EVALUATING KEY RISK FACTORS AFFECTING CARGO DAMAGES ON EXPORT OPERATIONS FOR CONTAINER CARRIERS IN TAIWAN

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SUMMARY

The main purpose of this article is to apply the Analytic Hierarchy Process (AHP) method to analyse key risk factors affecting cargo damages on export operations for container shipping carriers in Taiwan. Based on the literature and experts' opinions, a hierarchical structure with three risk aspects and eleven risk factors was constructed. We then applied the AHP procedure and AHP experts' questionnaires to evaluate the key risk factors. The empirical results showed that: (1) 'Shipping proxy phase' is the most important aspect affecting cargo damages on export operations for container shipping carriers in Taiwan. (2) In order of relative importance, the top four key risk factors are "shipper's concealed items have not been reported," "inappropriate cargo packaging," "insecure fixation between the container and ship deck," and "error in printed documents." Furthermore, some recommendations concerning effective risk management strategies and advices are provided for container shipping carriers.

1. INTRODUCTION

Maritime shipping businesses are mainly divided into liner and tramp shipping service. Among liner shipping service (Meng et al., 2015), the design of container packaging unitization benefits enhancement of transportation and loading efficiency; allowing intermodal facilities transfer of transportation models. This reduces shipping time, packaging costs and the rate of cargo damage and loss by theft while increasing port usage rate or reduce ship idle time at ports. After the explosion of container shipping in the 1960's, container shipping service has developed into the main operation model of liner shipping market.

Since container shipping carriers are often characterized by high prices, large variety of types, different forms of packaging, high global shipping volume, they face different risks and threats that may impact their export operations (Akyuz, 2017; Chang et al., 2015; Tseng et al., 2015). Examples like error in loading, damaged packaging, incomplete document declarations etc., can result in unsuccessful loading of cargo or even customs fines, cargo release dispute, delay in cargo delivery etc. The occurrence of many risky incidents include generate hidden costs that cannot be compensated from insurance alone (e.g. damage to reputation, loss of cargo source, loss of management time, additional processing work for employees, increase of costs or losses for employee training, agreement violations, fines and other legal costs etc) (Kristiansen, 2013). In addition, the incidence occurrence rate and the degree of loss are high for maritime transportation than any other form of transport. If an accident occurs out at sea (Pedersen, 2010; Hsu and Kao, 2017), the maritime transportation business shall face innumerable financial losses, sometimes severely affecting the business management and future development.

As the maritime transportation becomes increasingly competitive in the world, proper risk management (Kristiansen, 2013) is ever so important for container shipping carriers in order to maintain their business operations. Container shipping carriers are required to pay close attention to every operation phase. If an error, loss or defect occurs, container shipping carriers experience other additional costs. The enlargement of container ships has become a trend in maritime transportation (Tran and Haasis, 2015). The more cargo on a container ship, the higher the loss and hence the higher the compensation (Drewry, 2016). Furthermore, in the intensely competitive container shipping market, what risks of export operations do liner shipping carriers face? What are the key risk factors involved? Hence, under the global trend of container ship enlargement, operation risk management is a research topic worthy of in-depth study for container shipping carriers.

Taiwan's geographic environment is that of an island. Due to a lack of natural resources, Taiwan has gradually developed an export based economy (Tseng et al., 2015), which is used to ship export items around the globe. Thus, container shipping service plays a vital role in Taiwan's economic development, a nation that focuses mainly on international trade. This study chiefly seeks to evaluate key risk factors affecting cargo damages for container carriers engaging in export shipping operations. Experience showed that an evaluation of key risk factors, which involves a multiple criteria problem, is not an easy task. The issue of evaluating key risk factors faces how to evaluate the relative weights of the various risk factors; however, the relative weights based upon this evaluation in which information is subjective, e.g., phrase of 'much more important than' or 'weak importance.' The Analytic Hierarchy Process (AHP) method (Saaty, 1980) is a suitable approach to tackle this multiple criteria problem. Hence, in order to evaluate the key risk factors affecting cargo damages on export operations, this research plans to employ the AHP method (Chou and Ding, 2016; Hsu and Kao, 2017) to evaluate the relative weights of the various risk factors in this paper.

In summary, the main purpose of this study is to apply the AHP method to analyse key risk factors affecting cargo damages on export operations for Taiwan's container shipping carriers. This study initially will conduct a review of possible cargo damage risk factors of different operation phases. Followed by confirmation of key cargo damage factors for container shipping carriers through AHP, in order to focus on the management of said factors for shipping carriers. Lastly, this study will propose a set of strategies as basis for executable risk management strategies and recommendations. The rest of this article is organized as follows: The second section presents the preliminary risk factors affecting cargo damages on export operations, and the third section describes the AHP method. The fourth section performs an empirical study, and the final section presents the study's conclusions.

2. PRELIMINARY RISK FACTORS

The important step of risk management is to identify the preliminary risk factors associated with cargo damages on expert operations for container carrier in this paper. Main risk identification methods include the financial statement analysis, surveys, flow charts, past event experience, onsite investigation, agreement content (such as investigation of insurance policies) etc. The process flow chart of expert operations for container shipping carrier was examined in this study. This study divided export operations into 3 phases and combined with interviews of five experts, each with more than 20 years of experience in export operations. Finally, this study classified the risks faced by container shipping carriers in the practical export operations under three risk aspects of "shipping proxy phase," "loading and transport phase," and "destination port service phase." The characteristics of these risk aspects and 11 risk factors are explained as follows; and their codes are shown in parentheses.

2.1 SHIPPING PROXY PHASE

The first risk aspect is the "shipping proxy phase (R_1)" (Chang et al., 2015; Ellis, 2011; Hsu et al., 2009; Husdal and Bråthen, 2010; Kung, 2007; Wang et al., 2014; Wu, 2015; Yen and Chen, 2004; field interview with experts). The consignor approaches the container shipping carrier to negotiate date and shipping conditions as well as sign the shipping order (S/O) which is used in the container yard to receive withdraw an empty container. This risk aspect includes four risk factors, that is, "shipper's concealed items have not been reported (R_{11})," "error in printed documents (R_{12})," "inappropriate cargo packaging (R_{13})," and "container corrosion holes (R_{14})," respectively.

- *Shipper's concealed items have not been reported*. The consigner might submit false custom declarations on the cargo's item, weight, or properties (e.g.: dangerous cargo declared as normal cargo) in order to avoid inspection; acquire lower shipping or insurance rates. This is especially apparent when the loading of the container is done by the cargo owner. The container shipping carrier has no way of knowing whether the actual contents of the container are suitable for safe loading, transportation or storage. This puts the ship and relevant employees in an uneasy situation during the transportation period. If an incident occurs, the ship and the safety of its personnel are in jeopardy as well as huge economic losses. Thus container shipping carriers should first communicate with the consigner and strictly demand honest declaration cargo according to regulations, as well as promote awareness of dangerous cargo related conventions and regulations. The enhancement of the consignor's knowledge of dangerous cargo will contribute to international transport safety will ensuring the rights of the cargo owner.
- *Error in printed documents*. As more and more countries tighten trade document requirements, the job content of maritime documents and procedure flow has increased as well. Clients now also have higher demands for document validity and accuracy. The validity time pressure may induce errors on the documents. If an error is found and not reported to customs within the validity time period, some countries might even implement heavy fines (such as Manila North port in Philippines). Any small errors within the documents would result in mistakes of following procedures, such as wrong destination, and resulting in a delay of cargo. This will bring the container shipping carrier additional costs. Evidently, the correctness of the documents is an important factor of risk management for container shipping carriers.
- *Inappropriate cargo packaging*. The purpose of packaging is to prevent cargo damage from external collision and pressure and to ensure the completeness of the cargo's weight and quantity when loading, transporting or storing. The degree of cargo damage closes correlates to the packaging quality and in turn affects the safety of transport. This is especially apparent in container transportation where consignors get the misconception that the protection from the container allows for light cargo packaging. Cargo owners need to consider the stacking, movement, shaking and other involved when undergoing packaging the cargo, so as to withstand different forms of external variables.
- *Container corrosion holes*. The condition, completeness and eligibility of the shipment directly affect the safety of cargo transport. Studies show that holes within the container is the highest risk factor for incidents. In the process of transportation, damaged containers often result in the infiltration of rain, sea water and water vapour, etc. and dampening the cargo. To minimize cargo damage caused by container rust holes, container shipping carriers

should the container yard properly inspect containers before they are given to cargo owners. Additionally, container shipping carrier should also remind consignors the need to examine the condition of the containers and ask lorry drivers to sign containers with caution.

2.2 LOADING AND TRANSPORT PHASE

The second risk aspect is the "loading and transport phase (R_2)" (Chang, 2011; Hsu, 2010; Husdal and Bråthen, 2010; Li and Tsan, 2010; Snowdon, 2014; Ueng, 2012; Vilko and Hallikas, 2012; Wu, 2015; field interview with experts). The container is loaded onto the ship, transported to the destination and discharged. This risk aspect includes four risk factors, that is, "insufficient cargo space resulting in over-extended shipping time (R_{21})," "insecure fixation between the container and ship deck (R_{22})," "refrigeration compressor malfunction (R_{23})," and "ship crew error (R_{24})," respectively.

- *Insufficient cargo space resulting in over-extended shipping time*. Since cargo space cannot be saved, when a ship leaves the port, the cargo space of the given voyage cannot be saved for the use of the following voyage. Leftover cargo slots result in a loss for the container shipping carrier. Thus container shipping carrier will oversell cargo space to allow more efficient distribution and usage; hence higher expected profits. If oversell leads to insufficient cargo space, certain containers are shut out to meet the maximum capacity limits. When a consignor's demand for cargo space exceeds supply, the consignor might face delayed shipment due to not having enough cargo space even after receiving a signed S/O from the container shipping carrier. Thus the oversell of cargo space results in insufficient cargo space and delayed shipping, which generates risks of prolonged cargo delivery and may even cause cargo damage.
- *Insecure fixation between the container and ship deck*. Studies indicate: among the reasons for incident occurrence in loading containers onto the deck, inappropriate container fixation is the main factor for containers falling into the sea. Thus confirmation on fixation apparatus should be done before the ship leaves the port. The falling of containers into the sea from insecure fixation not only results in cargo damage compensation, but also severly threatens the ship and the safety of its crew. As enlargement of ships become a trend, the amount of containers on a ship has increased and effective management of containers loading on to the deck is of vital importance for container shipping carrier enterprises.
- *Refrigeration compressor malfunction*. As our living quality rises and living style changes, the demand for chilled and frozen ingredients has gradually increased, which has contributed to the emphasis on the quality of temperature sensitive ingredients. Since refrigeration containers are mainly used to store high economic value, yet easy to decay cargo; an incident due to inadequate temperature control will often result in contamination of all the items within the container and the responsibilities of the delivery personnel is higher in comparison. Studies indicate that loss of temperature control is the most severe failure mode for a refrigeration container. If the functions refrigeration container compressor fails, the temperature inside the refrigeration container will be different to that of the cargo owner, hence causing a great damage to the cargo. Thus cold chain logistics have to properly maintain the temperature within the refrigeration container as well as relevant conditions of thermostatic safe delivery.
- *Ship crew error*. In order to effectively reduce shipwrecks, the maritime transport industry has focused on the improvement of hardware and technologies. However, there is no obvious reduction of shipwreck occurrences. As for the reason, human factors are the most direct causes for shipwrecks. Container shipping carriers need to establish a proper safety management system that is to be implemented in ship management in order to avoid accidents out at sea, damage to ships, loss of cargo and human lives.

2.3 DESTINATION PORT SERVICE PHASE

The third risk aspect is the "destination port service phase (R_3)" (Husdal and Bråthen, 2010; Liao and Chang; 2004; Lin et al., 2002; Schoenherr et al., 2008; Tseng et al., 2015; Tummala and Schoenherr, 2011; Yang et al., 2010; field interview with experts). The process of the owner retrieving the cargo after the container has been discharged. This risk aspect includes three risk factors, that is, "foreign agency errors and omissions (R_{31})," "cargo owners not retrieving their cargo (R_{32})," and "commercial fraud (R_{33})," respectively.

- *Foreign agency errors and omissions*. The expansion of foreign businesses and provision of services for container shipping carriers, are generally executed by a shipping agency that is familiar with local laws & regulations and maritime transport businesses. If oversea agents are not familiar with local laws & regulations, resulting in the cargo owners not being able to retrieve their cargo at designated ports, cargo may be damaged or lost. Container shipping carriers should carry out regular evaluations. If major flaws appear in evaluation results or daily operations, or if the container shipping carriers cooperate with unreliable agents, container shipping carriers can consider changing agents.
- *Cargo owners not retrieving their cargo*. After the 2008 financial crisis, international trade took a devastating blow. The economy spiraled downwards with many cargo owners going into debt, resulting in

daily increase of the number of unclaimed cargo at the ports. These ship containers are kept on long term idle and are unable to be used in transportation cycle. This generates risks in the form of large sums of delay costs, storage costs, electricity costs and maintenance costs. Even though container shipping carriers can organize auctions to sell cargo that has not been retrieved as compensation for generated costs and interest burdens, more often than not, the expenses generated from idle container cargos is higher than the value of the cargo itself. The delivery personnel are then listed by local courts as the defendant and demands payment of related costs. When accepting items for transportation, cargo loading offices must take into consideration the cargo owner's background, business reputation and credit, etc.

- *Commercial fraud*. Since international trade faces many changes, business fraud has become common. Common forms of fraud include the cargo recipient opening shipping containers and claiming the contents do not match the bill of lading (B/L). Another form of fraud includes the recipient working with third parties to withdraw cargo with fake B/L then coming in a second time demanding the cargo which they have already withdrawn. Business units should be aware of countries and governments that encourage export, where tax return frauds occur in fake export. In addition, container shipping carriers should strictly execute by standard operation procedures in dealing with the issuing of B/L, cargo withdraw and B/L acceptance.

3. AHP METHOD

The analytic hierarchy process (AHP) model proposed by Saaty (1980) is used to evaluate the relative weights of key risk factors affecting cargo damages on export operations for container shipping carriers in this article. The steps (Liao et al., 2016) involved in this method can be briefly summarized as follows:

Step 1: Construction of the evaluation aspects and risk factors.
Step 2: Establishment of pair-wise comparison matrices for all evaluation aspects and risk factors.
Step 3: Consistency testing.
Step 4: Computation of the weights of all evaluation aspects and risk factors.
Step 5: Calculation of integrated weights for each risk factor.

3.1 CONSTRUCTING EVALUATION ASPECTS AND RISK FACTORS

The construction of evaluation aspects and risk factors affecting cargo damages on export operations for container shipping carriers is the most important part of this article. Three evaluation aspects and 11 risk factors are described in Section 2. The AHP method employs an assessment system with a hierarchical structure to evaluate the research issues. The hierarchical framework diagram shown in Figure 1.

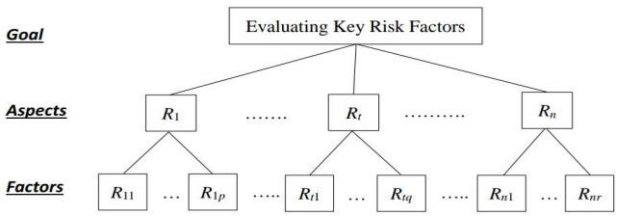

Figure 1. Hierarchical structure

3.2 ESTABLISHING PAIR-WISE COMPARISON MATRICES FOR ALL EVALUATION ASPECTS AND RISK FACTORS

The fundamental scales of AHP method, shown in Table 1, are employed to evaluate the relative importance for all evaluation aspects and risk factors; then the pair-wise comparison matrices are established.

Table1. The fundamental scales of AHP method

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favour one activity over another
5	Essential or strong importance	Experience and judgment strongly favour one activity over another
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance can be demonstrated in practice
9	Absolute importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between adjacent scale values	When compromise is needed

Source: Saaty (1980)

Assume that there are h experts ($E_1, \ldots, E_k, \ldots, E_h$) in a committee. These experts are responsible for evaluating relative importance of n evaluation aspects ($R_1, \ldots, R_t, \ldots, R_n$) and relative importance of $p, \ldots, q, \ldots, r$ risk factors ($R_{11}, \ldots, R_{1p}, \cdots, R_{t1}, \ldots, R_{tq}, \cdots, R_{n1}, \ldots, R_{nr}$) under each evaluation aspect (R_t, $t = 1, 2, \ldots, n$).

Letting a_{ts}^k, $k = 1, 2, \ldots, h$, $\forall t$, $s = 1, 2, \ldots, n$, is relative importance of evaluation aspect R_t to R_s given by expert E_k. The pair-wise comparison matrix A^k of relative importance of evaluation aspects R_t and R_s given by expert E_k can be constructed as follows:

$$A^k = [a_{ts}^k]_{n \times n} \tag{1}$$

where $a_{ts}^k = 1$, $\forall t = s$; and $a_{ts}^k = 1/a_{st}^k$, $\forall t \neq s$.

Using same process, pair-wise comparison matrices of relative importance of $p, \ldots, q, \ldots, r$ risk factors ($R_{11}, \ldots, R_{1p}, \cdots, R_{t1}, \ldots, R_{tq}, \cdots, R_{n1}, \ldots, R_{nr}$) under each evaluation aspect (R_t, $t = 1, 2, \ldots, n$) given by expert E_k can be constructed.

3.3 CONSISTENCY TESTING

Consistency testing is an important element of the AHP method, and can be performed using the consistency ratio (*C.R.*), which is defined as:

$$C.R. = \frac{C.I.}{R.I.} \tag{2}$$

where *C.I.* and *R.I.* denote the consistency index and random index. And

$$C.I. = \frac{\lambda_{\max}^k - n}{n - 1} \tag{3}$$

where n is the number of evaluation aspects compared, and $\lambda_{\max}^k$ is the eigenvalue of pair-wise comparison matrix $A^k = [a_{ts}^k]_{n \times n}$.

Herein, $\lambda_{\max}^k$ is calculated by the following steps:

(1) Calculate the weight w_t^k of evaluation aspect R_t.

$$w_t^k = \left(\prod_{s=1}^{n} a_{ts}^k \right)^{1/n} \Bigg/ \sum_{t=1}^{n} \left(\prod_{s=1}^{n} a_{ts}^k \right)^{1/n}, \quad t = 1, 2, \ldots, n; \; k = 1, 2, \ldots, h. \tag{4}$$

(2) Calculate the eigenvalue $\lambda_{\max}^k$ of pair-wise comparison matrix $A^k = [a_{ts}^k]_{n \times n}$.

$$w_t^k = \left(\frac{1}{n} \right) \left(\sum_{t=1}^{n} \left(\sum_{s=1}^{n} a_{ts}^k w_s^k / w_t^k \right) \right) \tag{5}$$

The *R.I.* value can be obtained from Table 2. When the *C.R.* value is less than or equal to 0.1, the consistency test is successful (Saaty 1980).

Table 2. Random index

n	1	2	3	4	5	6	7
R.I.	0.00	0.00	0.58	0.90	1.12	1.24	1.32

Source: Saaty (1980)

3.4 COMPUTATING THE WEIGHTS OF ALL EVALUATION ASPECTS AND RISK FACTORS

Let there are $l \leq h$ experts whose evaluation results pass the consistency test. Let b_{ts}^r, $r = 1, 2, \ldots, l$; $\forall t$, $s = 1, 2, \ldots, n$, be the relative importance of evaluation aspect R_t to R_s given by expert E_r. The pair-wise comparison matrix B of the relative importance of all evaluation aspects given by all q experts can now be constructed as follows:

$$B = [b_{ts}]_{n \times n} \tag{6}$$

where $b_{ts} = \left(\prod_{r=1}^{l} b_{ts}^r \right)^{1/l}$, if $t < s$; $b_{ts} = 1$, $\forall t = s$; $b_{st} = 1/b_{ts}$, $\forall t \neq s$.

Let $w = (w_1, w_2, \ldots, w_t, \ldots, w_n)$ be the eigenvecter of the pair-wise comparison matrix $B = [b_{ts}]_{n \times n}$, Then, the weight w_t of evaluation aspect R_t can obtain by

$$w_t = \left(\prod_{s=1}^{n} b_{ts} \right)^{1/n} \Bigg/ \sum_{t=1}^{n} \left(\prod_{s=1}^{n} b_{ts} \right)^{1/n}, \quad t = 1, 2, \ldots, n. \tag{7}$$

Using same process, the pair-wise comparison matrices of relative importance between $p, \ldots, q, \ldots, r$ risk factors ($R_{11}, \ldots, R_{1p}, \cdots, R_{t1}, \ldots, R_{tq}, \cdots, R_{n1}, \ldots, R_{nr}$) under each evaluation aspect (R_t, $t = 1, 2, \ldots, n$) given by all l experts whose evaluation results pass the consistency testing can be constructed. Then, the weights of all risk factors can be obtained using the similar steps.

3.5 CALCULATING INTEGRATED WEIGHTS FOR EACH RISK FACTOR

Let w_t, $t = 1, 2, \ldots, n$, be the weight of evaluation aspect R_t. Let w_u, $\forall = 1, \ldots, p; \cdots; \forall = 1, \ldots, q; \cdots; \forall = 1, \ldots, r$, be the weight of $p, \ldots, q, \ldots, r$ risk factor. The integrated weights of each $p, \ldots, q, \ldots, r$ risk factor can be denoted as

$$p_u = w_t \times w_u, \ t = 1, 2, \ldots, n. \quad \forall u = 1, \ldots, p; \cdots; \ \forall u = 1, \ldots, q; \cdots; \ \forall u = 1, \ldots, r. \tag{8}$$

4. EMPIRICAL STUDY

In this section, an empirical study evaluating key risk factors affecting cargo damages on export operations for container shipping carriers in Taiwan is conducted as follows.

4.1 DATA COLLECTION AND RESULTS

An AHP questionnaire with three evaluation aspects and 11 risk factors was used to compile the pair-wise comparison matrices for all evaluation aspects and risk factors in this article. To check whether the expressions were clear or important questions were missed, five shipping experts and scholars were invited to pre-test this AHP questionnaire. Finally, two rounds of correction based on the AHP questionnaire design principles were carefully performed, and the final AHP questionnaire was completed.

The survey performed in this article sought to evaluate relative importance of risk factors affecting cargo damages on export operations for container shipping carriers in Taiwan. The questionnaires were distributed during a three-month period, and many container shipping industry personnel were invited to fill in the AHP questionnaires. The surveys were completed through e-mails, phone calls, and in-person interviews conducted by the authors. The returned questionnaires were checked to determine whether the *C.I.* value of each matrix of each layer was less than or equal to 0.1 (Saaty, 1980). When the *C.I.* value of a matrix is higher than 0.1, this implies that the respondent had made an inconsistent pair-wise comparison of two evaluation aspects (or risk factors). To prevent the occurrence of errors, the authors helped such respondents to correct their judgments until the *C.I.* value of each matrix was less than or equal to 0.1. A total of 33 questionnaires were issued, of which 25 were recovered for validity, for a valid recovered rate of 80.65%. In addition, the demographic data gathered through the AHP questionnaire indicated that 56% had worked at stevedoring industry for more than 16 years, and most of them were top level managers and middle level managers. Those valid recovered questionnaires should therefore be sufficient to provide a representative range of views; as a result, those numbers of valid responses were deemed acceptable (Robbins, 1994).

After encoding the valid recovered questionnaires and combining the experts' views, this survey used the AHP procedures described in Section 3 to derive relative weights at each layer, which enabled us to rank the evaluation aspects and risk factors in terms of relative importance (see Table 3).

The findings are summarized as follows:

1. 'Shipping proxy phase' ranked 1, was the most important evaluation aspect for evaluating cargo damages on export operations for container shipping carriers in Taiwan. 'Loading and transport phase,' was ranked in second, while 'destination port service phase' was last.
2. In the 'shipping proxy phase' aspect, the "shipper's concealed items have not been reported" factor was the most important in terms of normalized weight. In the 'loading and transport phase' aspect, "insecure fixation between the container and ship deck" was the most important risk factor. In the 'destination port service phase' aspect, "foreign agency errors and omissions" was the most important risk factor.
3. The top four key risk factors by integrated weights are (1) "shipper's concealed items have not been reported," (2) "inappropriate cargo packaging," (3) "insecure fixation between the container and ship deck," and (4) "error in printed documents." The weights of these for key critical factors are all above 9%, and the sum of four weights is 51.99% (about 1/2).

Table 3. The weights for all evaluation aspects and risk factors

Evaluation aspects	Normalized / Integrated weight (A)	Risk factors	Normalized weight (B)	Integrated weight (C)=(A)*(B)
R_1: Shipping proxy phase	0.506 (1)	R_{11}: Shipper's concealed items have not been reported	0.486 (1)	0.2459 (1)
		R_{12}: Error in printed documents	0.178 (3)	0.0901 (4)
		R_{13}: Inappropriate cargo packaging	0.182 (2)	0.0921 (2)
		R_{14}: Container corrosion holes	0.154 (4)	0.0779 (7)
R_2: Loading and transport phase	0.279 (2)	R_{21}: Insufficient cargo space resulting in over-extended shipping time	0.222 (3)	0.0619 (9)
		R_{22}: Insecure fixation between the container and ship deck	0.329 (1)	0.0918 (3)
		R_{23}: Refrigeration compressor malfunction	0.311 (2)	0.0868 (6)
		R_{24}: Ship crew error	0.138 (4)	0.0385 (11)
R_3: Destination port service phase	0.215 (3)	R_{31}: Foreign agency errors and omissions	0.405 (1)	0.0870 (5)
		R_{32}: Cargo owners not retrieving their cargo	0.271 (3)	0.0583 (10)
		R_{33}: Commercial fraud	0.324 (2)	0.0697 (8)

Remark: Numbers in parentheses are ranks.

4.2 DISCUSSIONS OF THE MITIGATION OF RISK FACTORS

The study deems it necessary to propose a series of effective concrete controls for potential risks in maritime business operations. It can then be used by container shipping carriers as reference in reducing risks in export operations and enhancing its safety. Thus, this research conducts interviews with experts to propose risk management strategies and advices for the following 4 key risk factors.

4.2(a) Shipper's concealed items have not been reported

If the subject thinks the consignor is involved in false declarations of cargo items, it will result in the container shipping carrier being unable to appropriately operate the loading procedure and will become an important risk. Thus the following 5 strategies (Bao, 2007; Cheng, 2012; Ellis, 2011; Hsieh, 2011; field interview with experts) are provided as reference.

(1) *Demand the consignor to undergo declaration according to regulations*. To avoid false declarations, container shipping carriers should communicate with the cargo owner before hand during the cargo space booking procedure and demand strict declaration according to regulations.
(2) *Client credit investigation*. Consideration needs to be made on the consignor's business reputation, especially for first-time clients. Sales representatives should conduct credit investigations and for large amounts of cargo, onsite visits should be conducted to prevent false declaration from occurring.
(3) *Establish a consignor credit database and cargo damage and loss record system*. Container shipment carriers should properly execute client control and establish a safety standard operation procedure in accepting cargo from low integrity blacklisted clients.
(4) *Evaluate whether the cargo provided by the consignor could be dangerous cargo based on the name of contents and its packaging*. When encountering cargo with suspicious name, property or nature, a cautious attitude should be adopted and when necessary, ask the consignor to provide relevant references such as Material Safety Data Sheet or Material Component Analysis Sheet.
(5) *Hold regular training*. Enhance the training of relevant business personnel, hold regular training and use case studies to elevate the awareness and adopt countermeasures.

4.2(b) Inappropriate cargo packaging

The purpose of packaging is to prevent damage and infiltration in the transportation, loading and storage processes. It can result in a loss of cargo or damage the safety of personnel and cargo. Thus the following 2 strategies (Kung, 2007; Tseng et al., 2015; field interview with experts) are provided as reference.

(1) *Emphasize on the importance of secure packaging*. The practical reason for poor packaging from the consignor is to save costs and choose to use packaging that does not meet the transport standards. Thus sales representatives should educate consignors on the importance of packaging in the transportation process when accepting cargo. Emphasis should be made on the inability of compensation if the cargo is to suffer damage due to improper packaging. If the delivery personnel gets injured in the process, the consignor is also responsible for their injuries.
(2) *Execute proper packaging using professional packaging technology*. Advise the cargo owner to choose professional packaging technology from packaging companies and listen to the recommendations from professionals or give consignors packaging instructions to prevent cargo damage and ensure safe transportation.

4.2(c) Insecure fixation between the container and ship deck

Shipping containers are a standard form of transportation method. Its placement on the ship deck means fixation problems can cause damage to the cargo and in severe cases; even threaten the safety of the boat and its personnel. Inappropriate securing means containers will fall to the sea. Thus the following 2 strategies (Chang, 2011; Ueng, 2012; field interview with experts) are provided as reference.

(1) *Appropriately follow the container securing manual*. To lower the loss from improper securing of the container, the monitoring of securing personal and the actual securing process should comply with the regulations of different types of container securing manuals.
(2) *Enhance in-service training*. Use the updated cargo securing safety information to enhance the training of relevant personnel so that they understand the importance and potential danger of container and cargo securing. Make sure safety standard operating procedures are implemented to prevent operational error.

4.2(d) Error in printed documents

The correctness of the documents is an important risk management factor Thus the following 4 strategies (Chang et al., 2015; Yang, 2011; Wu, 2015; field interview with experts) are provided as reference.

(1) *Properly implement operation procedures and increase system familiarity*. In facing the risk of human typing errors, the document personal should follow standard operation procedures and enhance their familiarity with the operating system and

clearly check documentation content to reduce the occurrence of human errors.

(2) *Establish contrasting information systems*. Establish a contrasting information system and optimize operations with supplementary documents of the information system. B/L inspection measures should be implemented and reminders provided when there is an error in data input, in order to reduce errors and ensure the correctness of the data.

(3) *Educate the consignor on the necessity of immediate inspection of all issued documents*. Container shipping carriers should educate cargo owners on inspection of the correctness of the content within the documents issued in order to prevent loss from errors in document production.

(4) *Hold regular educational training*. In order for document personnel to properly understand the demands of the consignor in processing the appropriate documents, regular educational training should be held. Equip documentation personnel with basic knowledge in international trade and cargo transportation procedures. Case studies can be implemented into the training to analyse the reason for error, engage in damage control and prevent mistakes from happening again. The goal is to enhance operation quality and the occupation and risk awareness of document personnel.

5. CONCLUSIONS

Container shipping carriers are important logistic service providers for international logistics chain and thus need to be aware of whether export operations are smooth. If an error or defect occurs, extra costs fees are generated for the cargo and personal. In addition, proper risk management for import and export operations is an important issue that container shipping carriers must address. As Taiwan is an economic body that mainly relies on export, this research focuses on the cargo damage risks of container shipping carriers of the Taiwanese region aiming to provide export operation risk management references.

At first, a total of three evaluation aspects with eleven preliminary risk factors are generated from literature and experts interviews. With regards to evaluate key risk factors, an empirical study using the AHP method has been performed. The results show that: The top four key risk factors affecting cargo damages on export operations for container carriers are (1) “shipper’s concealed items have not been reported,” (2) “inappropriate cargo packaging,” (3) “insecure fixation between the container and ship deck,” and (4) “error in printed documents,” respectively.

Lastly, the majority of the key risk factors are concerned with the expertise and familiarity with operations of the personnel. Thus relevant resources should be invested in the internal training of container shipping carriers (including orientation training and in-service training), to prevent the increase of cargo damage risks. In addition, this research only analyses the key risk factors, without focusing on aforementioned evaluation of risk management strategies. This study recommends future container shipping carriers to review the plausibility of every risk management strategy to as to allow the company to properly implement effective risk management strategies.

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