008); Salleh (2007); Wen and Huang (2007); Vernimmen et al. (2007); Notteboom (2006); Liao et al. (2004); Yen and Chen (2004); Mentzer et al. (1999); Brooks (1995); Brooks (1991); Brooks (1985); Collison (1984)

Table 1. Relevent subcriteria of influence factors in maritime service for CSLs (cont.).

Influencing factors	Definitions	Sources
Sailing frequency	The amount of vessels, ports of call frequency and the number of departures	Wen and Lin (2016); Yang et al. (2014); Chung et al. (2011); Tongzon (2009); Brooks and Trifts (2008); Wong et al. (2008); Vernimmen et al. (2007); Wen and Huang (2007); Notteboom (2006); Brooks (1995); Brooks (1990); Slack (1985); Brooks (1985); Collison (1984)
Integrated logistics	An logistics company combines inland and maritime services for intermodal transport. Development and integrated international logistics operation mode, providing consistent door-to-door services	Huang (2014); Rogerson et al. (2014); Yang et al. (2014); Chung et al. (2011); Vernimmen et al. (2007); Yeung (2006); Yen and Chen (2004); Tiwari et al. (2003); Heaver (2001); Brooks (1985); Krapfel and Mentzer (1982)
Transit time	Refers to time spent for goods in transport	Huang (2014); Yang et al. (2014); Brooks and Trifts (2008); Wong et al. (2008); Douglas et al. (2006); Brooks (1990); Slack (1985); Brooks (1985); Collison (1984)
Maritime expertise	Providing professional advice on shipper transport, and capacity of transport-related problem processing with transport and logistics expertise	Wen and Lin (2016); Chung et al. (2011); Wong et al. (2008); Liang et al. (2007); Wen and Huang (2007); Yen and Chen (2004); Brooks (1995); Brooks (1985)
Transport security	CSLs shall conform to laws and regulations of the contract and pay more attention to ensure the ship and cargo safety	Wong et al. (2008); Liang et al. (2007); Shry and Chu (2005); Yen and Chen (2004); Slack (1985); Brooks (1985)
Combination of operating route	Most appropriate route combinations are based on the arrangement and efficiency of direct or transshipment services	Rogerson et al. (2014); Chung et al. (2011); Vernimmen et al. (2007); Douglas et al. (2006); Liao et al. (2004); Brooks (1985)
Reputation and image	In order to establish a good image and reputation, CSLs should actively participate in social public benefit activities, implementations of green energy and environmental protections, as well as fulfilling corporate social responsibilities.	Wen and Lin (2016); Chung et al. (2011); Kannan et al. (2011); Kannan (2010); Wen and Huang (2007); Yen and Chen (2004); Brooks (1991); Slack (1985)
Surcharges	Recurrent or non-recurrent charges, such as bunker adjustment factor, currency adjustment factor, peak season surcharge, port congestion surcharge and inland transport costs	Rogerson et al. (2014); Yang et al. (2014); Chung et al. (2011); Tongzon (2009); Slack (1985)
Staff appearance	Good overall image of CSL contacts with the shipper to develops a positive impression by the shipper, e.g., being well groomed and appropriately dressed	Wen and Lin (2016); Chung et al. (2011); Brooks (1985)
Loading and unloading charges	Recurrent charges or additional surcharges for loading and unloading in port, including terminal handling charges, container freight station charges, as well as demurrage and detention	Chung et al. (2011); Slack (1985)
Customs clearance efficiency	The proportion of goods to be inspected by customs, together with clearance efficiency, relationship with customs and cargo with follow-up treatment of items detained by customs	Chung et al. (2011); Slack (1985)

III. RESEARCH METHODS AND EVALUATION FRAMEWORK

The following is a description of research methods used in this paper, together with the influence factors of evaluation framework.

1. Modified Delphi Method

There are numerous related service impact factors affecting CSLs. To explore the most appropriate evaluation subcriteria and reach an agreement between experts, this study adopts the Modified Delphi Method (MDM) to develop the structured questionnaire. A group of experts synthesizes the senior managers' opinions without interference. With statistical analysis and systematic processing methods, an archive can facilitate the expert group to develop its evaluation subcriteria of influence factors for maritime service of CSLs. The collection of expert opinions, determination of consistency, stability and consent determination was as follows (Lee et al., 2008).

1) Collection of Expert Opinions

According to the methods mentioned above, this study used three rounds of questionnaires to collect experts' opinions, and thereby understand the factors influencing OFFs' selection of CSLs. In order to understand the extent to which the experts agree on the description of each topic, a Likert scale was used to evaluate reactions of the experts' opinions, supplemented by

collecting individual experts' opinion. For questionnaire statistics, this research used the quartile deviation test on the variation of individual observations to understand the consensus of all experts.

2) Determination of Consistency

Faherty (1979) indicated that a quartile deviation of less than or equal to 0.6 can be considered to indicate that the opinions of experts reached a high level of consistency. The quartile deviation from 0.6 to 1.0 indicates that the experts' opinions reached a moderate degree of consensus for this topic. And if a quartile deviation, greater than 1.0 indicates the topic does not reach a consensus. On the consistency test, if more than 85% topics reached a high or moderate level of consensus, the questionnaire could be considered as completed.

3) Determination of Stability

When a topic does not reach consensus, Murry and Hommons (1995) suggested that there is small possibility, lower than 20%, of experts altering their opinions. This situation showed the consistency and stability.

4) Consent Determination

"Strongly disagree", "disagree", "neither agree nor disagree", "agree" and "strongly agree" are the format of a typical 5-point Likert item in this study. Regarding how most of experts make appropriate judgement, we applied statistical mode to represent expert opinions.

2. The Revised DEMATEL

The Battelle Memorial Institute of the Geneva Research Centre between 1972 and 1976 developed the DEMATEL approach. The approach establishes an initial direct relation matrix to observe the degree of interaction between factors, and the matrix and related mathematical theory are used to calculate the causal relationship between influence degrees of all factors, thereby clarifying the complex causal relationship between the evaluation criteria and decision-making goals (Seyed-Hosseini et al., 2006; Hsu et al., 2013). Since the initial direct relationship matrix may not converge to zero in the original version of DEMATEL, this is improved by the Revised DEMATEL (Lee et al., 2013). It is calculated as follows.

1) Define and Determine the Relationship Between the Factors

Filter and define factors in the system according to experts' experience and literature review.

2) Calculate the Initial Average Matrix

Let $A = (a_{ij})_{n \times n}$ be an average matrix of the respondents' direct matrices in which the entry (i, j) indicates the direct influence that factor i exerts on factor j. The initial average matrix $A = (a_{ij})_{n \times n}$ is given by

$$A = \frac{1}{H} \sum_{k=1}^{H} B^{(k)} \tag{1}$$

where $B^{(k)}$ is the answering matrix of the k-th respondent.

3) Calculate the Normalized Initial-Direct Relation Matrix X, Which Is Calculated by

$$X = \frac{A}{s} \tag{2}$$

where

$$s = \max(\max_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}, \varepsilon + \max_{1 \le j \le n} \sum_{i=1}^{n} a_{ij}) \tag{3}$$

and ε is a very small positive number.

4) Derive the Total Influence Matrix S

All indirect influence matrices are $X_2, X_3, \ldots, X_k, \ldots, X^{\infty}$ the total influence matrix, which is equal to

$$S = X(I - X)^{-1} \tag{4}$$

3. Evaluation Framework of Influence Factors

Moeller and Shafer (1987) proposed that the experts should be selected based on their experience, knowledge, reputation and willingness to cooperate. For achieving satisfaction in evaluation subcriteria, OFFs objectively gathered the influence factors for choosing CSLs, based on the reviewed literature. The combined marketing 4C frameworks proposed by Lauterborn (1990) include structures for customer needs, customer costs, customer communication and customer convenience. Regarding the scope of evaluations, criteria and subcriteria from this study, Fig. 1 shows abstract influence factors for maritime service from CSLs.

IV. EMPIRICAL ANALYSIS AND DISCUSSIONS

This section is based on questionnaires filled out by the experienced and knowledgeable shipping industry experts. Based on this data, we use Excel software to analyze the relevance and correlation of the influence factors for OFFs to choose CSLs.

1. Survey Results

The questionnaire survey of this study is divided into two stages, first by mailing surveys and then by direct questionnaires and interviews. Murry and Hammons (1995) and Rowe and Wright (1999) stated that the most appropriate number of experts should be between 10 and 30 when applying the Delphi method. If there are more than 30, this will lead to complications and a greater workload. It creates difficulties in obtaining valid conclusions. Accordingly, this study uses convenience sampling focusing on 15 major OFFs. Participants in this survey, including general managers, deputy general managers, and managers, are responsible for selecting CSLs for their corporations. For the first, second and third stages 30, 26 and 21 questionnaires were distributed, with effective questionnaire return rates

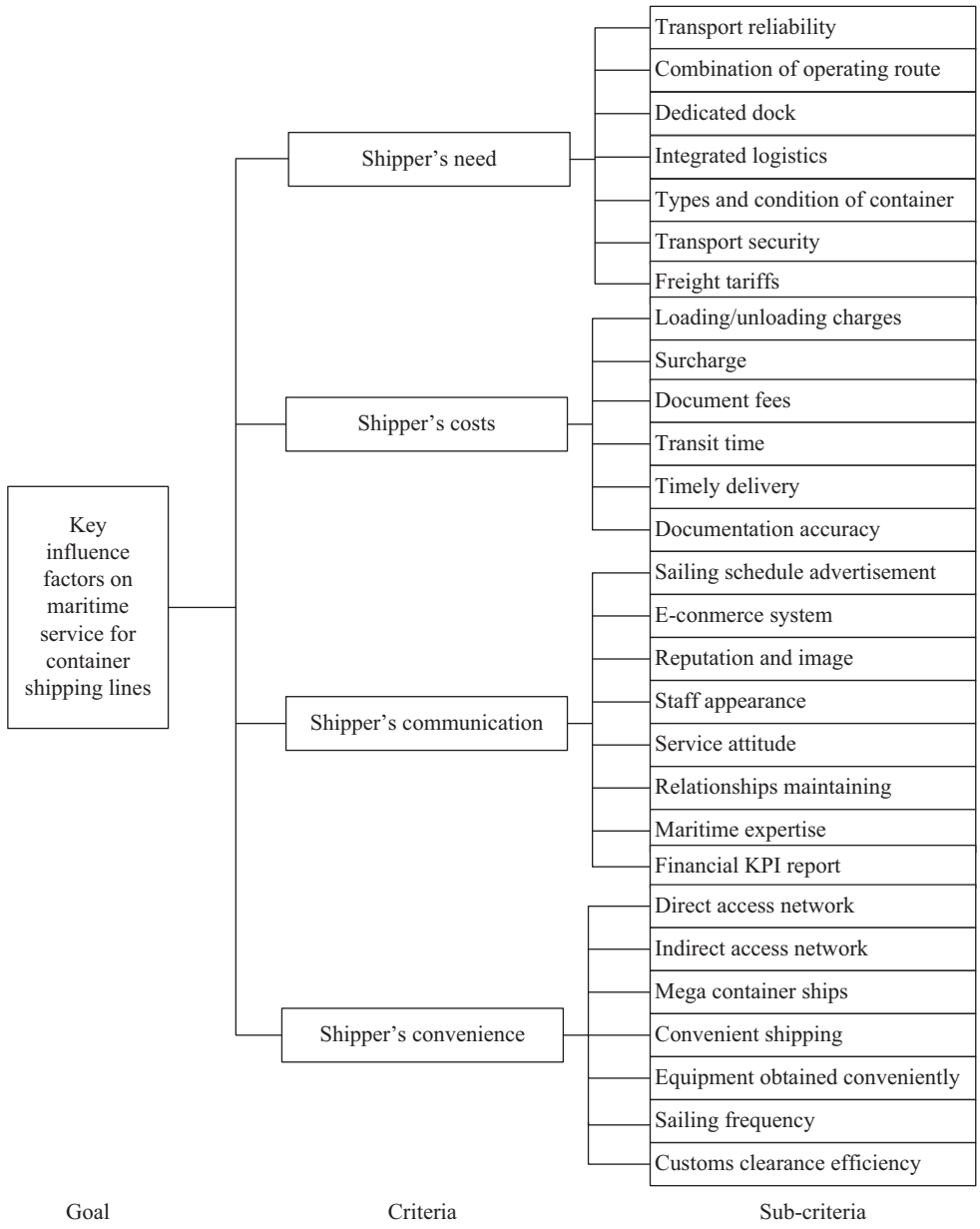

Fig. 1. Evaluation framework of influence factors on maritime service for OFF's selecting CSLs.

of 86.67%, 80.77% and 80.95%. The screening processes on influence factors for OFFs selecting CSLs are shown in Table 2.

2. Overall Assurance Analysis of Influence Factors

Faherty (1979) indicated that a quartile deviation of less than or equal to 0.6 can be considered that the opinions of experts reached a high level of consistency. A significance level equal to or above 3.5 can be considered that the opinions of experts can be accepted (Chen and Chen, 2011). The quartile deviation in this study is less than or equal to 0.6 and the significance is above 3.5, indicating that the expert opinions reached consistency, and so the evaluation subcriteria are retained. From the evaluation subcriteria, this study obtained 12 factors: 'transport reliability,' 'integrated logistics,' 'transport security,' 'freight tariffs,' 'transit time,' 'timely delivery,' 'service attitude,' 'maritime expertise,' 'direct access,' 'convenient shipping,' 'sailing frequency,' and 'customs clearance efficiency.' These are used to process the correlation analysis of key influence factors in maritime service for CSLs.

3. Correlation Analysis of Influence Factors

An example is illustrated in this section. Let us revisit the example by the Revised DEMATAL, as follows. Lee et al. (2013) let $B^{(1)}$ and $B^{(2)}$ are the matrices of a system that are given by two experts. The answer matrices corresponding to the matrixes are as follows:

Table 2. Screening process on influence factors for OFFs selecting CSLs.

Evaluation factors	First round			Second round			Third round		
	assurance	consistency	result	assurance	consistency	result	assurance	consistency	result
Transport reliability	4	0.5	retention	-			-		
Combination of operating route	3.25	0.625	observed	3.75	0.5	delete	-		
Dedicated dock	3	1	observed	3	0.625	observed	3	0.5	delete
Integrated logistics	3	0.625	observed	4	0.5	retention	-		
Types and condition of container	3	0.625	observed	3	0.5	delete	-		
Transport security	4	0.5	retention	-			-		
Freight tariffs	5	0	retention	-			-		
Loading/unloading charges	3	0.5	delete	-			-		
Surcharges	4	1	observed	3	0.625	observed	3	0.5	delete
Document fees	3.25	0.625	observed	3	0.5	delete	-		
Transit time	4	0.5	retention	-			-		
Timely delivery	4	0.5	retention	-			-		
Documentation accuracy	3	0.5	delete	-			-		
Sailing schedule advertisement	2	1	observed	2	0.5	delete	-		
E-commerce system	3	0.5	delete	-			-		
Reputation and image	3	0.5	delete	-			-		
Staff appearance	3	0.5	delete	-			-		
Service attitude	4	0.5	retention	-			-		
Relationships maintaining	3	0.5	delete	-			-		
Maritime expertise	4	0.5	retention	-			-		
Financial KPI report	2.75	0.625	observed	4	0.625	observed	3	0.5	delete
Direct access network	4	0.5	retention	-			-		
Indirect access network	3.25	0.125	delete	-			-		
Mega container ships	3	1	observed	2.75	0.5	delete	-		
Convenient shipping	4	0.5	retention	-			-		
Equipment obtained conveniently	4	0.625	observed	3	0.375	delete	-		
Sailing frequency	4	0.5	retention	-			-		
Customs clearance efficiency	4	0.5	retention	-			-		

$$B^{(1)}=\begin{bmatrix}0&4&2&0\\4&0&0&1\\1&0&0&4\\0&2&4&0\end{bmatrix} \text{ and } B^{(2)}=\begin{bmatrix}0&3&0&1\\4&0&1&0\\1&0&0&4\\0&1&3&0\end{bmatrix}$$

Step 1.

Initial average influence matrix is

$$A=\begin{bmatrix}0&3.5&1&0.5\\4&0&0.5&0.5\\1&0&0&4\\0&1.5&3.5&0\end{bmatrix}$$

Step 2.

Let $\varepsilon = 10^{-5}$. initial influence matrix is

$$X=\begin{bmatrix}0&0.6999986&0.1999996&0.0999998\\0.7999984&0&0.0999998&0.0999998\\0.1999996&0&0&0.7999984\\0&0.2999994&0.6999986&0\end{bmatrix}$$

Step 3.

Since

$$X^{\infty}=\begin{bmatrix}0&0&0&0\\0&0&0&0\\0&0&0&0\\0&0&0&0\end{bmatrix},$$

we have

Table 3. Correlation values of key influence factors.

Influence affecting factors	D_k	R_k	$D_k + R_k$ (ranking)	$D_k - R_k$ (ranking)
C11 transport reliability	1.094	1.406	2.500 (2)	-0.321 (5)
C14 integrated logistics	1.673	0.994	2.667 (1)	0.679 (1)
C16 transport security	0.311	0	0.311 (7)	0.311 (3)
C21 freight tariffs	0	0.332	0.332 (6)	-0.332 (6)
C25 transit time	1.010	0.635	1.645 (4)	0.375 (2)
C26 timely delivery	0.668	1.405	2.073 (3)	-0.737 (7)
C47 customs clearance efficiency	0.320	0.303	0.623 (5)	0.017 (4)

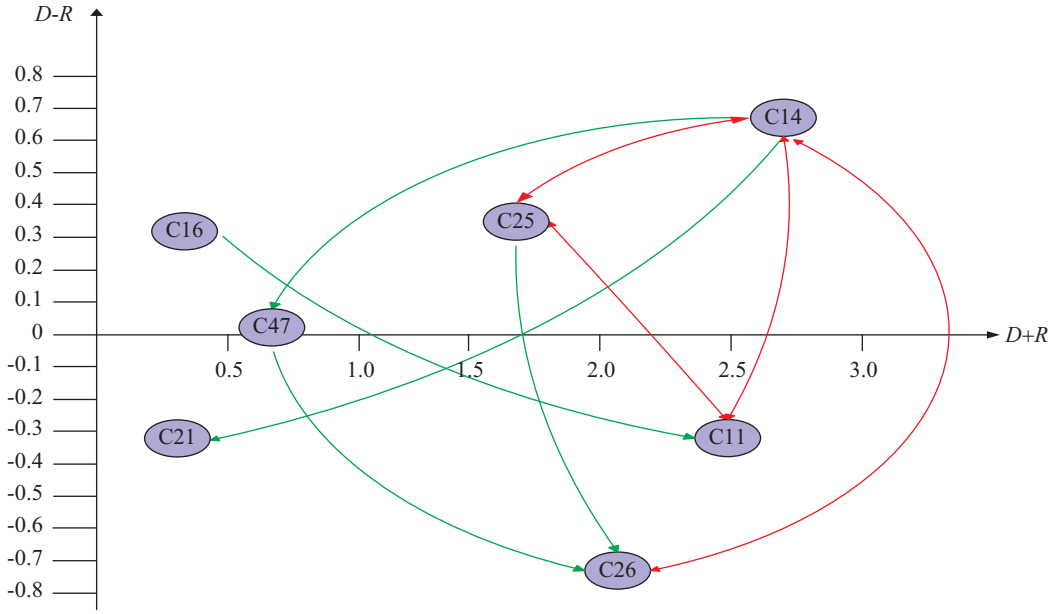

Fig. 2. Cause and effect relationship of key influence factors.

$$S = X + X^1 + X^2 + \ldots + X^{\infty} =$$

$$\begin{bmatrix} 125000.0321 & 125000.397 & 124999.8209 & 124999.7497 \\ 125000.5204 & 125000.026 & 129999.7497 & 124999.7043 \\ 124999.7303 & 124999.717 & 125000.0321 & 125000.5204 \\ 124999.7173 & 124999.860 & 125000.3973 & 125000.0256 \end{bmatrix}$$

For the correlation of key influence factors, in order to obtain stronger influence factors, 0.14 is used as the threshold in this study. This is completed to remove any factors that have a low correlation since a direct or indirect relationship value greater than 0.14 indicates a greater significance effect. Therefore, the sum of determinant by each row and column calculates the total extent of affected and ranking in the key influence factors. D_i indicates the extent of the factor's influence on other factors, R_j indicates the extent of the factor receiving influence, and $(D_k + R_k)$ indicates the intensity of the factor with others. A larger value indicates that the total impact factor is greater. $(D_k - R_k)$ indicates the extent of factors' interaction. A positive number indicates that the factor is an influence factor, whereas a negative number means the factor is influenced. A figure indicating the cause and effect relationship in the key influence factors given a set threshold is presented in Table 3 and Fig. 2.

Table 3 shows that after a given threshold, the high degree of correlation factors include 'C14 integrated logistics,' 'C11 transport reliability,' 'C26 timely delivery,' 'C25 transit time,' 'C47 customs clearance efficiency,' 'C21 freight tariffs,' and 'C16 transport security'.

4. Managerial Implications

Compared with other main influence factors, 'integrated logistics' is the primary factor, and it can be bidirectionally affected by 'transit time,' 'timely delivery' and 'transport reliability'. Followed by 'transit time,' it can be bidirectional affected by 'transport reliability' and 'integrated logistics'. Due to the rise of logistics and transport services, logistics providers are part of the transport industry. Along with the increase in the changing of transport conveyors, it will also raise the transit time and probability of damaged goods, so CSLs will be involved with

different transport services and units for providing consistent logistics services. If a CSL can integrate logistics effectively, reduce transit time, enhance 'timely delivery' and 'transport reliability,' reduce complex shipping activities handling by OFFs, economize time, labor and expenditure, this will increase an OFF's intention to use that CSL for shipment.

Yeung (2006) indicated that if CSLs attempt to gain market advantage, in addition to providing products and services, they should also have a complete logistics system. For CSLs, Zacharia and Mentzer (2004) indicated that logistics are significantly effective in assisting enterprises, creating competitive advantage, improving profitability and customer satisfaction. This provides more competitive 'freight tariffs' and shortens 'transit time' in order to attract OFF's intention. Furthermore, 'transport reliability' can be unidirectional affected by 'transport security'. Due to the dramatic increase in global economic development and trade capacity, with the growth of vessel quantity and the trend of maximizing vessel size, the demands on maritime shipping have not been reduced, even with improvements in marine science and technology. Furthermore, CSLs can ensure the safety of navigation and decrease damage to cargo, which will also create their credibility to OFFs.

Subsequently, 'transit time' can be bidirectionally affected by 'transport reliability'. Because maritime transport takes more time than other modes of transport, CSLs should conform the provisions of international laws and safety regulations to maintain seaworthiness, schedule reliability and be consistent to actual time of arrival and estimated time of arrival. Thereby it would increase OFFs acceptance of the transit time and timely delivery by CSLs. In other words, CSLs should not only care about 'transport reliability' or reducing 'freight tariffs,' if they can satisfy both of those and other factors to enhance 'timely delivery,' this will increase the likelihood of becoming priority for OFFs.

Among the consequence factors, 'timely delivery' is the most important, followed by 'freight tariffs' and 'transport reliability'. Concerning 'timely delivery,' long transit time and shipment delay will affect the subsequent customs clearance efficiency and logistics operations, which in turn will affect the overall shipment scheduling by OFFs and increase the cost of CSLs to arrange rescheduling inland transport services. Therefore, accuracy of delivery time is considered the primary consequence factor. There are both unidirectional and bidirectional relationships between 'timely delivery,' 'integrated logistics,' 'transit time' and 'customs clearance efficiency'. These relationships indicate that 'timely delivery' is affected by the aforementioned factors. Thus OFFs will consider 'integrated logistics,' 'transit time,' 'customs clearance efficiency,' and 'transport reliability' when considering 'timely delivery'. Those factors indicate that the services scope and quality standards provided by CSLs, together with all the other factors will affect the acceptance of 'timely delivery' for OFFs. As for 'freight tariffs' and 'transport reliability,' they will be affected by 'integrated logistics,' indicating that OFFs who are considering 'freight tariffs' will also consider 'integrated logistics' and 'transport reliability'. Therefore, CSLs should not only be more flexible in their 'freight tariffs,' but also provide 'integrated logistics' and 'transport reliability' in order to attract OFF's shipment attention.

V. CONCLUDING REMARKS

The global container transport business has become increasingly competitive due to the increasingly global economy and greater trade demands. Market uncertainty and the shipping environment's unpredictable changes may become important guidelines for shipper's choice of CSLs (Murphy and Hall, 1995). This study is based on the OFF's orientation to establish an framework for the evaluation of influence factors in maritime service for OFFs who are selecting CSLs. Based on shippers' needs, shippers' costs, shippers' communication, and shippers' convenience as evaluation factors and 28 evaluation subcriteria, a questionnaire survey for OFFs selecting Taiwanese CSLs was prepared and administered. MDM was used to define the adaptation of evaluation subcriteria and the Revised DEMATEL was used to define the relevance and suitability of key influence factors in maritime service for CSLs.

The analysis of influence factors affecting maritime service for OFFs selecting CSLs included 'transport reliability,' 'integrated logistics,' 'transport security,' 'freight tariffs,' 'transit time,' 'timely delivery,' 'service attitude,' 'maritime expertise,' 'direct access,' 'convenient shipping,' 'sailing frequency,' and 'customs clearance efficiency'. These 12 factors are the most appropriate evaluation subcriteria. Correlation analysis of influence factors for OFFs selecting CSLs, and the key influence factors are 'integrated logistics,' 'transit time,' 'transport security' and 'customs clearance efficiency'. The key consequence factors are 'timely delivery,' 'freight tariffs,' and 'transport reliability'. In the literature, only Chung et al. (2011) analyzed the relevance of key influence factors for OFFs selecting CSLs, and the results indicated that sales expertise could affect transport reliability. In contrast, the current study finds that transport reliability can be affected by transport security. It is shown that the OFFs might be influenced by shipping accidents, such as the MOL and TSL in Hong Kong and Taiwan. Considering transport fees, this study also finds that integrated logistics is still affecting freight tariffs. However, timely delivery was not considered in the analysis of previous literature.

POSTSCRIPT

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