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Influence of Structural Variation of Container Shipping Industry towards Ocean Freight Forwarders

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ABSTRACT

The industry of container shipping lines (CSLs) has undergone a substantial structural change recently, including the withdrawal of CSLs and reshuffling for strategic alliances. Previous research was limited on the influence of an industrial restructure of CSLs towards the operations of ocean freight forwarder (OFF) companies. This study used the similarity aggregation method (SAM) to complement this gap from a survey of 50 OFFs with varied experiences in Taiwan. The results revealed that OFFs paid more attention to the rights and obligations for cargo claims and observed details for operational dynamics of CSLs. They also had a greater focus on risk management. OFFs perceived the competitive pressure to generate more business that could be found from their rapid responses to the changes of shipper logistical decision-making and requirements. Interestingly, brand reliability and service quality for existing CSLs had no apparent variations.

Key words : container shipping lines (CSLs), strategic alliances, ocean freight forwarder (OFF), similarity aggregation method (SAM)

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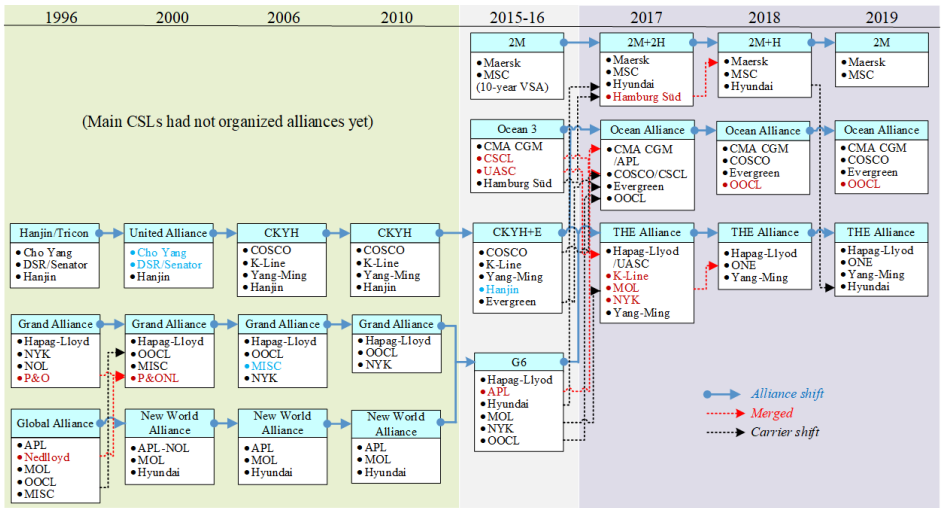
1. Introduction

The industry of global container shipping lines (CSLs) has undergone dramatic changes as to the structure of companies since 2015. Some famous and large carriers have been merged, such as Neptune Orient Lines Limited, China Shipping Container Lines (CSCL), and United Arab Shipping Company; or some even withdrew from this industry, such as Hanjin Lines. Three Japan-based primary shipping lines, NYK, K-Line, and MOL, divided their container operation systems into a merged new brand called Ocean Network Express (ONE) in 2018. Although the Orient Overseas Container Line (OOCL) still existed, most equity shares were acquired by COSCO Shipping. These CSLs were ranked top 20 in the supply of ship fleet capacities and joined strategic alliances (SAs) for many years. Since the end of 1995, the first generation of SAs started an operational model of both competition and cooperation. SAs of CSLs must confront members' shifts for every contracted term because of the variation of freight rate levels and the operation status of individual carriers. Durations of 2006 to 2010 and after 2018, the constitution of SAs revealed relatively stable (Figure 1). The reshuffling of SAs coped with the above events has formed entirely new industrial operating systems for shipping carriers. Simply put, industrial concentration levels for CSLs are growing; and cooperation and competition among the larger companies are tighter than before (Varbanova, 2017).

The main fuse hidden in these events is competition regarding the continuous upsizing of containerships among CSLs. The larger the ship sizes, the greater

Figure 1. Historical development for strategic alliances of CSLs.



CSL, container shipping lines; UASC, United Arab Shipping Company; NOL, neptune orient lines limited.

the benefits of economies of scales. Larger containerships increase investment and operation costs and establish a higher barrier for carriers considering entering the market. Short-sea services were reasonably affected by a cascading effect of deployed ship sizes (OECD, 2015).

Shipping lines are at the top of the ocean transportation chain, which consists of many other downstream stakeholders, such as port operators, ocean freight forwarders (OFFs), and logistics integrators, among others. This study focuses on any possible influence from the new operating environment for global CSLs towards the operations of OFFs because freight forwarding businesses are most directly concerned with shipping lines. In particular, the sudden closure of Hanjin Lines in 2017 had caused an unprecedented influence on global OFFs to protect the rights of shippers and claim benefits.

This study explores how OFFs have managed their operations during this period of dramatic change that flowed upstream and what this influence was on their operations. This study proposed 18 factors after the preview of industrial and academic experts to design a questionnaire to investigate 50 practitioners of OFFs in Taiwan. This questionnaire asked respondents to express agreement levels for all factors. For exploring the recognition of all expert opinions, this study used a fuzzy similarity aggregation method (SAM) to rank all aspects and made an insightful and sensitivity analysis based on the differences of respondent positions, experiences, and business classifications. These results can clarify the real concerns for OFFs facing a new operating environment driven by larger players' withdrawal in the upstream industry. CSLs can understand their operational partners' anxious issues when they appear enormous internal alternation from this study, and then take appropriate countermeasures not to disturb the whole market.

The following section reviews previous studies by examining the service of OFFs and evaluating the factors involved in selection carriers. Section 3 introduces the methodology of the proposed fuzzy SAM and the operation steps. Section 4 describes the research design and investigation results. Section 5 reports and discusses results obtained from the SAM analysis. The final section concludes with the findings of this research and possible future areas of study.

2. Literature Review

Freight forwarding services depend on the supply conditions provided by CSLs. A large-scale variation of the industrial environment of CSLs will affect the operation resources of OFFs. This section reviews the services offered by OFFs and then examines the evaluated criteria of OFFs and shippers in selecting CSLs. The third part of the literature review focuses on the influence of the CSLs industry environment on freight forwarders.

2.1 Services of Freight Forwarders

Freight forwarders are agents who provide related services for consignment deliveries on their own or in a client's name. They always organize the transportation of shipments with various characteristics and assumes responsibility for their delivery. Freight forwarders play the role of carriers when dealing directly with shippers; in contrast, they change their position while consigning shipments to actual carriers. Many larger OFFs have expanded their services with integrated logistics management for cross-country operations (Burkovskis, 2008).

Service qualities or attributes of OFFs have attracted various studies seeking to clarify the factors that affect shipper selection for consigned shipments. Reliability, service, and price are primary dimensions that shippers consider (Kilibarda et al., 2016; Perlman et al., 2009). Reliability presents the gaps between the perceived and expected values of shippers. Aggregated and integrated services reveal the requirement of globalization businesses for contemporary producers. The excellent transit handlings with a rationalization of freight rates are the noticeable conditions to present the competitive advantages of forwarders (Lin and Liang, 2011). Service qualities through information tracing, availability of cargo space, the competency of emergency handling, the ability of claims, and freight rates might show a higher priority for improvement (Yang, 2012). Notably, customer response, information technology, and knowledge management affected organizational performance for OFFs (Shang and Lu, 2012). Innovation capability and firm performance of OFFs have been examined to have a positive and significant relationship (Yang, 2012).

The service conditions of OFFs are pretty crucial for their customers; however, most parts of these conditions depend on the provision of CSLs. A considerable variation of the industrial dynamics of CSLs affects the arrangement of forwarding arrangement inevitable and right.

2.2 Shipping Line Selection of Shippers and Ocean Freight Forwarder (OFFs)

Shipping line selection is crucial because the cooperating relationship might need to be maintained for a long time between the shipper/forwarder and any carrier. In the early operation environment, carriers' door-to-door elapsed time and timing-related services were the unique deterministic criterion of carrier selection decision (Brooks, 1990; Lu, 2003). As the complexity of global logistics operations increased, more criteria, such as freight rates, scheduling, carrier reputation, slot availability, and on-time arrival/departure, became the additional conditions in carrier selection (Kannan, 2010; Lu, 2013). To play an intermediary role, OFFs still take shipper needs into account in carrier selection. Customs clearance efficiency and transport security are two critical factors correlated with integrated logistics (Ho et al., 2017).

The competitiveness of CSLs usually affects OFFs and shippers in selection. Schedule reliability, document accuracy, service quality, freight rate, and door-to-door service and environment significantly reflect the competitive performance among CSLs (Fanam et al., 2018). For specific markets, such as between Taiwan and southern China, different operation scales of OFFs reveal various consideration focuses. Large companies focused on the following dimensions: freight charges and information technology; whereas smaller companies preferred to focus on service performance and the reputation of the CSLs (Wen and Lin, 2016).

Although previous research (Ergin et al., 2022) indicated that the changes in world trade and maritime transport made the customers' expectations vary, including shippers, consignees, and OFFs, the factors in selecting CSLs, reviewed from the studies mentioned above, mainly focus on freight rates, service conditions and qualities, and schedule reliabilities. Customer relations-related criteria have become more critical than the freight criterion. This study supports the phenomenon that the whole chain of maritime transport for container deliveries is changing, which is also proposed by this study.

2.3 Industry Environment Influence on Freight Forwarders

The enormous variation from the industry of CSLs did not occur frequently. The Ocean Shipping Reform Act of 1999 in the United States induced a dramatic change to the industry of CSLs. This act almost reformed the maritime operation practice at that time. The challenges and opportunities of the intermediaries of non-vessel operating common carriers (NVOCCs) made a greater investment in information technology and other advanced tools and processes for supply chain management (Clott, 2000). Greater service values then were achieved than the traditional selling approach.

CSLs used cost-oriented competition strategies to benefit from economies of scale by ship enlargement, i.e., the more quantities of transported goods with the lower unit transport costs (Lu and Yeh, 2019; Tran and Haasis, 2015; Valentine et al., 2013). Only higher slot utilization can bring additional profits to the shipping lines. However, if deep ocean loops visit too many ports, there is a decrease in the benefits of the high load factor because extra port time and berthing cost further decrease.

Most of the critical perspectives of top managers in CSLs to operate mega-ships are concerned about the ship lines themselves (Lu and Yeh, 2019), like increases in investments in building or leasing containers, changes of service networks of shipping lines, and management of empty container repositioning. Still, some factors will directly alter the logistics system operations, such as seaborne feeder services and inland transportation. The relationships between CSLs and OFFs are also affected by a significant burden to fill up a ship to capacity.

The changing features because of such chain effects affect the operation and service of OFFs. Most other partners in the transportation chain are not necessarily favorable for mega-ships (OECD, 2015). Some possible misgivings are the

upsizing ships, such as service frequency reduction, risks concentrating in a single vessel, delivery disruptions or delays, port hinterland infrastructure and connectivity, peak congestion, and delay for truck companies, among others that may affect all stakeholders.

OFFs play the interface role between CSLs and shippers, but most previous studies discussed the service and selection relationships in the normal operating environment of container shipping. The CSL industry is currently situating a significant alternation on a higher concentration of service conditions because of the reduction of larger players. The influence of this phenomenon might gradually leaven to alter the service resources and even the priorities of company management of OFFs. This study attempts to dig out some valuable findings for the perceived influence of OFFs.

3. Research Design

The upstream changes of industrial structure caused different perceptions to different operation levels in OFF companies. The employees confronted such critical moments and might perceive undetermined or fuzzy recognition for the related topics. This study attempts to combine subjective opinion with fuzzy techniques for a group consensus result. This study exploited the SAM to consider the possible difference in recognitions because of the difference of backgrounds and experiences of respondents. This treatment can demonstrate more reliable results to ensure the market judgment for our topic. The following sub-sections firstly introduce the concept of SAM and then the investigation results.

3.1 Method

This study infers the similarity calculation equation for triangular fuzzy numbers to develop the operation procedure of SAM. This approach is more accessible than using trapezoid fuzzy numbers proposed by Hsu and Chen (1996). The calculation of exact similarity with triangular fuzzy numbers in the Section 3.1.1 is also the contribution of this study. Based on this calculation, the following two sections provide the operation steps of SAM and the defuzzification processes.

3.1.1 Similarity measure concept

Fuzzy techniques can aggregate opinions from multiple experts evaluating an uncertain decision environment. The fuzzy concept comes from a judgment that might be expressed in a numerical range with a different membership strength to represent the possible decision determination. Let X be a universal set. A fuzzy set A in X is characterized by a membership function $u_A(x)$ associated as a real number

in the interval between 0 and 1 with each point in X. The value of $u_A(x)$ at x represents the membership grade of x in A.

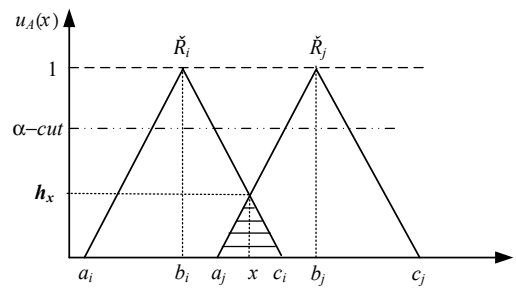
A triangular fuzzy number is a popular method of defining the membership function to express a decision maker's fuzziness. Equation (1) expresses the membership grades for a triangular fuzzy number A in real line $\Re$ referring to u_A: $\Re \rightarrow$ (0, 1), where $-\infty < a \le b \le c < \infty$ (Dubois and Prade, 1978). The grade of b represents a maximal grade or the most probable value of membership in A, i.e., $u_A(b) = 1$. The interval (a, c) is the range of this set's lower and upper bounds, for which length also represents A's fuzziness. Thus, a triangular fuzzy number A can be represented by 3-tuples $A = (a, b, c)$.

$$u_A(x) = \begin{cases} (x-a)/(b-a), & a \le x \le b \\ (c-x)/(c-b), & b \le x \le c \\ 0, & otherwise \end{cases} \tag{1}$$

Suppose two experts have their estimates $\widetilde{R}_i$ and $\widetilde{R}_j$ represented by triangular fuzzy numbers, but assumed they have a common intersection at some α-level cut, $\alpha \in (0, 1]$. Figure 2 and equation (2) express that the agreement degree $S(\widetilde{R}_i, \widetilde{R}_j)$ is defined by the proportion of the consistent area to the total area, also known as a similarity measure function (Zwick et al., 1987).

$S(\widetilde{R}_i, \widetilde{R}_j)$ can be further inferred as the flowing with the elements of two triangular fuzzy numbers $R_i = (a_i, b_i, c_i)$ and $R_j = (a_j, b_j, c_j)$ and expressed as Equation (3). If two estimates are the same, i.e., $\widetilde{R}_i = \widetilde{R}_j$, $S(\widetilde{R}_i, \widetilde{R}_j) = 1$. In contrast, if

Figure 2. Concept of similarity measures for two triangular fuzzy numbers.



$$S(\widetilde{R}_i, \widetilde{R}_j) = \frac{\int_{\mathbf{x}} (\min\{\mu_{\widetilde{R}_i}(x), \mu_{\widetilde{R}_j}(x)\}) dx}{\int_{\mathbf{x}} (\max\{\mu_{\widetilde{R}_i}(x), \mu_{\widetilde{R}_j}(x)\}) dx} \tag{2}$$

two estimates are entirely different, $S(\widetilde{R}_i, \widetilde{R}_j) = 0$. Higher a $S(\widetilde{R}_i, \widetilde{R}_j)$, the higher the consistency or similarity.

$$\frac{x - a_j}{b_j - a_j} = \frac{c_i - x}{c_i - b_i} \rightarrow x = \frac{c_i b_j - b_i a_j}{c_i - b_i + b_j - a_j} \quad \text{and} \quad h_x = \frac{c_i - a_j}{c_i - b_i + b_j - a_j}$$

$$S(\widetilde{R}_i, \widetilde{R}_j) = \frac{\frac{1}{2}(c_i - a_j) \times \frac{c_i - a_j}{c_i - b_i + b_j - a_j}}{\frac{1}{2}(c_i - a_i) + \frac{1}{2}(c_j - a_j) - \frac{1}{2}(c_i - a_j) \times \frac{c_i - a_j}{c_i - b_i + b_j - a_j}}$$

$$S(\widetilde{R}_i, \widetilde{R}_j) = \frac{(c_i - a_j)^2}{(c_i - a_i + c_j - a_j) \times (c_i - b_i + b_j - a_j) - (c_i - a_j)^2} \tag{3}$$

3.1.2 Similarity aggregation method (SAM) operation steps

Suppose the fuzzy numbers of *n* respondents for a question in an item. Let $S_{ij} = S(\widetilde{R}_i, \widetilde{R}_j)$ to represent the measured similarity of respondents *i* and *j*. Applying the operation proposed by Hsu and Chen (1996) to the triangular fuzzy numbers. The operational steps are described as follows:

Step 1: Calculate agreement degrees for every two respondents and construct the agreement matrix (AM). This matrix is defined as $AM = [S_{ij}]_{n \times n}$, $i, j = 1, 2, \ldots, n$. Each element S_{ij} can be calculated with equation (3).

Step 2: Calculate the average agreement degree (AAD) for respondent *i* by Equation (4).

$$A(E_i) = \frac{1}{n-1} \sum_{\substack{j=1 \\ j \neq i}}^{n} S_{ij}, \; i = 1, 2, \ldots, n \tag{4}$$

Step 3: Calculate the relative agreement degree (RAD) for respondent *i* by Equation (5).

$$RAD_i = \frac{A(E_i)}{\sum_{i=1}^{n} A(E_i)}, \; i = 1, 2, \ldots, n \tag{5}$$

Step 4: Set the relative weights of the importance levels for all respondents, i.e., $\underline{r_i}$, $i = 1, 2, \ldots, n$. Then, calculate the important degree w_i for all respondents by Equation (6).

$$w_i = \frac{r_i}{\sum_{i=1}^{n} r_i}, i = 1, 2, \ldots, n \tag{6}$$

Step 5: Calculate the consensus degree coefficients (CDC) for all respondents by Equation (7) with a given β value, where $0 \le \beta \le 1$.

$$CDC_i = \beta \times w_i + (1 - \beta) \times RAD_i, i = 1, 2, \ldots, n \tag{7}$$

Step 6: Calculate the aggregation result $\widetilde{R}$ with fuzzy multiplication and addition by Equation (8). $\widetilde{R}$ represents an overall fuzzy number of combining every fuzzy opinion of each respondent.

$$\widetilde{R} = \sum_{i=1}^{n} CDC_i \otimes \widetilde{R}_i \tag{8}$$

The final results of SAM present triangular fuzzy numbers for every question proposed by this study. They can be ranked by their priorities using a certain defuzzification method.

3.1.3 Defuzzification for ranking

The defuzzification process transforms a fuzzy number into a proper and crisp value compared to other fuzzy numbers. Some defuzzification methods for triangular numbers have been proposed. This study used the method proposed by Chen and Hsieh (2000) and equation (9) to defuzzy the final results of SAM. This method is similar to the center of gravity (COG) method and easy to operate. Further, the fuzzy ranking principles are followed as Equation (10) to compare two fuzzy numbers A_i and A_j.

$$D(A_i) = \frac{a_i + 4b_i + c_i}{6} \tag{9}$$

$$A_i \succ A_j \Leftrightarrow D(A_i) > D(A_j)$$
$$A_i \approx A_j \Leftrightarrow D(A_i) = D(A_j)$$
$$A_i \prec A_j \Leftrightarrow D(A_i) < D(A_j) \quad (10)$$

3.2 Investigation

For exploring the influence of the industrial environment change of CSLs, this study collected possible alternations from the literature to invite nine experts to preview the appropriateness of the proposed question items. The panel of this focus group consisted of five senior managers from freight forwarder companies and four professors who continuously devoted themselves to marine shipping research. Then, this study distributed the revised questionnaire to 50 industrial experts to investigate their agreement levels for all question items. Primary processes in the whole research design are described as follows.

3.2.1 Questionnaire contents

The designed questionnaire at the first phase consisted of 16 influential factors extracted from the support references. Most experts deleted the factor of "OFFs perceive the sales representatives of CSLs lacking sufficient advanced knowledge and capability." They provided suggestions to modify the other six factors by precisely describing the situation of changes, such as revising "Choice for available cooperated carriers changes" as "Choice for available cooperated carriers decreases." Furthermore, three factors stemmed from their observation and were implemented to be appended. These question items included "OFFs should quickly respond to the changes of logistical decision making from shippers," "OFFs care more about risk management than before," "OFFs track CLSs' operation dynamics more in detail." Table 1 shows the contents of the ready questionnaire to distribute to the next round of experts.

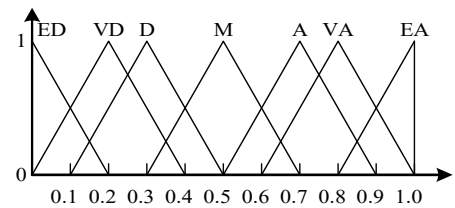
Table 1. Contents of the distributed questionnaire and support references of factors

No.	Factors	Support references
1	Freight rates offered by carriers are obviously changed.	Lin and Liang (2011); Lu (2013); Wen and Lin (2016); Ho et al. (2017)
2	The route mixes to provide shippers decrease.	OECD (2015); Lu and Yeh (2019); Ho et al. (2017)
3	The provisioning capability of empty containers to shippers gets better.	Ho et al. (2017); Lu and Yeh (2019)

4	Truck fees increase because of ship call changes.	OECD (2015)
5	The choice for available cooperated carriers decreases.	Lu et al. (2006)
6	Control ability of forwarders for ship slots decreases.	Lu (2013); Wen and Lin (2016); Lu and Yeh (2019)
7	Handling and additional charges increase.	Lin and Liang (2011); Ho et al. (2017)
8	Transport reliability of CSLs decreases.	Lu (2013); Wen and Lin (2016); Lu and Yeh (2019)
9	Service quality of CSLs decreases.	Lin and Liang (2011); OECD (2015); Lu and Yeh (2019)
10	Brand reliability of CSLs decreases.	Lu et al. (2006); Lu (2013); Wen and Lin (2016); Ho et al. (2017)
11	OFFs should quickly respond to the changes in logistical decision making from shippers.	*Proposed by the focus group*
12	OFFs change the perception to an e-commerce application.	Lin and Liang (2011)
13	The pressure of getting more freight businesses increases.	Grimstad and Neumann-Larsen (2013); Lu and Yeh (2019)
14	OFFs care more about risk management than before.	*Proposed by the focus group*
15	OFFs are more concerned about the rights and obligetions for freight damage claims.	Lin and Liang (2011)
16	OFFs track CLSs' operation dynamics more in detail.	Proposed by the focus group
17	The liaison burden between OFFs and CSLs decreases.	Lu (2013)
18	The complexity of shipment consolidation increases.	Burkovskis (2008); Lin and Liang (2011)

CSL, container shipping lines; OFF, ocean freight forwarder.

Table 2. Triangular fuzzy numbers and membership function for linguistic variables

Linguistic variables for importance	Triangular fuzzy numbers	Membership function
Extremely disagree (ED)	(0, 0, 0.2)	
Very disagree (VD)	(0, 0.2, 0.4)	
Disagree (D)	(0.1, 0.3, 0.5)	
Moderate (M)	(0.3, 0.5, 0.7)	
Agree (A)	(0.5, 0.7, 0.9)	
Very disagree (VA)	(0.6, 0.8, 1)	
Extremely agree (EA)	(0.8, 1, 1)	

The questionnaire asked respondents to express the agreement in perceived recognition from their practical experience for each factor. A 7-point scale of linguistic variables, from 1 for extremely disagree to 7 for extremely agree, were applied to measure respondent opinions. Table 2 shows the settings of triangular fuzzy numbers for every linguistic variable and their membership function.

3.2.2 Sampling

The questionnaires of formal investigation were preset to distribute to 50 freight forwarders in Taiwan from January to March 2018. This study used snowball sampling to construct the invested panel by introducing respondents one by many. Most of them were the board of directors and supervisors of the International OFF League at Taipei (IOFFLAT). However, the recommendable conditions were advised in every introducing linkage. The main conditions included that the respondents' served companies must have already acquired the certification of AEO and be the required business markets, i.e., short sea, deep ocean, or both. These respondents serve companies that belong to the 741 members in this league that share more than 85% of OFFs in Taiwan. This panel consists of diversified features considering the balance on personal background and experience and service scales and scopes of their serving companies.

All respondents returned their opinions, and every questionnaire was effective. Respondents over 40 years old responded to more than 60%, almost the exact percentages for work experience greater than 16 years. The main business markets for deep ocean or short sea services were even at 40%. The remainder 20% focused on both markets. More than 50% of respondents were titled manager. The ratio of respondents serving companies with 15 years or greater was 68%. Table 3 shows the backgrounds of sampling respondents. This sampling revealed high reliability with Cronbach's α value of 0.834 and a good validity in the Bartlett test with KMO statistics of 0.74 for the questionnaire, respectively.

Table 3. Structure of sampling respondents

Sample characteristics	Groups	Effective samples	Group shares (%)	Cumulative percentage (%)
Age	21 to 30	9	18.0	18.0
	31 to 40	10	20.0	38.0
	41 to 50	17	34.0	72.0
	51 to 60	10	20.0	92.0
	Above 60	4	8.0	100.0
Work experience (years)	Below 5	7	14.0	14.0
	6 to 10	9	18.0	32.0

Work experience (years)	11 to 15	3	6.0	38.0
	16 to 20	8	16.0	54.0
	21 to 25	14	28.0	82.0
	Above 26	9	18.0	100.0
Main business market	Deep ocean	20	40.0	40.0
	Short sea	21	42.0	82.0
	Both in even	9	18.0	100.0
Title	Top manager	10	20.0	20.0
	Middle manager	18	36.0	56.0
	OP/CS staff	15	30.0	86.0
	Sales	4	8.0	94.0
	Document staff	3	6.0	100.0
Company history (years)	Below 5	5	10.0	10.0
	6 to 10	6	12.0	22.0
	11 to 15	5	10.0	32.0
	16 to 20	6	12.0	44.0
	21 to 25	3	6.0	50.0
	Above 26 years	25	50.0	100.0

4. Similarity Aggregation Method (SAM) Analysis

The results of descriptive statistics provide a preliminary concept for this investigation. This section uses SAM to aggregate the consensus of opinions from all respondents based on the settings of their conditions, such as work experience, main business markets managed, and job titles.

4.1 Results for All Experts

The given value of β in Equation (7) is a critical setting to distinguish the individual weights for respondents. While $\beta = 0$ means the RAD is considered only without taking the relative weights of each respondent's importance levels (w_i), i.e., $CDC = RAD$. This section first reports the case of $\beta = 0$ to neglect the different individual conditions of all respondents. Table 4 shows that the linguistic expression for every respondent opinion was first transformed into the system of triangular fuzzy numbers.

Following the steps of SAM operation, we constructed eighteen 50×50 matrixes of agreement degrees for every factor. Each S_{ij} follows equation (3) calculation to complete the mutual consensus evaluation for respondents. Then, the AAD ($A(E_i)$), RAD, and CDC for each respondent can be calculated as Equations

Table 4. Calculated indexes for the 1st question item while $\beta = 0$

Sample (i)	$A(E_i)$	RAD_i	CDC_i	Sample (i)	$A(E_i)$	RAD_i	CDC_i
1	0.618076	0.027610	0.027610	26	0.618076	0.027610	0.027610
2	0.618076	0.027610	0.027610	27	0.618076	0.027610	0.027610
3	0.618076	0.027610	0.027610	28	0.268598	0.011999	0.011999
4	0.618076	0.027610	0.027610	29	0.618076	0.027610	0.027610
5	0.268598	0.011999	0.011999	30	0.618076	0.027610	0.027610
6	0.618076	0.027610	0.027610	31	0.268598	0.011999	0.011999
7	0.618076	0.027610	0.027610	32	0.315242	0.014082	0.014082
8	0.315242	0.014082	0.014082	33	0.618076	0.027610	0.027610
9	0.268598	0.011999	0.011999	34	0.268598	0.011999	0.011999
10	0.618076	0.027610	0.027610	35	0.618076	0.027610	0.027610
11	0.618076	0.027610	0.027610	36	0.148688	0.006642	0.006642
12	0.148688	0.006642	0.006642	37	0.268598	0.011999	0.011999
13	0.618076	0.027610	0.027610	38	0.618076	0.027610	0.027610
14	0.268598	0.011999	0.011999	39	0.618076	0.027610	0.027610
15	0.618076	0.027610	0.027610	40	0.618076	0.027610	0.027610
16	0.148688	0.006642	0.006642	41	0.045253	0.002022	0.002022
17	0.618076	0.027610	0.027610	42	0.315242	0.014082	0.014082
18	0.148688	0.006642	0.006642	43	0.618076	0.027610	0.027610
19	0.618076	0.027610	0.027610	44	0.148688	0.006642	0.006642
20	0.315242	0.014082	0.014082	45	0.618076	0.027610	0.027610
21	0.618076	0.027610	0.027610	45	0.268598	0.011999	0.011999
22	0.268598	0.011999	0.011999	47	0.148688	0.006642	0.006642
23	0.618076	0.027610	0.027610	48	0.618076	0.027610	0.027610
24	0.618076	0.027610	0.027610	49	0.148688	0.006642	0.006642
25	0.618076	0.027610	0.027610	50	0.315242	0.014082	0.014082

RAD, relative agreement degree; CDC, consensus degree coefficient.

(4), (5), and (7). For example, Table 5 illustrates the calculation results for question item 1. Considering the fuzzy opinions of all respondents, the aggregation result, following as Equation (8), $\widetilde{R} = (0.467452, 0.667452, 0.867048)$ for question item 1.

The same steps were conducted for other question items. Table 5 collects all aggregation results of every question item and their defuzzification for ranking results. Items 11 to 16, with defuzzification values over 0.7, were clustered as an

item group with significant changes.

4.2 Analysis to Append Expert Weights

For exploring the possibility of different results from individual conditions, this study set the relative weights with a variety of respondent identities. The analysis categories included their work experience, main managing business markets, and job titles. The given relative weights were set from 1 to the number of the investigated group. Table 5 shows that the greater the importance of the respondent group, the larger the setting weight. It was noted that the influence of the shipping lines industry occurred more for deep ocean services than for short sea markets because of growing ship sizes. The relative weights of businesses markets were set as larger as the scope of respondent management of the deep ocean. After a normalization process of the given weights, each respondent has a given relative weight of the importance (r_i) in carrying on the SAM operations.

As equation (6), every respondent's important degree (w_i) can be calculated. Further, let $\beta = 0.5$ express a neutral preference so that the required processes in SAM can be implemented. Table 6 shows the example for all indexes of the first question item that has been weighted by work experience for all respondents.

Table 7 shows the results using the same operation of SAM for three kinds

Table 5. Weight settings for different individual background

Analysis category	Group	Samples	Given weights	Sum of weights	Weights of normalization
Work experience	Below 5 years	7	1	21	0.0476
	6 to 10 years	9	2		0.0952
	11 to 15 years	3	3		0.1429
	16 to 20 years	8	4		0.1905
	21 to 25 years	14	5		0.2381
	Above 26 years	9	6		0.2857
Main business markets	Short sea	21	1	6	0.1667
	Deep ocean	20	3		0.5000
	Both in even	9	2		0.3333
Title	Top manager	10	5	15	0.3333
	Middle manager	18	4		0.2667
	OP/CS staff	15	3		0.2000
	Sales	4	2		0.1333
	Document staff	3	1		0.0667

Table 6. Calculated indexes with work experience for the 1st question item

Sample (i)	$A(E_i)$	RAD_i	w_i	CDC_i	Sample (i)	$A(E_i)$	RAD_i	w_i	CDC_i
1	0.618076	0.027610	0.026316	0.026963	26	0.618076	0.027610	0.010526	0.019068
2	0.618076	0.027610	0.026316	0.026963	27	0.618076	0.027610	0.015789	0.021700
3	0.618076	0.027610	0.026316	0.026963	28	0.268598	0.011999	0.026316	0.019157
4	0.618076	0.027610	0.031579	0.029595	29	0.618076	0.027610	0.005263	0.016437
5	0.268598	0.011999	0.031579	0.021789	30	0.618076	0.027610	0.015789	0.021700
6	0.618076	0.027610	0.026316	0.026963	31	0.268598	0.011999	0.005263	0.008631
7	0.618076	0.027610	0.026316	0.026963	32	0.315242	0.014082	0.010526	0.012304
8	0.315242	0.014082	0.026316	0.020199	33	0.618076	0.027610	0.026316	0.026963
9	0.268598	0.011999	0.026316	0.019157	34	0.268598	0.011999	0.005263	0.008631
10	0.618076	0.027610	0.026316	0.026963	35	0.618076	0.027610	0.010526	0.019068
11	0.618076	0.027610	0.021053	0.024331	36	0.148688	0.006642	0.010526	0.008584
12	0.148688	0.006642	0.026316	0.016479	37	0.268598	0.011999	0.021053	0.016526
13	0.618076	0.027610	0.021053	0.024331	38	0.618076	0.027610	0.015789	0.021700
14	0.268598	0.011999	0.021053	0.016526	39	0.618076	0.027610	0.005263	0.016437
15	0.618076	0.027610	0.026316	0.026963	40	0.618076	0.027610	0.005263	0.016437
16	0.148688	0.006642	0.026316	0.016479	41	0.045253	0.002022	0.031579	0.016800
17	0.618076	0.027610	0.031579	0.029595	42	0.315242	0.014082	0.031579	0.022831
18	0.148688	0.006642	0.031579	0.019111	43	0.618076	0.027610	0.031579	0.029595
19	0.618076	0.027610	0.026316	0.026963	44	0.148688	0.006642	0.010526	0.008584
20	0.315242	0.014082	0.021053	0.017567	45	0.618076	0.027610	0.031579	0.029595
21	0.618076	0.027610	0.031579	0.029595	45	0.268598	0.011999	0.010526	0.011262
22	0.268598	0.011999	0.021053	0.016526	47	0.148688	0.006642	0.021053	0.013847
23	0.618076	0.027610	0.021053	0.024331	48	0.618076	0.027610	0.010526	0.019068
24	0.618076	0.027610	0.005263	0.016437	49	0.148688	0.006642	0.010526	0.008584
25	0.618076	0.027610	0.010526	0.019068	50	0.315242	0.014082	0.005263	0.009673

RAD, relative agreement degree; CDC, consensus degree coefficient.

of weighted categories. The defuzzification figures slightly differ, but the ranks of the top seven and question items 4, 8, and 17 for the three types of weighting schemes are the same. For comparison with the result of setting $\beta = 0$ in Table 6, the sequence of the top three factors is presented differently. The weighting schemes for different individual background conditions of respondents slightly altered the evaluation results to obtain a more distinguished and reliable group consensus. After the industrial change of upstream, OFFs cared more about their rights

and obligations when damage claims occurred. The dynamics of operation details from the changes of carriers attracted OFFs more attention. Meanwhile, such enormous variation from upstream actually generated more significant pressure on the freight businesses to OFFs. This result might be why OFFs experienced no reduction in liaison burden with their cooperated CSLs.

4.3 Discussion

From the investigation summary, the variation of industrial structure among CSLs generated influences for OFFs. Several factors were ranked higher in the consensus, belonged to inner awareness, and were event-driven. The sudden broken-down announcement from the Hanjin Lines caused onboard containers detained on its ships because they were prohibited from sailing into harbors. Port administrators and operators worried this company could no longer pay off port tariffs and charges. Panicked shippers were confronted with a complex situation in which their cargo could not be delivered to fulfill the trade contract and could not perform redelivery by other shipping lines. There is only one solution that shippers can use to claim compensation for their consigned forwarders with this event. In the same situation, OFFs also play a role as shippers to carriers; their rights are also hampered by bankruptcy, which falls on freight forwarders. OFFs might have related knowledge on handling this situation, but they cannot do anything about it because they are inexperienced. Involuntarily, freight forwarders must pay greater attention to the rights and obligations regarding cargo damage claims as part of their processes. OFFs are often willing to avoid such things and wish never to have them happen again by reminding employees to observe the details of the operational dynamics of CSLs closely. Such experiences induce OFFs to care more about risk management than before.

The hidden factor of continuous growth of containership sizes puts more significant pressure on CSLs to maximize their capacity as cost-saving is measured as unit transportation for containers. These targets were also transferred to cooperating OFFs before the close date for each stop of mega-ship voyages. This pressure was also passed on from online forwarders of larger ships to off-line OFFs like a cascading effect, which led OFFs to uncertainty and hesitancy on ship slot control. Also, the changes of port call for routes because larger ships or strategical alliance deployment might result in the alternation of shippers' logistical chains and will exert OFFs pressure to rapidly respond to the changes of logistical decision making from shippers. OFFs might require rerouting seaborne and inland transports for shippers at those ports without mega-ship calls. Any additional charges in a new routing operation, such as truck fees and stevedoring charges, may appear different. A large scale of port rotation alternation and service network change because of cascading effects of mega-ships or the reshuffling of SAs, at the same time, might influence the freight rates that CSLs offered to OFFs.

Table 8. Comparison of defuzzification results between different weighting measures

Question item	Weighted by work experience					Weighted by business market					Weighted by job title				
	$\tilde{R}$ = (a, b, c)			Defuzzification	Rank	$\tilde{R}$ = (a, b, c)			Defuzzification	Rank	$\tilde{R}$ = (a, b, c)			Defuzzification	Rank
	a	b	c			a	b	c			a	b	c		
1	0.448989	0.648989	0.845629	0.648429	7	0.446647	0.646647	0.845322	0.646426	7	0.446086	0.646086	0.843636	0.645678	7
2	0.436884	0.635766	0.825442	0.634232	8	0.421550	0.619237	0.808346	0.617807	11	0.426044	0.624294	0.814525	0.622958	9
3	0.330201	0.530201	0.722462	0.528911	16	0.332026	0.532026	0.722210	0.530390	17	0.328655	0.528655	0.719401	0.527113	15
4	0.361047	0.558855	0.751834	0.558050	13	0.362245	0.559911	0.756958	0.559808	13	0.353818	0.551484	0.746284	0.551006	13
5	0.424344	0.623224	0.813943	0.621864	9	0.440758	0.638443	0.829192	0.637287	8	0.426151	0.624398	0.816832	0.623429	8
6	0.412863	0.611762	0.805426	0.610890	11	0.433117	0.630821	0.822481	0.629814	10	0.423567	0.621833	0.814054	0.620826	11
7	0.423020	0.621889	0.796375	0.617825	10	0.440527	0.638202	0.813799	0.634522	9	0.426201	0.624438	0.802282	0.621039	10
8	0.363439	0.562288	0.761560	0.562359	12	0.380376	0.578031	0.775582	0.578014	12	0.368016	0.566233	0.764346	0.566216	12
9	0.337648	0.529217	0.728005	0.530420	15	0.356613	0.551056	0.747526	0.551394	14	0.341164	0.533921	0.732076	0.534821	14
10	0.326243	0.525088	0.722813	0.524901	17	0.334641	0.532291	0.728751	0.532093	16	0.327056	0.525268	0.722852	0.525163	16
11	0.550216	0.750216	0.911409	0.743748	5	0.550583	0.750583	0.909689	0.743767	5	0.549459	0.749459	0.910812	0.743018	5
12	0.537461	0.737461	0.909646	0.732825	6	0.541739	0.741739	0.903872	0.735428	6	0.531065	0.731065	0.902748	0.726346	6
13	0.564071	0.764071	0.901942	0.753716	3	0.582197	0.782197	0.913799	0.770797	3	0.573489	0.773489	0.905653	0.762183	3
14	0.553827	0.753827	0.919623	0.748126	4	0.557549	0.757549	0.921400	0.751524	4	0.558954	0.758954	0.922805	0.752929	4
15	0.594548	0.794548	0.937778	0.785086	1	0.594790	0.794790	0.936560	0.785085	1	0.594790	0.794790	0.937122	0.785179	1
16	0.588041	0.788041	0.940094	0.780050	2	0.592059	0.792059	0.941144	0.783573	2	0.589250	0.789250	0.941706	0.781326	2
17	0.302881	0.502881	0.697505	0.501985	18	0.282455	0.482455	0.678445	0.481787	18	0.293691	0.493691	0.689119	0.492929	18
18	0.336403	0.534313	0.723568	0.532871	14	0.340268	0.536386	0.724547	0.535060	15	0.328470	0.524588	0.713873	0.523449	17

As information and communication technologies progressed, industrial restructure made carriers emphasize the use and development of modern information techniques, such as the appearance of blockchain technology. The cooperation among runners and other stakeholders or even transaction platform providers, such as Alibaba, let OFFs alter e-commerce applications' perception. This development is the channel through which OFFs can observe the detailed operation dynamics. In Taiwan, some OFFs even build up a transaction platform to enforce the integration capabilities of freight consolidation in advance. The function of e-commence has developed to maximization of logistics integration.

Noted that carrier services on transport reliability and quality did not worsen because of reduced CSLs or reshuffling SA members. The brand confidence of existing CSLs did not slack to OFFs. OFFs did not detect the consolidated operations becoming more complicated than before. However, OFFs were still required to keep intensive relationships with shipping lines. The connections to complement one another between OFFs and carriers were not changed.

Although the survey results contributed from the sampling to the 50 respondents of OFFs in Taiwan, recent rapid and considerable changes in the global supply chain support the robustness of the main findings summarized in this study. The recent case that a giant containership named 'EVER GIVEN' blocked the Suez Canal and resulted in the largest general average claim in global maritime history (https://theloadstar.com/). This event deepens global OFFs risk recognitions for their relationships with CSLs. The outbreak of the COVID-19 pandemic made a severe shortage of ship slots and empty containers because of worsened logistical speed and lengthened cycle time for load equipment of CSLs (https://home.kuehne-nagel.com/). Slot control and reservation became the best advantage of OFFs to attract their businesses despite shippers being aware of extraordinarily forwarding handlings.

Stakeholders in the container transportation chain launched the new digital logistics platform for providing customers with instant online cargo booking and tracking (https://container-news.com/). Such development puts forwarders or NOVCCs a heavy erodent pressure on their businesses. Global logistical integrators vigorously appeal to customers to use their networks for a suitable choice of transportation alternatives with lower risk (https://home.kuehne-nagel.com/). This tendency also expresses the importance of e-commerce platforms for OFFs in future operations.

Although the phenomena above are accompanied by special events occurring, the significant relationships with the structural variation of the CSL industry are apparent. However, transport reliability and quality in ocean container deliveries almost collapsed because of the unstoppable COVID-19 pandemic. Port congestion stalling the regular cycle times of ships and containers induced the extraordinary soaring of freight rates (https://www.lloydsloadinglist.com/). These event-driven influences are unexpected after the structural variation of the CSL industry.

5. Conclusion and Suggestion

Driven by the progress of growing containership sizes, the whole industry of CSLs has confronted a grim challenge during this last decade. The degree of industrial centralization gradually increased, while some CSLs with unhealthy financial status withdrew, more mergers and acquisitions occurred, and global SAs reorganized again. This study explored the influence of OFFs, the vital partners of CSLs, and the enormous variation of industrial structure and environment among CSLs. For clarifying the key factors that influence OFFs' operation and management and crucial concerns in their decisions, this study has proposed 18 question items based on a literature review and in-depth expert interviews. Questionnaires with seven rating levels for recognition agreement were distributed to 50 experts who served in various OFF companies.

The investigation results revealed that most question items approached at an agreed level. The analysis results of SAM, based on fuzzy operation techniques, ensure that the experience of facing a sudden bankruptcy of a shipping line increased OFFs awareness on the rights and obligations for freight damage claims. OFFs enforced risk management, in particular, to track the operation dynamics of shipping lines. The event of 'EVER GIVEN' has sufficiently reflected the same worries from OFFs and shippers as found in this study.

Among all ordinary operation practices, OFFs felt the competitive pressure of freight consignment. Quotations of freight rates from shipping lines seem to be more changed than before. Fast cooperation steps between shipping lines and transaction platform providers resulted in the changes of OFFs' perception towards e-commerce. The alternation of port calls on service routes made OFFs quickly respond to shippers' logistical requirements changes. However, shipment consolidation seems not to have become more complicated than before. The service qualities, brand confidence, transport reliabilities, and cooperated relationships with CSLs did not worsen for OFFs, although the number of CSLs decreased.

This study investigated and understood how industrial restructuring consequences from CSLs affected OFFs along the container shipping chain. OFFs can keep attention on the risk management to prevent another wave just in another case. Any stakeholder should be reluctant to be seriously affected because of the ripper from other industries. The industry of CSLs can also learn the concerned scruples affected OFFs from this study. If the whole society of CSLs would like to take the responsibility to avoid the extensive effects of industrial restructures to the downstream stakeholders, this study provides a valuable reference for the OFFs' recognition.

These changes among CSLs also bring alternation to other partners, such as port operators and inland transportation partners, which can be further studied. The severe outbreak of Covid-19 at the beginning of 2020 brings another unprecedented influence on the global transportation industry. From the findings of this

study, OFFs might be ready to confront the effects of an extraordinary impact on CSLs. OFFs might temporarily enjoy a short-term benefit because of increasing freight rates, while CSLs temporarily encounter considerable decreases in transportation demand. The influence and effect of pandemics spreading towards CSLs, OFFs, and other stakeholders along shipping value chains should be an inevitable and timely topic for further study.

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