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An evaluation of operational risks for general cargo ship operators

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ABSTRACT

As general cargo ships (GCSs) hold certain advantages over more mainstream shipping services, GCSs have a considerable degree of importance in the shipping market. This paper focuses on the use of risk evaluation procedures to perform empirical analysis of the operational risk faced by GCS operators, which is a subject that has garnered relatively little academic attention. After identifying risk factors, four risk aspects and 16 operational risk factors are determined and used to construct an Analytic Hierarchy Process (AHP)-based risk matrix evaluation model. An expert questionnaire addressing both subjective and objective facets is then used to perform evaluation of the model, enabling conversion of the relative weights to risk scales. Lastly, the determination of each risk factor's risk areas allows the proposal of risk management strategies. The results indicate that four of the risk factors are in the high risk area; these consisted of the loading stage factor "delays at port of loading," the laden voyage stage factor "poor stowage and securing," the laden voyage stage factor "perils of the sea," and the discharging stage factor "delays at port of discharge." This paper also proposes risk management strategies on the basis of the experts' recommendations, and its findings can provide shipowners and charterers with a reference for the drafting of risk clauses when entering into a charter party.

1. Introduction

Ship operation is a specialized and complex business. Ship operations are subject to the regulations and conventions established by the flag state government and the International Maritime Organization (IMO). Moreover, the responsibility for the operation and management of each ship and the safety of the ship's operation rests with the shipowner or other organizations and personnel entrusted by the shipowner responsible for ship operation and management. Therefore, good risk management regarding ship operation is an essential factor in ensuring the implementation of loss prevention. Furthermore, how to reduce the risk of ship operation to ensure a company's profitability is the operator's concern. Additionally, to facilitate the risk assessment of ship operations, this study explores the possible risks faced by shipowners or charterers while performing ship operations from an operational risk perspective. This can facilitate the reference of relevant risk clauses for signing future charter party contracts.

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Bulk carriers are commercial vessels chiefly shipping general bulk cargo (such as coal, iron ore, and grains, etc.). The cargo carried by these ships is characterized by massive volume, uniformity, low value, little ability to afford shipping fees on the part of the shippers, fixed transport direction, and seasonal movement. Since scheduled round-trip sailings are not provided, there are no fixed sailing routes, and sailing schedules are determined on the basis of cargo transport needs, bulk carriers constitute a tramp shipping service category [1]. Compared with general cargo ships (GCSs) [2, 3] transporting general cargo in packages, bags, cartons, drums, and bales, etc., commercial vessels chiefly sailing on fixed, busy transport routes, and carrying packaged cargo as their chief service constitute a service category similar to liner shipping [1]. In the world today, there are many types of GCSs and types of cargo carried by GCSs, and these vessels also berth at numerous ports. Most GCSs are currently equipped with their own lifting equipment. Although loading and unloading can be complex, since lifting equipment is generally safe and economical, it is widely used on vessels on near-sea shipping lines and inland waters [4].

Looking from the perspective of the shipping industry's development, there were few notable differences in bulk carrier vessels until the late 1960s. After that time, however, and particularly after the expansion of container transportation, different types of bulk carrier vessels [5] with greater efficiency and specialization were developed to meet various needs. In addition, although the development of such specialized vessel types as bulk carriers, oil tankers, and container ships has continued unabated [6], the GCSs have maintained a certain share of the shipping market. According to data from Clarksons Research Online [7], there are 1,898 vessels with 10,000-29,999 Deadweight Tonnage (DWT); small and largely equipped with derrick cranes, these vessels account for 15.38% of all bulk carriers. In addition, larger vessels (30,000-64,999 DWT), which are typically equipped with derricks and/or cranes and can be employed for general cargo shipment, account for 61.7% of all bulk carriers. Although general cargo vessels have traditionally been in the range of from several thousand DWT to around 20,000 DWT, there has been a trend toward the construction of larger ships in recent years as carriers seek to boost the economic efficiency of their fleets. Some carriers consequently currently operate large Handymax bulk vessels with approximately 61,350 DWT, and this has enlarged the boundaries of GCS size. Furthermore, the industry's development following major increases in container shipping fees during the second half of 2020 have underscored the importance of GCS in the shipping market. For a period of time afterwards, the average daily leasing fees of GCS-related shipping indexes such as Baltic Supramax Index (BSI) and Baltic Handsize Index (BHSI) were higher than those of the Baltic Capesize Index (BCI) and Baltic Panamax Index (BPI).

As summarized by the American Export Line [5], the advantages of GCSs include (1) no need to break oversized cargo down into smaller shipments; (2) the majority of ports around the world are equipped to deal with breakbulk shipping; (3) large machinery can be shipped to any port of the world without reassembly at the final destination; and (4) the paperwork involved in breakbulk shipping is simpler. According to Notteboom et al. [2] and Det Norske Veritas (DNV) [8], in spite of the diversification of vessel type, GCSs still retain great attractiveness when transporting cargo that cannot easily be carried on container ships. Furthermore, the role of GCSs in boosting port employment and port added value also ensures that GCSs will continue to play an important role in the future shipping market.

Ocean transport employs ships as its means of conveying passengers and cargo, and is an economic activity creating spatial and temporal utility [1]. Numerous scholars have conducted various studies investigating operating risk in shipping, and many of these studies have examined operating risk from the perspective of shipping operators (such as carriers and time charterers). For instance, Sua et al. [9] investigated freight rate risk in bulk shipping; Alexandridis et al. [10] analyzed the effectiveness of hedging freight rate risk for container ships, bulk carriers, and oil tankers; Chang et al. [11] investigated operating cost risk in container shipping; Dai et al. [12] and Merika et al. [13] investigated assets price risk in dry bulk shipping; Wang et al. [14] examined financial risk management in the oil tanker market; Shin et al. [15] relied on the case of Hanjin Shipping's bankruptcy to investigate carriers' leasing contract periods and financial risk, and conducted a comparison with ship purchase strategies; and Aziz et al. [16] studied vessel safety and risk management for single-engine icebreakers performing bulk shipping in Canada's subarctic waters. According to Alizadeh and Nomikos, [17] operating risk in the shipping industry chiefly consists of shipping fee rate risk, operating cost risk, interest rate risk, asset price risk, credit risk, and pure risk, where interest rate risk can be assessed through financial analysis. But even though considerable research on risk for various kinds of ocean shipping vessels (including bulk carriers, oil tankers, and container ships, etc.) can be found in the literature, there are very few studies concerning the operating risk of GCS operators (GCSOs), not to mention GCSOs' operating risk response strategies. In order to address this gap by investigating the fundamental risks confronted by GCSOs, this paper studied the risk factors associated with GCSOs' everyday operating and business activities. The goal of this effort was to provide shipowners and charter operators an overview of GCS operating risk based on analysis of the most salient risk factors.

This paper sought to assess operational risks facing GCSOs. Risk evaluation requires the application of systematic procedures [18], which include risk identification, risk analysis and evaluation, risk strategies, and risk treatment. This study consequently applied these risk evaluation procedures to the assessment and empirical analysis of GCSOs' operational risk management. Apart from this section, the second section of this paper examines the risk evaluation process, the third section preliminarily determines GCSOs' operating risk factors, the fourth section explains the research method, the fifth section describes empirical analysis, and the sixth section provides conclusions.

2. Risk evaluation process

This study employed the risk evaluation process proposed by Shang and Tseng [18] to evaluate GCSOs' operational risk management, and the risk management evaluation framework used was as shown in Fig. 1.

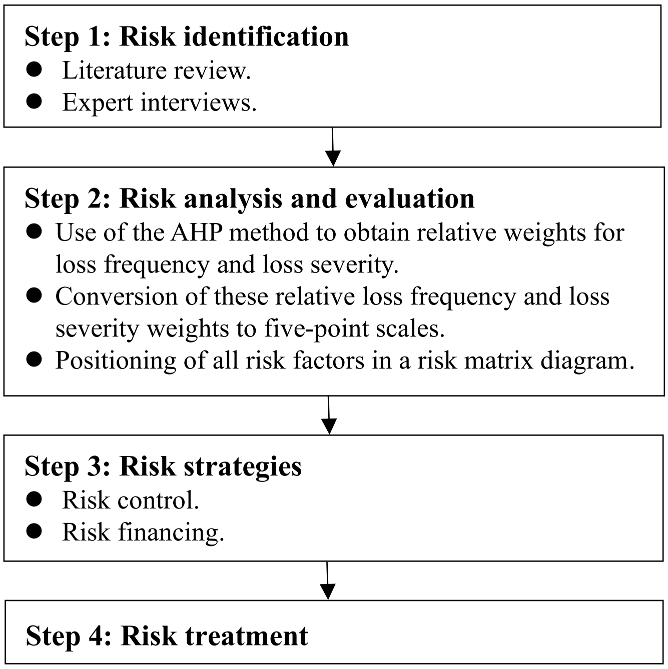

Fig. 1 Risk management evaluation framework

The following is an overview of the risk evaluation framework in this study:

(1) Risk identification: This paper first conducted a review of the literature to gather operational risk factors encountered by GCSOs, which was assisted by interviews with experts and scholars. This enabled the compilation of a list of the operational risk factors generally considered to be most important.

(2) Risk analysis and evaluation: A Risk Matrix Model (RMM) constructed on the basis of risk loss frequency and amount of losses [18, 19] was used to assess the position of various operational risks. This will help risk managers to draft risk management strategies focused on the most relevant risk factors, enabling GCSOs to reduce the probability of losses and minimize the impact of operating losses. This study also applied the Analytic Hierarchy Process (AHP) method [20] to determine the relative importance of risk

loss frequency (LF) and loss severity (LS). Risk LF and LS were then rated on a 5-point scale on the basis of relative importance, which facilitated the positioning of the various operational risks.

(3) Risk strategies: Risk management measures chiefly consist of risk control and risk financing methods. This paper relied on expert interviews to determine the most important risk control strategies, enabling the proposal of strategies for coping with various risk factors.

(4) Risk treatment: Recommendations concerning the implementation and management of risk control strategies are provided.

3. Preliminary risk factors for GCSOs

Risk is exposure to change. Risk has been defined in many literature. However, economist Frank H. Knight defined risk and uncertainty in his famous book "Risk, Uncertainty and Profit". He believes that risk being uncertainty associated with probabilities. He is commonly credited with defining the distinction between decisions under “risk” (known change, or measurable probability) and decision under “uncertainty” (unmeasurable probability, or indeterminable chance) [21]. Risk management is a management process through implementing decision-making. The purpose is to minimize the impact of possible losses for an enterprise and the costs incurred to reduce the frequency or magnitude of loss. This can reduce the expected cost and the degree of variability of loss. Risk perception refers to the process of noticing, interpreting, and memorizing information pertaining to risk-related matters, so it is an individual's judgment of the subjective risk [22, 23].

Shipping lines gain their basic risk perception from the risks they face during the process of vessel operation and management. Alizadeh and Nomikos [17] identified operational risks in their classified list of the business risks encountered in the shipping industry. Nguyen and Wang [24] believed that operational risk should refer to be the risk entailed by everyday operating activities or corporate business activities. However, from the perspective of GCS operation, because GCSs tend to be fairly small and routes tend to be short, the impact of fuel oil cost fluctuation risk is relatively minimal. In contrast, since sailing and turnaround time delays, problems in loading and unloading operations, and damage to cargo can cause costs to increase, these can be seen as major operational risk factors for GCSs.

With regard to the industry's service model, GCS shipping is characterized by a broad range of port selection options, cargo diversity, short voyages, and frequent sailings. To facilitate analysis of the GCS operating process, this study gathered operational risk aspects from actual shipping practice in Yan [25], UK Protection and Indemnity (P&I) Club [26], and Lopez [27], where this shipping practice reflected the perspective of a vessel operator (such as an owner or time charterer). Operational risk aspects affecting GCSOs were found to consist of the four major operating processes "ballast voyage", "loading stage", "laden voyage", and "discharging stage".

The following is a summary of these chief operating processes:

(1) Ballast voyage: Because GCSs often carry a wide variety of cargoes and may serve numerous ports, effective cargo planning is necessary. GCSOs must therefore pay particular attention to the ports where these vessels will be loading and unloading their cargoes, the cleanliness of cargo holds used to carry varied cargoes, route and port planning, and the needs of various cargoes.

(2) Loading stage: Because GCSs chiefly carry breakbulk cargos, the loading process must depend on the presence of onboard equipment such as derricks or cranes. There must also be a sufficient number of dock workers, and vessels may need to be loaded and unloaded as quickly as is possible under the prevailing circumstances (customary quick dispatch—CQD). As a consequence, unless delays in vessel operation are caused by shipper-related factors, in which case there will be detention charges, ship operators must bear responsibility for time losses caused by waiting for docks, weather-related delays, and loading delays. This will entail risk of increased time cost.

(3) Laden voyage: GCSs are relatively small, may be heavily impacting by sea states, and often carry cargo consisting of relatively high-value finished or semi-finished products. These attributes impose greater

requirements on route planning to minimize sailing time, and on stowage and securing of cargo in the holds. As a result, time cost and cargo damage compensation risks can be high during laden voyages.

(4) Discharging stage: If GCSs must meet CQD unloading requirements, risk of time loss during the discharging stage can be difficult to avoid or shift.

This paper's first and most important step was to identify risk factors, and preliminarily determine whether these risk factors are likely to be encountered by GCSOs during operating processes. To ensure consistency with actual practice, this study performed a review of relevant literature and employed operations analysis to identify cost risks faced by carriers during shipping operations (especially cost risks caused by time delays), and preliminarily determined risks faced by GCSOs during the various operating stages. In the following step, interviews with experts and five GCS operating companies enabled the preliminary determination of major operational risk aspects and the corresponding 16 operational risk factors, which are shown in Table 1.

Table 1 Preliminary risk factors affecting GCS operation

Risk aspect	Risk factor	Description	References
Ballast voyage (A)	Loading preparation risk (A_1)	A delay from the previous voyage or need for more hold clearance time will cause the loading time for the next voyage be missed.	UK P&I Club [26]; Roshamida et al. [28]; Tseng et al. [29]; Isberter [30]
	Voyage planning risk (A_2)	Poor planning of sailing route or fuel will lead to increased sailing time or a sub-optimal route.	Roshamida et al. [28]; Isberter [30]; field investigation; expert interviews
	At-sea risk during ballast voyage (A_3)	Unfavorable weather while a ship is at sea may force the vessel to take shelter or lead to a sub-optimal route or increased sailing time.	Tseng et al. [29]; Isberter [30]; Liu and Cui [31]
	Risk of ship malfunction during ballast voyage (A_4)	The malfunction of shipboard equipment may force the discontinuation of planned shipping operations or delay loading time.	Roshamida et al. [28]; Isberter [30]; Liu and Cui [31]
Loading stage (B)	Delays at port of loading (B_1)	Congestion at the port of loading may force ships to wait for use of port facilities or poor weather may hamper loading operations.	Liu and Cui [31]; Chang and Xu [32]; field investigation; expert interviews
	Cargo owner-related delays (B_2)	Cargo owner-related factors include failure to prepare cargo in time and slow cargo loading time, which may lengthen ship turnaround time and increase costs.	Roshamida et al. [28]; field investigation; expert interviews
	Delayed operations at the port of loading (B_3)	Poor arrangement of fueling or loading of supplies, etc. or coordination difficulties during the alongside loading stage may lengthen ship turnaround time.	Liu and Cui [31]; Chang and Xu [32]; field investigation; expert interviews
	Equipment malfunction during loading stage (B_4)	Equipment malfunctions during the ship loading stage, or the unavailability of necessary equipment, may interrupt loading operations, require the use of extra equipment, or lengthen operating time.	Liu and Cui [31]; Chang and Xu [32]; field investigation; expert interviews
Laden voyage (C)	Poor stowage and securing (C_1)	If cargo in the hold is poorly secured, emergency remedial measures may be needed when cargo shifts or cargo damage occurs.	Roshamida et al. [28]; Isberter [30]; Liu and Cui [31]
	Route planning risk (C_2)	Poor routes planning may lengthen sailing time and increase fuel costs.	Roshamida et al. [28]; Tseng et al. [29]; Chang and Xu [32]

Table 1 Preliminary risk factors affecting GCS operation (*Continued*)

Risk aspect	Risk factor	Descriptions	References
Laden voyage (*C*)	At-sea risk during the laden voyage stage (C_3)	Unfavorable weather while a ship is at sea may force the vessel to take shelter or lead to a sub-optimal route or increased sailing time.	Tseng et al. [29]; Isberter [30]; Liu and Cui [31]
	Risk of ship malfunction during laden voyage (C_4)	The malfunction of shipboard equipment may delay or force the discontinuation of a voyage.	Roshamida et al. [28]; Isberter [30]; Liu and Cui [31]
Discharging stage (*D*)	Delays at port of discharge (D_1)	Congestion at the port of discharge may force ships to wait for use of port facilities or poor weather may hamper unloading operations.	Liu and Cui [31]; Chang and Xu [32]; field investigation; expert interviews
	Recipient-related delays (D_2)	Recipient-related factors include customs clearance and slow unloading operations, which may lengthen ship turnaround time and increase costs.	Roshamida et al. [28]; field investigation; expert interviews
	Delayed operations at the port of discharge (D_3)	Poor arrangement of fueling or loading of supplies, etc. or coordination difficulties during the alongside loading stage may lengthen ship turnaround time.	Roshamida et al. [28]; Liu and Cui [31]; Chang and Xu [32]
	Equipment malfunction during discharge period (D_4)	The malfunction or unavailability of loading equipment may interrupt loading operations, require the use of extra equipment, or lengthen operating time.	Roshamida et al. [28]; Liu and Cui [31]; field investigation; expert interviews

4. Research method

The Australia/New Zealand risk management standards (AS/NZS 4360) [33] were among the earliest standards of their kind to be compiled, and have been adopted by many countries and international organizations. This study used a RMM [18, 34, 35] to grade and position various risk factors for the purpose of risk analysis and evaluation, and the results can enable risk managers to draft appropriate risk management strategies for different risk factors. This will help companies reduce the probability of losses and lessen financial impact.

Generally speaking, a risk matrix classifies risks based on the two major aspects of LF and LS, where LS typically has four levels and LF seven levels. However, the LF and LS dimensions of a risk matrix do not necessarily have these number of levels [19, 36]. For instance, we can construct a risk matrix with 20 grid cells in which LF has five levels and LS has four levels, or a risk matrix with 25 grid cells in which both LF and LS have five levels. In this study, the risk matrix we construct for the operational risk faced by GCSOs has five LF levels and five LS levels.

(1) LF: Loss frequency refers to the frequency (probability) of a specific risk accident occurring during a specific period of time, and is divided into 5 levels (1 through 5).

(2) LS: Loss severity refers to the severity of losses after a specific risk occurs during a specific period of time, and is divided into 5 levels (1 through 5).

After LF and LS have been estimated, it is necessary to define the risk value (RV), which is used to set the risk grade of each cell in the risk matrix. This study defined RV as LS × LF, and the resulting risk level matrix is as shown in Fig. 2.

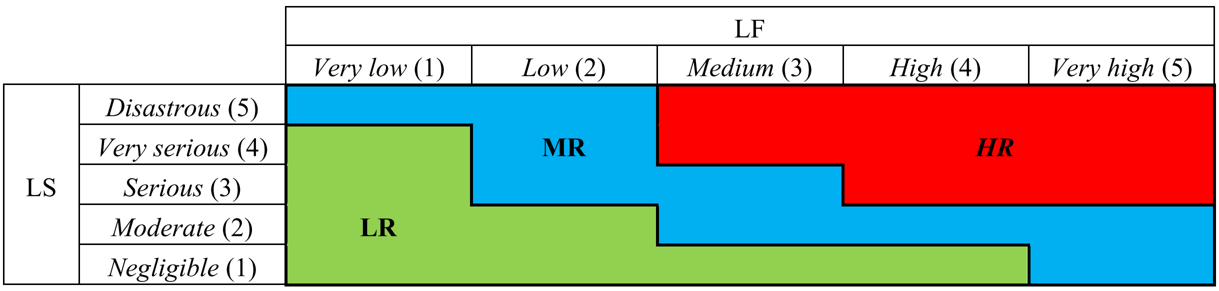

Fig. 2 Risk matrix diagram

A risk level matrix is typically divided into areas with different severity on the basis of LF and LS levels, and this study divided the operational risk values of GCSOs into the following three risk areas:

(1) Low risk (LR) area: Has RV of 1-4, indicating that severity of harm is relatively low. This level of risk may be handled through self-retention, or through risk prevention and risk control measures during the course of routine operating procedures.

(2) Medium risk (MR) area: Has RV of 5-10, indicating that this level of risk can be managed through risk control and prevention measures with reasonable cost and effectiveness.

(3) High risk (HR) area: Has RV of 11-25, indicating that risk control and prevention measure expenditures must be made immediately, and risk avoidance strategies must ultimately be adopted.

A 5-point Likert scale is typically used in questionnaire surveys used to obtain LF and LS values [35]. However, it was felt that the survey questions would be excessively subjective if a 5-point scale was used. Hence, the AHP method [20] was employed for evaluation in this study in order to achieve greater objectivity. The AHP method is a multiple-criteria decision-making (MCDM) method that combines qualitative and quantitative aspects [35, 37], and can transform a complex evaluation system into a clear-cut hierarchical framework through a series of operating steps. In addition, because pairwise comparison is considered to be one of the most effective methods of reaching decisions, the AHP method adopted in this study employed a 9-point scale to perform pairwise comparison of the weights of individual evaluation criteria when constructing a pairwise comparison matrix. After calculation of the eigenvalue and eigenvector of the matrix, the AHP method uses the largest eigenvalue to perform consistency testing, which allows the relative weight of each evaluation criterion to be obtained.

In the MCDM process, the determination of preferences by decision-makers is one of the most important analytical stages [38]. Furthermore, assessing the weight of each criterion is a key step enabling decision-makers to establish their preferences. In particular, in today's increasingly complex society, in view of decision-makers' differing criteria preferences, there is often a need to integrate the weights of a number of decision-makers' preferences in order to summarize the result of value trade-offs. Accordingly, the solution of collective decision-making problems typically relies on the professional experience and value judgments of a panel of experts [39]. In this process, experts in different fields are often selected to provide a diverse range of views concerning a specific problem, which can facilitate the determination of criteria weights. Among the many MCDM methods, the AHP method is considered a very effective approach [35, 40-42].

The advantages of the AHP method [39, 40] include ease of use, simple comparisons, broad applicability, and the ability to acquire the views of a majority of experts and decision-makers. This method can simplify complex decision-making problems by decomposing them into a hierarchical structure, and uses assessment via pairwise comparisons facilitate the experts' comparative evaluations. This allows the relative weights of assessment criteria to be obtained efficiently. The constant application and refinement of the AHP method has also made AHP theory increasingly comprehensive and informative. The application of the AHP method to the field of risk assessment has also grown increasingly diverse. Thanks to its use of a systematic hierarchical framework, Saaty's AHP method [20] can determine the degree of influence between different risk factors. It can also effectively capture the consensus views of a majority of experts and decision-makers, and can consequently allow the relative importance of various risk factors to be expressed as tangible weight values. This study therefore uses the AHP method to assess and analyze the relative importance of risk factors in terms of LF and LS.

Furthermore, because AHP method is a commonly used decision-making method, there are many journal papers [35, 37, 40-43] describing its mathematical calculation procedures. To save space, this paper will not further describe the AHP method's operating procedures here. If readers wish to understand the method's operating steps in greater detail, they may consult Saaty's book [20], which was consulted when drafting this paper's empirical procedures.

The AHP-based risk analysis and evaluation steps employed in this study differ from the questionnaire survey employing a 5-point Likert scale used in the RMM method, and are summarized as follows:

Step 1: The AHP method was employed to obtain the relative weights of the risk evaluation factors in terms of LF and LS.

Step 2: The relative weights of all risk factors in terms of LF were ranked, and expressed as $w_f^a, \ldots, w_f^b$. Similarly, the relative weights of all risk factors in terms of LS were ranked, and expressed as $w_s^a, \ldots, w_s^b$. The largest (w_f^b and w_s^b) and smallest (w_f^a and w_s^a) weights among the weights of all risk factors were then obtained for LF and LS. After the smallest LF weight was subtracted from the largest LF weights, the resulting interval was divided into five equal parts ($\left(w_f^b - w_f^a\right)/5$), and the interval was thus converted into a 5-point Likert scale. Similarly, the interval between the largest and smallest LS weight was divided into five equal parts ($\left(w_s^b - w_s^a\right)/5$), and this interval was also converted into a 5-point Likert scale. This paper further converted the range of the relative weights for LF and LS into 5-point scales, as shown in Table 2.

Table 2 Conversion of the range of the relative weights for LF and LS into 5-point Likert scale

5-point Likert scale	LF	LS
1	$w_f^a \le F < \frac{4w_f^a + w_f^b}{5}$	$w_s^a \le S < \frac{4w_s^a + w_s^b}{5}$
2	$\frac{4w_f^a + w_f^b}{5} \le F < \frac{3w_f^a + 2w_f^b}{5}$	$\frac{4w_s^a + w_s^b}{5} \le S < \frac{3w_s^a + 2w_s^b}{5}$
3	$\frac{3w_f^a + 2w_f^b}{5} \le F < \frac{2w_f^a + 3w_f^b}{5}$	$\frac{3w_s^a + 2w_s^b}{5} \le S < \frac{2w_s^a + 3w_s^b}{5}$
4	$\frac{2w_f^a + 3w_f^b}{5} \le F < \frac{w_f^a + 4w_f^b}{5}$	$\frac{2w_s^a + 3w_s^b}{5} \le S < \frac{w_s^a + 4w_s^b}{5}$
5	$\frac{w_f^a + 4w_f^b}{5} \le F \le w_f^b$	$\frac{w_s^a + 4w_s^b}{5} \le S \le w_s^b$

Step 3: The 5-point scales corresponding to each of the risk factors (as shown in Table 2) were positioned in a risk matrix diagram (as shown in Fig. 2), allowing the risk area of each risk factor to be determined.

5. Empirical study

This section consists of two subsections respectively dealing with the questionnaire and data collection, and the results and discussions.

5.1 Questionnaire and data collection

This study relied on an AHP expert questionnaire to obtain the relative weights of the various risk factors, which facilitated establishment of 5-point LF and LS scales for the various risk factors and determination of the risk areas of the individual factors. The content of the AHP expert questionnaire was based on the 4 risk aspects and 16 risk factors shown in Table 1, and enabled the relative weights of the risk factors in terms of LF and LS to be determined. The questionnaire was distributed to 10 companies in Taiwan either operating their own GCSs or operating GCSs under time charter (T/C) arrangements; the authors visited experts at these companies in person and requested that they complete the AHP expert questionnaires.

AHP operating procedures were employed to confirm the validity of the AHP questionnaire. If the consistency index (C.I.) values and consistency ratio (C.R.) values are less than or equal to 0.1 [20], this shows that the pairwise comparison matrix is consistent, and thus represents the unanimous judgment of experts. The questionnaire can then be considered a valid expert questionnaire. It is worth mentioning that the judgments represented by the pairwise comparison matrix for each questionnaire should meet the requirements of consistency. If a pairwise comparison matrix is inconsistent, this shows that there is confusion in the experts' judgments. When that happens, the experts must redo the questionnaire until the requirements of consistency are met.

Robinson [44] recommended that at least 5-7 experts should ideally provide their input concerning decision-making questions. Twenty questionnaires were distributed in this study, and a total of 17 valid questionnaires were obtained after discarding questionnaires that were incomplete or did not pass consistency testing, for a valid questionnaire recovery rate of 85%. The data from the recovered valid questionnaires should therefore possess representativeness. Basic information concerning the respondents (see Table 3) revealed that 70.58% were in the 41-60 age group, 76.46% had 11-30 years of experience in the ocean shipping industry, 64.71% had more than 11 years of GCS experience, and 82.35% currently hold middle or upper management positions. These attributes further indicated that the data from the AHP expert questionnaire possessed representativeness.

Table 3 Profiles of the respondent experts

Basic information	Distribution	Number of experts	Percentage (%)
Age (years old)	31-40	4	23.53
	41-50	6	35.29
	51-60	6	35.29
	Over 61	1	5.89
Seniority in maritime industry (years)	6-10	3	17.65
	11-20	7	41.17
	21-30	6	35.29
	Over 31	1	5.89
Seniority in GCS (years)	Less than 5	1	5.89
	6-10	5	29.41
	11-20	5	29.41
	21-30	5	29.41
	Over 31	1	5.89
Job title	Coordinator	3	17.65
	Senior manager / Manager	10	58.81
	GM / Vice GM	3	17.65
	Chairman	1	5.89

5.2 Results and discussions

5.2.1 Calculation of relative weights

The AHP method [20] encompasses "pool first" and "pool last" approaches to integrating experts' preferences in group decision-making. Here the pool first approach employs the geometric mean method of integrating preferences, while the pool last approach integrates preferences via the arithmetic mean. Because Saaty [20] believed the geometric mean method better expresses the consensus of a decision-making group, this study uses the pool first approach to integrate the experts' preferences.

The pool first preference integration approach used in this study involved using the geometric mean to integrate all of the experts' pairwise comparison values meeting the condition of consistency, and allowing the construction of a pairwise comparison matrix. The elements in this pairwise comparison matrix represent the combined judgment values based on the experts' views. Before compiling combined judgment values, it is necessary to determine whether all experts' judgments satisfied a test of consistency. This study used the judgment values on the 17 valid questionnaires to establish a pairwise comparison matrix using the geometric mean method. AHP procedures [40] were then used to calculate the local weight and global weight of each risk aspect. On the basis of these operating procedures, this article obtained the local / global weights of the 16 LF and LS risk assessment factors, which are shown in Table 4 and Table 5.

Table 4 The local / global weights and rankings of risk factors in terms of LF

Risk aspect	Local / global weights	Risk factor	Local weights	Global weights
A	0.216 (3)	A_1	0.265 (2)	0.0572 (8)
		A_2	0.172 (4)	0.0372 (13)
		A_3	0.331 (1)	0.0715 (5)
		A_4	0.232 (3)	0.0501 (9)
B	0.289 (2)	B_1	0.464 (1)	0.1341 (1)
		B_2	0.233 (2)	0.0673 (7)
		B_3	0.138 (4)	0.0399 (11)
		B_4	0.165 (3)	0.0477 (10)
C	0.291 (1)	C_1	0.283 (2)	0.0824 (4)
		C_2	0.113 (4)	0.0329 (15)
		C_3	0.389 (1)	0.1132 (2)
		C_4	0.215 (3)	0.0626 (6)
D	0.204 (4)	D_1	0.486 (1)	0.0991 (3)
		D_2	0.193 (2)	0.0394 (12)
		D_3	0.159 (4)	0.0324 (16)
		D_4	0.162 (3)	0.0330 (14)

Note: (1) Nomenclature of code names of each risk aspect and risk factor can be referred to Table 1.
(2) The parentheses number after the weight number is ranking.

Table 5 The local / global weights and rankings of risk factors in terms of LS

Risk aspect	Local / global weights	Risk factor	Local weights	Global weights
A	0.176 (4)	A_1	0.208 (3)	0.0366 (12)
		A_2	0.173 (4)	0.0304 (16)
		A_3	0.342 (1)	0.0602 (6)
		A_4	0.277 (2)	0.0488 (9)
B	0.275 (2)	B_1	0.428 (1)	0.1177 (2)
		B_2	0.217 (2)	0.0597 (7)
		B_3	0.172 (4)	0.0473 (10)
		B_4	0.183 (3)	0.0503 (8)
C	0.356 (1)	C_1	0.362 (1)	0.1289 (1)
		C_2	0.101 (4)	0.0360 (13)
		C_3	0.319 (2)	0.1136 (3)
		C_4	0.218 (3)	0.0776 (5)
D	0.193 (3)	D_1	0.454 (1)	0.0876 (4)
		D_2	0.173 (4)	0.0334 (15)
		D_3	0.179 (3)	0.0345 (14)
		D_4	0.192 (2)	0.0371 (11)

Note: (1) Nomenclature of code names of each risk aspect and risk factor can be referred to Table 1.
(2) The parentheses number after the weight number is ranking.

It can be seen from the results of analysis in Table 4 that (1) the highest ranking risk aspect consisted of "laden voyage (*C*)," which was followed by "loading stage (*B*)," "ballast voyage (*A*)," and "discharging stage (*D*)." These four risk aspects had weights in the range of 0.204-0.291, and there was little difference between these four aspects in terms of risk frequency. (2) The five risk factors with the highest relative weights consisted of the loading stage factor "delays at port of loading (B_1)," the laden voyage-period factor "at-sea risk during the laden voyage stage (C_3)," the discharging stage factor "delays at port of discharge (D_1)," the laden voyage-period factor "poor stowage and securing (C_1)," and the ballast voyage-period factor "at-sea risk during ballast voyage (A_3)." These results indicate that GCSOs must address the problems entailed by the small size of GCS. These problems include vulnerability to sea conditions, the difficulty of ensuring timely loading and unloading operations, and the complexity of handling diverse and high-value cargo types. In addition, it was found that the two discharging stage factors "equipment malfunction during discharge period (D_4)" and "delayed operations at the port of discharge (D_3)," and the laden voyage-period factor "route planning risk (C_2)" had the lowest relative weights. This finding suggested that they had relatively low risk probability and were highly familiar to operators. However, we cannot rule out that the respondents' work was more closely connected with the dedicated export docks used at the time of loading, and which have stricter usage requirements. Their work may also have had less connection with the public docks used at the port of discharge, which typically can be used with greater flexibility. As a consequence, the respondents may have been less concerned about risk factors at the port of discharge than at the port of loading.

The results of analysis shown in Table 5 indicate that (1) the risk aspect with the largest weight consisted of "laden voyage (C)," which was followed by "loading stage (B)," "discharging stage (D)," and "ballast voyage (A)," which reveals that the risk aspect "laden voyage" had the greatest influence on overall risk. (2) The three risk factors with the largest weights consisted of the laden voyage-period factor "poor stowage and securing (C_1)," the loading stage factor "delays at port of loading (B_1)," and the laden voyage-period factor "at-sea risk during the laden voyage stage (C_3)." The three risk factors with the lowest weights consisted of the discharging stage factors "delayed operations at the port of discharge (D_3)" and "recipient-related delays (D_2)," and the ballast voyage-period factor "voyage planning risk (A_2)." These findings suggest that GCS operation is indeed characterized by relatively high value cargoes and difficulty in controlling loading and unloading time costs. The low weights of the risk factors D_2 and D_3 can be explained by the practical reality that GCSOs are not in such a position of power over cargo owners and recipients as are bulk carrier operators. This is chiefly because GCSOs tend to enter into long-term cooperative relationships with cargo owners and recipients, which provides them with fixed sources of cargo. And apart from ensuring that GCSOs are familiar with cargo owners and recipients' habits, these long-term relationships may also involve a certain degree of mutual forbearance.

5.2.2 Conversion of weights to evaluation scales

Referring back to the "AHP-based risk matrix evaluation model" in Section 4, the global weights in the rightmost column of Table 4 were ranked from smallest to largest in Step 2. It can now be seen that the smallest value is $w_f^a = 0.0324$, and the largest value is $w_f^b = 0.1341$. Dividing the interval between the smallest and largest values into five parts, we obtained a value of $\left(w_f^b - w_f^a\right)/5 = (0.1341 - 0.0324)/5 = 0.02034$. The interval range was converted into a 5-point Likert scale formula, and the value of interval F in this 5-point Likert scale could then be calculated. For example, the interval formula for scale "2" was $\frac{4w_f^a + w_f^b}{5} \le F < \frac{3w_f^a + 2w_f^b}{5}$, and the global weights of the risk factors in Table 4 all fell within a range of $\frac{(4\times0.0324)+0.1341}{5} \le F < \frac{(3\times0.0324)+(2\times0.1341)}{5}$ (*i.e.*, $0.05274 \le F < 0.07308$). The risk factors can now be converted to scale "2" in order to assess LF. For example, since the global weight of risk factor A_1 was 0.0572, which fell within the range $0.05274 \le F < 0.07308$, this weight can be used in the conversion to scale "2".

Similarly, the global weights in the rightmost column of Table 5 were ranked from smallest to largest. It can be seen that the smallest value is $w_s^a = 0.0304$, and the largest value is $w_s^b = 0.1289$, which yields five intervals of $\left(w_s^b - w_s^a\right)/5 = (0.1289 - 0.0304)/5 = 0.0197$. The value of interval F in the corresponding 5-point Likert scale can now be obtained using the foregoing calculation method.

Lastly, using the formulas in Table 2, the LF and LS weight ranges were converted into 5-point Likert scale, which yielded the results shown in Table 6.

Table 6 Conversion of LF and LS weights into 5-point Likert scale

		LF	LS
Largest weight		$w_f^b = 0.1341$	$w_s^b = 0.1289$
Smallest weight		$w_f^a = 0.0324$	$w_s^a = 0.0304$
Fifths interval		$\left(w_f^b - w_f^a\right)/5 = 0.02034$	$\left(w_s^b - w_s^a\right)/5 = 0.0197$
5-point Likert scale	1	$0.0324 \le F < 0.05274$	$0.0304 \le S < 0.0501$
	2	$0.05274 \le F < 0.07308$	$0.0501 \le S < 0.0698$
	3	$0.07308 \le F < 0.09342$	$0.0698 \le S < 0.0895$
	4	$0.09342 \le F < 0.11376$	$0.0895 \le S < 0.1092$
	5	$0.11376 \le F \le 0.1341$	$0.1092 \le S \le 0.1289$

5.2.3 Determination of risk areas

The data gathered in tables 4-6 allowed the determination of the risk values (RVs) and risk areas, with the results shown in Table 7.

Table 7 LS, LF, RV, and risk area results

Risk factor	LF		LS		RVs	Risk area
	Relative weight	5-point scale (A)	Relative weight	5-point scale (B)	Risk value (A×B)	
A_1	0.0572	2	0.0366	1	2	LR
A_2	0.0372	1	0.0304	1	2	LR
A_3	0.0715	2	0.0602	2	4	LR
A_4	0.0501	1	0.0488	1	1	LR
B_1	0.1341	5	0.1177	5	25	***HR***
B_2	0.0673	2	0.0597	2	4	LR
B_3	0.0399	1	0.0473	1	1	LR
B_4	0.0477	1	0.0503	2	2	LR
C_1	0.0824	3	0.1289	5	15	***HR***
C_2	0.0329	1	0.0360	1	1	LR
C_3	0.1132	5	0.1136	5	25	***HR***
C_4	0.0626	2	0.0776	3	6	MR
D_1	0.0991	4	0.0876	3	12	***HR***
D_2	0.0394	1	0.0334	1	1	LR
D_3	0.0324	1	0.0345	1	1	LR
D_4	0.0330	1	0.0371	1	1	LR

Note: Please refer to Table 1 for the codes for each risk factor.

Lastly, this study marked the locations of the various GCSO risk factors on a risk level matrix in accordance with the results in Table 7, yielding the results shown in Fig. 3.

It can be seen from Fig. 3 that four of the risk factors fell within the HR area, one fell within the MR area, and the remaining 11 fell within the LR area. The four risk factors within the HR area consisted of the loading stage factor "delays at port of loading (B_1)," the laden voyage factor "poor stowage and securing (C_1)," the laden voyage factor "at-sea risk during the laden voyage stage (C_3)," and the discharging stage factor "delays at port of discharge (D_1)."

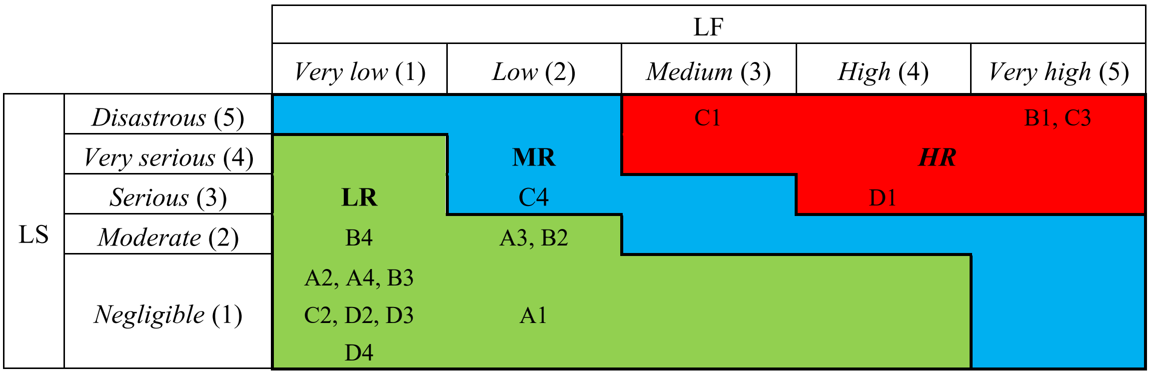

Fig. 3 Risk matrix diagram for GCSOs

Based on this result, this study suggests that GCSOs should consider prioritizing the four operational risk factors falling within the HR area, which are discussed as follows:

(1) Because GCSOs generally cannot disperse risk through control of the loading or unloading rate during the loading stage or discharging stage, the ship operator may have to absorb time cost risk resulting from possible dock congestion and waiting in port.

(2) Since the cargos carried by GCSs often consist of bare-packed high-value finished or semifinished products, when poor weather occurs, it may be necessary to interrupt or suspend loading and unloading operations to avoid damage to cargo. In such cases, despatch and demurrage fee mechanisms cannot be used to disperse time cost risk.

(3) Since GCS carry diverse cargoes and have complex cargo loads, and in view of cargo hold capacity and weight restrictions, GCS cargo stowage is complex work requiring professional knowledge. In addition, how to adequately stow and secure cargo is a very important issue in GCS operations. Moreover, whether cargo is well-secured is commonly not apparent until rough sea conditions are encountered after the end of the loading stage. And if a vessel carrying poorly-secured cargo encounters unfavorable sea conditions, in addition to affecting the vessel's safety, this may often cause cargo damage. When these circumstances occur, entering port to perform restowage and improve cargo securing will be very costly.

(4) Because GCS tend to be relatively small, they can be quite sensitive to perils of the sea. After loading, in view of vessel and cargo safety during laden voyage, it is typically necessary to carefully plan a suitable route and perform constant vigilance. It may also be necessary to reduce risk and avoid unfavorable sea conditions by through appropriate route revisions.

5.2.4 Recommended risk management strategies

Risk management strategies [45, 46] involve the selection or use of one or more methods to control risks. Risk management strategies can be generally classified as risk control and risk financing types [47], where risk control strategies refer to strategies or methods for reducing risk frequency and magnitude of possible losses. The goal of risk control strategies is to prevent and reduce losses, and these strategies chiefly include risk avoidance, risk transfer, loss prevention, and loss reduction. Risk financing strategies refer to prior financial operations, such as the use of fund raising, to enable the company to quickly restore the prior situation when a risk event occurs. Commonly used risk financing strategies chiefly consist of risk retention and the purchase of insurance.

Based on the foregoing empirical analysis, this study has proposed the following risk control strategies aimed at these risk factors. These strategies are provided to GCSOs as a reference for reducing operational risk. The risk strategies proposed in this paper consist of risk prevention, risk reduction, risk transfer, and risk retention methods [19, 29, 34, 35, 41, 42, 47], and are explained as follows:

(1) Risk prevention: Preventive risk management strategies aimed at minimizing the probability of losses will lessen the chance of risk accidents.

(2) Risk reduction: Risk management strategies aimed at reducing the impact of those losses that occur can consist of measures taken either before or after a risk accident.

(3) Risk transfer: Before risk accidents occur, risk can be transferred to a third party able to assume those risks via contract or other means.

(4) Risk retention: Following risk assessment, those risk factors characterized by low frequency and low loss severity are relatively uncommon and cause only relatively minor losses. In view of cost and effectiveness considerations, we recommend that GCSOs assume these losses through risk retention.

Based on the foregoing, this study proposes specific recommendations for controlling risk factors before risk accidents occur. These recommendations are provided to GCSOs as a reference for the improvement of operating safety and performance and reduction of risk accidents. In addition, following subsequent discussion with insurance scholars and expert practitioners, the authors propose risk management strategy and recommendations for the areas in Fig. 3 containing major risk factors, which are explained below.

It can be seen from Fig. 3 that the two most serious risk factors were "delays at port of loading (B_1)" and "at-sea risk during the laden voyage period (C_3)," which had loss frequency and loss severity values of 5 points. With regard to risk of sailing delays, as mentioned previously, because GCS generally are not protected by favorable loading/unloading rate terms, this study suggests that risk prevention strategy be employed in response. However, since delays are not covered in insurance contracts, risk transfer in the form of insurance compensation cannot be employed. Prior to loading, an assessment can be made of the amount of hoisting operations and the number of available dockside workers; apart from helping avoid detention charges, by lessening delay risk, this assessment can also reduce losses from delays in the ship's loading time or time spent at dockside.

With regard to risks while at sea, unfavorable weather may force a ship to go off course or suspend a voyage. As in the case of risk factor B_1, risk management strategies of prevention and transfer can also be employed to minimize this risk. For instance, precise assessment of meteorological considerations along sailing routes can help prevent encounters with storms, purchase of hull insurance can transfer risk of vessel damage to an insurance company, and membership in a P&I Club can transfer liability risk.

Furthermore, the two risks "poor stowage and securing (C_1)" and "risk of ship malfunction during laden voyage (C_4)" can also be addressed with risk transfer strategy. For instance, insurance coverage of poor stowage and ship malfunctions can transfer risk of damage, and membership in a P&I Club can facilitate obtaining compensation from an insurer in the event of poor stowage and accidents. It is also recommended that a risk reduction strategy of improved lashing and securing of cargo during stowing be employed to lessen the risk that poor stowage causes cargo damage. In the case of ship malfunctions, the most effective risk prevention strategy is rigorous implementation of maintenance SOPs for shipboard equipment and machinery at all times.

The risk factor "delays at port of discharge (D_1)", which is located in a MR area, is similar to the risk of delays at port of loading in nature. Both of these risks entail losses attributable to delays, where these losses may take the form of breach of contract penalties. Since risk transfer via insurance contract is also not possible in this case, a loss prevention strategy is recommended. In this case, a possible strategy is to communicate ahead of time with a port representative concerning unloading equipment, and arranging in advance for a sufficient number of workers and a suitable shift schedule.

Lastly, as well as low loss severity, those risk factors located in LR areas also tend to have low loss frequency. In this case, due to cost and resource considerations, risk treatment is typically not performed. Instead, it is recommended that cost-effective risk retention or risk prevention and risk reduction strategies be employed.

Table 8 summarizes the general types of risk management strategies that can be appropriately adopted to deal with the various risks faced by GCSOs.

Table 8 Recommended strategies to cope with the operational risk factors faced by GCSOs

Risk factors	Risk management strategies			
	Risk retention	Risk prevention	Risk reduction	Risk transfer
Loading preparation risk (A_1)		✓		
Voyage planning risk (A_2)	✓	✓		
At-sea risk during ballast voyage (A_3)		✓		
Risk of ship malfunction during ballast voyage (A_4)	✓	✓		
Delays at port of loading (B_1)		✓		
Cargo owner-related delays (B_2)			✓	✓
Delayed operations at the port of loading (B_3)	✓	✓		
Equipment malfunction during loading stage (B_4)			✓	✓
Poor stowage and securing (C_1)			✓	✓
Route planning risk (C_2)	✓	✓		
At-sea risk during the laden voyage stage (C_3)		✓		✓
Risk of ship malfunction during laden voyage (C_4)		✓		✓
Delays at port of discharge (D_1)		✓		
Recipient-related delays (D_2)	✓		✓	
Delayed operations at the port of discharge (D_3)	✓	✓		
Equipment malfunction during discharge period (D_4)	✓		✓	

6. Concluding remarks

Although GCSs do not have dominant status among shipping services, they possess certain advantages that container transportation and bulk shipping lack, and also comprise an important part of the shipping market. Furthermore, while the literature contain in-depth analysis of the operational risk faced by such vessel types as container ships, bulk carriers, and oil tankers, etc., there has been very little attention to operational risk encountered by GCSs. This study therefore analyzed the operational risk faced by GCSOs, and hopes that its findings can provide shipowners and charterers with a reference basis for risk evaluation in GCSs operations.

This study used risk assessment procedures to perform the empirical analysis of operational risks faced by GCSOs, enabling appropriate recommendations concerning risk strategies to be provided. After first preliminarily identifying risk factors, four risk aspects and 16 operational risk factors were determined, and a 5x5 risk matrix constructed. However, unlike conventional RMMs based on questionnaire surveys using a 5-point Likert scale, the evaluation model adopted in this study involved the conversion of the relative weights assigned by experts through use of the AHP method to 5-point risk scales. This approach reduced the possible subjectivity of the questionnaire survey, and yielded more objective assessments on the expert questionnaire. The 5-point LF and LS scales for the risk factors resulting from the conversion process were then positioned on a risk matrix, which allowed the determination of the risk area of each risk factor. Lastly, this study performed empirical analysis of GCSOs in Taiwan. The results indicated that four risk factors were located in the HR area, one risk factor was in the MR area, and the remaining risk factors were in the LR area. The four risk factors in the HR area comprised the loading stage factor "delays at port of loading," the laden voyage factor "poor stowage and securing," the laden voyage factor "at-sea risk during the laden voyage stage," and the discharging stage factor "delays at port of discharge." Based on the risks faced by GCSOs, and their attributes, this paper further provided risk management strategies reflecting the survey respondents' recommendations.

In social science research, the results of research surveys are inevitably influenced by the mix of backgrounds of the survey respondents. In other words, research findings may be highly influenced by the choice of experts and respondents. The questionnaire respondents in this study were selected from among senior personnel in Taiwan involved in self-owned GCSs operation or T/C leasing operations. As a consequence, this study's findings are only applicable to operating risk assessment among GCSOs in Taiwan, and do not allow the inference that global GCSOs face similar operating risks. In addition, although the basic information on the experts recruited in this study allow their ages, seniority in the maritime industry, seniority in GCS, and job title to be distinguished, it is assumed that the weights assigned by these experts are equal in importance. Instead, the local and global weights obtained in this study represent the summarized assessment results of all 17 experts. We therefore recommend that future research classify ship operation stakeholders (such as shipowners and charterers), which will allow determination of whether stakeholders have different views expressed as different weight values. Furthermore, if the relative importance of different types of risk factors is characterized by fuzziness and variability, future studies may employ the fuzzy analytic hierarchy process (FAHP) [37], which applies fuzzy set theory [48] in conjunction with the AHP method, to assess key risk factors [19, 37].

Because of the lack of comparative data in the literature on risk in shipping management, and particularly in studies of bulk carriers and GCS carriers [3, 4], this study was unable to perform comparative analysis and discussion. Furthermore, this evaluation model only performed evaluation and analysis of risk factors, but did not conduct cost and benefit analysis of risk strategies. Future research can therefore perform cost and benefit analysis of risk strategies, which will provide further important information as a decision-making reference for GCSOs. The findings of this study concerning operational risk in GCS management can give shipowners or charterers a reference to guide the drafting of charter party risk clauses so as to avoid or mitigate potential risks. The study's results can also provide a reference concerning the priority of operational risks. This can guide the planning of training content helping new GCS-related personnel minimize operational risk. Additionally, Gunes [49] mentions that there are many different types of bulk carriers (e.g. Small, Handysize, Handymax, Panamax, Capesize, Large Capesize, and Very Large Bulk Carrier (VLBC)). Future research can therefore assess different operational risks and develop corresponding risk strategies for different types of bulk carriers or GCSs.

Lastly, this study gathered only four risk assessment aspects and 16 risk factors from the literature and experts' recommendations. However, there are numerous other potential risk factors in GCS operating and working processes that have not been considered, and this may have affected this study's risk management strategy and recommendations. Upon review of this research (during publication), reviewers identified other potential risk management strategies not initially identified by the authors in this work. Accordingly, we recommend that future research perform an in-depth investigation of a greater number of operating risk factors, which will enable the determination of more all-inclusive and effective risk management strategies.

Furthermore, the economy of Taiwan is oriented mainly towards import and export trade. Taiwan has achieved good results in the global shipping industry. According to UNCTAD [50] data, the achievements include: (1) In terms of dead-weight tonnage, Taiwan’s fleet accounts for 2.6% of the world's total and ranks 8th in the world. (2) From the perspective of ship-owning economies, Taiwan accounts for 1.99% of the world's total, ranking 13th in the world. (3) Taiwan's top two container shipping companies are among the world's top 10, including Evergreen Marine Corp., and Yang Ming Marine Transport Corp. (4) In terms of cargo and vessel handling performance for dry bulk carriers, Taiwan is top 20 economies by vessel arrivals. Based on this, this study intends to use the proposed AHP-based risk matrix evaluation model to analyze the operational risk faced by GCSOs in Taiwan, and the information obtained will be used as a reference for Taiwanese GCSOs in the future. Considering the representativeness of relevant industries covered by the sample and the international nature of shipping industry, this study still has considerable reference value for operators or subsequent researchers even though the scope of samples of this study has a limitation on Taiwan.

Abbreviations

AHP	:	Analytic Hierarchy Process
AS/NZS 4360	:	Australia/New Zealand risk management standards
BCI	:	Baltic Capesize Index

BHSI	:	Baltic Handsize Index
BPI	:	Baltic Panamax Index
BSI	:	Baltic Supramax Index
C.I.	:	consistency index
C.R.	:	consistency ratio
CQD	:	customary quick dispatch
DNV	:	Det Norske Veritas
DWT	:	Deadweight Tonnage
GCSs	:	general cargo ships
GCSOs	:	GCS operators
HR area	:	high risk area
IMO	:	International Maritime Organization
LF	:	loss frequency
LR area	:	low risk area
LS	:	loss severity
MCDM	:	Multiple-criteria Decision-making
MR area	:	medium risk area
P&I Club	:	Protection and Indemnity Club
RMM	:	Risk Matrix Model
RVs	:	risk values
T/C	:	Time Charter
VLBC	:	Very Large Bulk Carrier

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