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Asian Seafarers' Perceptions of Maritime Security Implementation in the Container Shipping Context

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Abstract

Maritime security is an important issue in the shipping industry. The international maritime organization (IMO) developed a Code of International Ship and Port Facility Security (ISPS Code) to enhance maritime security against piracy, terrorism, and any other illegal actions. Questionnaires are used to elicit Asian seafarers' perceptions of maritime security in the container shipping context. Exploratory factor analysis and confirmatory factor analysis techniques are applied to analyze the data obtained there from in order to understand the effect of maritime security implementation onboard ship. Four primary dimensions of maritime security implementation were identified, namely: security knowledge and capability, security manpower, security training, and security equipment. Results revealed that respondents from Philippines had high perceptions on security knowledge and capability, security manpower, and security equipment dimensions, whereas respondents from India and Myanmar had high perceptions on security training dimension. Theoretical and practical implications from the research findings in maritime security management are discussed.

Keywords: Seafarer, International Ship and Port Facility Security Code (ISPS Code), Maritime security, Container shipping

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1. INTRODUCTION

Maritime security is the most serious threat in the contemporary shipping industry. Originally, the threat from piracy poses to navigation security and the safety of seafarers has existed since the dawn of mankind. In practice, piracy is similar to banditry, in that it is armed robbery using violence or the threat of violence in areas outside effective government control (Johnson and Pladdet, 2003). The number of registered piracy attacks between 1994 and 2003 showed an increase, and the impact of piracy in terms of injury and death to mariners is serious. In the first half of 2003, 234 pirate attacks resulted in 16 deaths, 52 injuries, 20 missing persons, and 193 hostages taken (Johnson and Pladdet, 2003). More recent statistics indicated that the total number of incidents of piracy and armed robbery against ships was 6,569 between 1984 and the end of December 2012 (IMO, 2013). In the course of these pirate incidents, 51 ships were reportedly hijacked, six crew members were killed, 42 were reportedly injured/assaulted, and 313 were taken hostage/kidnapped (IMO, 2013). Reports also indicate that Somali pirates have mother ships with speed boats that enable them to search ever more distant waters for vulnerable vessels. As a result, Somali pirates have extended the range of their piratical activities to Madagascar and the islands of India (Drehle, 2011). Thus, the threat of contemporary pirate attacks has become more serious and complex than previously.

Moreover, after the ramming of the "USS Cole" by a small boat laden with explosives in 2000; the terrorist attacks of September 11, 2001; and the attacks on the French tanker "Limburg" off the coast of Yemen in October 2002 enforce to consider the threaten of terrorism on the maritime security (Johnson and Pladdet, 2003). Terrorists may take hostages aboard cruise liners or ferries; deliberately sink or ground vessels to block harbors and/or channels; use ships as kinetic energy weapons to destroy other ships, bridges, and port facilities; empty tankers of their liquid cargo to create eco-disasters; deliberately set out to destroy ships and port facilities; and use ships to transport and perhaps detonate weapons of mass destruction and weapons of mass disruption (Rundmo, 2000). The modern threats of maritime security have widely spread into every node of the shipping context. The International Maritime Organization (IMO) considered the types of terrorism acts which threaten the security of ships, ports, offshore terminals and other facilities, and passengers, and developed the International Ship and Port Facility Security (ISPS) Code in December 2002. The ISPS Code was promptly entered into force on July 1, 2004.

This Code specifically endeavors to enhance ship and port security, and prevent shipping from becoming a target of international terrorism (Burmester, 2005; Chang et al., 2010). Since 2004, all those involved in the shipping industry, e.g. ports, carriers, shippers and ships, are requested to strictly follow the ISPS Code (Segars, 1997; King, 2005), and ship owners and ship operators are required to develop approved ship security plans and adopt appropriate security measures based on different security levels. In essence, the ISPS Code was developed to improve the risk management activity of ship owners and ship operators, to help them to determine appropriate security measures, and to assess the risks in each particular case in order to ensure the security of ships and port facilities (IMO, 2004).

Traditionally, pirate operations vary according to local conditions, the availability of targets, and the competence of the pirates involved (Abhyankar, 1999, 2002; Johnson and Pladdet, 2003). Pirates with little more than a small boat, ladders or grappling hooks, and automatic weapons, are able to board vessels and hold crews and cargo hostage. Pirate attacks have been categorized into five specific types (Rundmo, 2000; Abhyankar, 2002) according to how and where they occur: (1) ships are boarded and cash and valuables are stolen from the ship's safe and the crew with minimum amount of force; (2) ships at berth or at anchor are attacked by armed gangs; (3) ships are hijacked while underway, crew members are overpowered, and the entire cargo is stolen before the ship is handed back to the crew; (4) maritime attacks are associated with military or political features; and (5) different types of violence are shown towards ships and their crews.

The main aim of the new regulation whose is to enhance maritime security, including the protection of life, property and the marine environment. Moreover, the effective implementation of the ISPS Code relies heavily on the initiatives, co-operation and constant vigilance of seafarers to prevent breaches of maritime security (Hesse and Charalambous, 2004). Without seafarers' support and wholehearted commitment to the cause of security, implementation of the maritime security will be severely weakened. The cognitive and emotional components of risk perception are known to relate differently to risk behavior (Rundmo, 2000). Therefore, eliciting seafarers' perceptions of ISPS issues whilst the Code is being implemented onboard can provide insight into the limitations of its execution (Lehtinen, 1995; Mennis et al., 2005), which, in turn, can assist in improving maritime security in the shipping context. Seafarers' perceptions were elicited to provide insight into how the maritime security is currently being implemented onboard. Therefore, this study was conducted to evaluate the maritime security implementation in the maritime industry, especially focused on the container shipping context.

This paper consists of five sections. In the second section, the literature on security features in the shipping context is reviewed. In the third section, development of the research methodology, including questionnaire design, sampling technique, and research procedures, is described. Section four presents the empirical results derived from exploratory factor analysis, confirmatory factor analysis, and one-way analysis of variance (ANOVA). The research findings and their implications for security research and security management in the container shipping context are discussed in the final section.

2. SECURITY FEATURES IN THE SHIPPING CONTEXT

The ISPS Code supports SOLAS chapter XI to enhance maritime safety and security, and includes a mandatory section (part A) and a recommendatory section (part B). For ships, minimum functional security requirements include ship security plans, ship security officers, company security officers, and certain onboard equipment. Ships apply the ISPS Code according to the type of ship, its cargoes and/or passengers, its trading pattern, and the characteristics of the facilities of the port visited by the ship (Hermans et al., 2008).

The author was familiar with various types of vessels and had convenient chance to visit vessels calling in the port of Kaohsiung after the ISPS Code entering into force. He reviewed the literature on safety management, and then frequency formally and informally interviewed different levels of seafarer working onboard to discuss issues relating to pirate attacks and the maritime security implementation in their ships. The author also interviewed key personnel onboard ship which had experienced an attack by pirates carrying machine guns in the Aden area. He also visited a sister ship of *Zhenhua 4* and was made aware of the changes in ship structure and equipment since the ISPS Code had come into force. Interviews produced fruitful information regarding implementation problems, strengths and weaknesses of the maritime security, and seafarers' revealed their concerns about maritime security.

The most marking threaten on the shipping context is the modern pirates, because they have knowledge of what is being carried by specific ships and have all the sensational pirate attacks in which to operate (Sauvageot, 2009). Their access to modern equipment enables them to watch if they are being followed. At the first suggestion that an intervention force is on its way, they can wait and then commit their crime at a time when they know they have the time and space to escape. There were some marking events occurred in recent year. For example, the sensational pirate attacks in 2008, namely, the seizure of the Faina, the capture of the supertanker Sirius Star, and the Chinese ship *Zhenhua 4* showed that despite being unarmed, crew members of merchant ships can successfully fight off pirate attacks (Wong and Yip, 2011).

Normally, once pirates successfully board and hijack a ship, they take the crew hostage and threaten to sink the vessel, limiting options to rescue the crew and free the ship. Even though the ISPS Code provides a standardized, consistent framework for managing risk and permitting the meaningful exchange and evaluation of information between contracting governments, companies, port facilities, and ships, it has never prevented seafarers from experiencing pirate attack in the open sea.

The ISPS Code is specifically designed to enhance maritime security, and to particularly thwart acts of terrorism. The primary concerns of the ISPS Code (Part A) relating to ships focus on ship security, which includes control of access, monitoring the deck area, maintaining communications, etc.; ship security assessment; ship security plans and records; ship and company security officers; ship security training, drills and exercises; and verification and certification for ships. However, following the requirement of ISPS Code can the ship prevent from pirate attack? As combining the interviews, observation, and the security activities on board (Kessler, 1998; Hesse and Charalambous, 2004; Hermans et al., 2008), current study focused on some maritime security issues that are the requirement of the ISPS code to examine whether if the maritime security can really gain protection on board. The results of interviews revealed seafarers' considering issues and developed dimensions of a model are discussed in detail below.

2.1 Security Manpower

Burmester (2005) indicated that the prevention of breaches in maritime security ultimately relies upon the initiative and cooperation of seafarers. However, as a result of technological advances and innovations in the shipping industry, ships need fewer crew members for their operations. Ship owners' focus on cost cutting has also led to the need for fewer crew members aboard to operate the ship. Thus, given that even the largest bulk carriers and tankers have few crews, criminal gangs generally count on little resistance when they board them (King, 2005). Interviews with seafarers working in container ships and ship security officers prior to the design and distribution of the study instrument revealed their concern about insufficient numbers of crew members to deal with pirate attacks and to ensure maritime security onboard ship. The security manpower dimension was therefore proposed as a primary dimension of the assessment index for evaluating the maritime security implementation in this study.

2.2 Security Knowledge and Capability

One of the key objectives of the ISPS Code is to establish the respective roles and responsibilities of the related partners at the national and international level to ensure maritime security (King, 2005). Thus, all seafarers working onboard should have sufficientsecurity knowledge and capability to ensure security implementation performance. When their management places high priority on security issues, shipping companies will hire qualified seafarers and set up a security management system to enhance seafarers' security knowledge and capability to increase individual security competence (Chou et al., 2011). The security knowledge and capability dimension was therefore proposed as a key dimension in this study.

2.3 Security Training

The ISPS Code requires the development of a formal training program, that is to say, it specifies an on-going requirement for drills and exercises to keep the skills of shipboard and port facility personnel up-to-date after the ISPS Code has been implemented. Security training should be based on identified worker needs and designed to enhance relevant knowledge, skills, and attitudes. Hesse and Charalambous (2004) indicated that training and drills play an important role in ensuring implementation of the maritime security. Security should aim to improve workers' security performance and reduce negative outcomes. According to Burke et al. (2006), effective training will increase seafarers' security behaviors. Importantly, the more appropriate the security training adopted, the fewer the occurrences of negative outcomes. Thus, the security training dimension was viewed as an important factor for evaluating the maritime security implementation onboard ship.

2.4 Security Equipment

Maritime security equipment is used to prevent unauthorized boarding of ships in ports and at sea. However, since merchant ships' crew members are not armed (Wong and Yip, 2011), they have learned to defend themselves using nonlethal devices. Evasive maneuvers such as the utilization of high-powered spray hoses and the setting up of electric fences with high voltage pulses around ships have been used to discourage pirates from boarding vessels (Diaz and Dubner, 2009). High-tech equipment is also required to be fitted onboard, such as the Automotive Identification System (AIS) on all ships of 500 gross tonnage and above, a Ship Security Alert System (SSAS) for seafarers to use to notify the authorities and other ships of a terrorist hijacking, and a detector to check baggage and cargo for any explosive devices before embarking. Exception of the use of the latest high-tech equipment, ships can increase their security, for example, by strengthening lock pins or setting up digital security locks on access doors, constructing iron grids on the stairs between the weather deck and accommodation quarters, and providing seafarers with wooden bats and whistles while sailing through known piracy areas. In the case of the *Zhenhua 4*, its crew members successfully fought off the Somali pirates by cutting away the ladder connecting the access between the main deck and the accommodation quarters and locking themselves in these quarters to avoid being taken as hostages if the pirates came aboard. When the pirates attacked the ship, as well as hiding in the accommodation quarters, crew members used all resources available onboard, such as water cannon, homemade incendiary bombs, recycling beer bottles and other weapons to prevent the pirates from boarding the vessel and entering the accommodation area. This event raised a number of questions about merchant ships' defense. How can all seafarers effectively protect themselves from pirate attack? Is the existing security equipment sufficient to help ensure security onboard? Given the importance of security equipment for defense purposes, it was proposed as an important dimension in this study for evaluating the maritime security implementation performance onboard ship.

3. METHODOLOGY

3.1 Questionnaire Design and Content

The questionnaire was designed through a literature review and field study. Questionnaire perception attributes were based on the nine threats referred to in Part B of the ISPS Code, i.e. (1) Damage to, or destruction of the ship; (2) Hijacking or seizure of the ship or of persons onboard; (3) Tampering with cargo; (4) Unauthorized access or stowaways; (5) Smuggling weapons or equipment; (6) Use of the ship to carry perpetrators and their personal equipment; (7) Use of the ship itself as a weapon or as a means to cause damage or destruction; (8) The threat of attack from the seaward direction whilst at berth or at anchor; and (9) Attacks whilst at sea. Questionnaire was designed to elicit seafarers perceived the effectiveness of all security activities implementing on board. The questionnaire perception attributes related to the aforementioned four primary dimensions of security knowledge and capability; security manpower; security training; and security equipment, which were applied to elicit the seafarers' perceptions if the security activities can prevent them free from the threats of these primary issues.

A two-page questionnaire comprising two parts was subsequently developed as the study instrument, which was considered to be crucially important for evaluating the maritime security effectiveness. The first part of the questionnaire presented 28 statements to which seafarers were requested to indicate their perceptions regarding their level of execution on board ship. According to Seo's (2005) research, the impact of organizational factors on security onboard can influence workers' perceptions of work environment characteristics. The second part of the questionnaire therefore contained six questions which elicited respondents' rank, nationality, age, length of work experience, ship service route, and ship size.

A draft questionnaire was distributed to 16 Chinese seafarers, 10 Pilipino, and 12

Taiwanese for conducting pilot study. After piloting a draft version of the questionnaire, modifications were made based on their feedback, and then a final version was written in traditional Chinese and simple Chinese for seafarers from Taiwan and Mainland China and in English for general seafarers by a bilingual Captain. Respondents were asked to rate their agreement level with the 28 perception attributes using a five-point Likert scale, where 1 corresponded to "strongly disagree" and 5 to "strongly agree".

3.2 Data Collection and Sampling

A convenient sampling technique was used in this study. When a vessel called at terminal 70 and terminal 120 of Kaohsiung port, packages of questionnaires with a greetings and explanatory letter were delivered to the captain of the vessel between October and December 2009. In total, seven hundred and twenty questionnaires were distributed and 276 usable ones were returned, a response rate of 38.3%. The Statistical Package for the Social Science (SPSS) 13.0 for Windows 2003 was used to carry out the analysis processes. Factor analysis makes it possible to reduce the number of items for more convenient general application and without sacrificing validity (Lu and Tsai, 2008). Principal components analysis with Varimax rotation was applied. The greatest amount of variance, eigen values greater than one, and a scree plot were used as criteria to extract the number of factors (Benson and Nasser, 1998; Churchill and Iacobucci, 2004; Hair et al, 2006). Cronbach's alpha was used to identify items closely correlated with each other and therefore demonstrably measuring the same underlying component or dimension.

Criterion related validity should be established by correlating the scores with outcome data, preferably collected by some method other than the questionnaire instrument. Factor analysis reveals the underlying structure of a scale and shows whether there are distinct factors or themes being measured. It requires reasonably large data sets (of about 100) or a sample where there is a 10:1 ratio of participants to items (Ferguson and Cox, 1993; Hair et al., 2006). Factors with three items or fewer are too close to being variable specific and should be discarded (Guadagnoli and Velicer, 1988). The internal reliability data for proposed/identified factors can also be assessed. A Cronbach's alpha score of 0.7 or higher is usually regarded as indicative of acceptable internal reliability (DeVellis, 1991).

4. RESULTS OF EMPIRICAL ANALYSIS

4.1 The Respondents

Respondent's characteristics in terms of job title, nationality, age, length of work experience, ship service route, and ship size were elicited to help to ascertain whether seafarers' perceptions were influenced by these characteristics. Among respondents, 11 were captains and 21 were chief officers (see Table 1). Because these ranks play a supervisory and security officer onboard ship, they were categorized as supervisors. Respondents also included 50 deck officers, 103 deck ratings, 53 engineers and 38 engine ratings. As regards nationality, 80 respondents were from Mainland China, 16 from India, 22 from Myanmar, 52 from the Philippines, and 86 from Taiwan. The small number of respondents from other countries (20), including Singapore (1), Korea (2), Russia (4), Ukraine (8), Tuvalu (4) and Tanzania (1), were categorized under the 'Other' group. With respect to age, results indicated that 103 respondents were aged 30 years or less, 73 were aged between 31 and 40, 55 were aged between 41 and 50, and 45 were 51 years old or above. Ninety-six respondents had work experience three years or less, 68 between 4 and 9 years, and 112 had 10 years or more. Most respondents 199 (72.1%) worked onboard container ships which serviced the Pan Asia route, 33 respondents' employing ships serviced the Far East/Europe route, and those of 44 respondents serviced the Far East/ North America route.

4.2 Factor Analysis Results

Exploratory factor analysis (EFA) is popularly employed in exploratory studies and was conducted to develop and evaluate measurement dimensions in this study. In order to detect the presence of meaningful patterns among the original variables and extract the main factors, principal component analysis with varimax rotation was applied to reduce the 28 perception attributes into a smaller and manageable set of underlying dimensions. The Kaiser-Meyer-Olkin value of 0.936 indicated that the data were suitable for conducting factor analysis, and the Bartlett Test of Sphericity [$\chi^2 = 6042.48$, $P < 0.001$] suggested that correlations existed amongsome of the response categories. Eigenvalues greater than one was used to determine the number of factors in each data set (Gorsuch, 1983; Churchill and Iacobucci, 2004). Results presented in Table 2 indicate that four factors

Table 1 Profile of respondents

	Characteristics	Frequency	Percentage (%)
Job title	Captain	11	4.0
	Chief officer	21	7.6
	Deck officer	50	18.1
	Deck rating	103	37.3
	Engineer	53	19.2
	Engine rating	38	13.8
Age	30 or less	103	37.3
	Between 31 to 40	73	26.4
	Between 41 to 50	55	19.9
	51 or more	45	16.3
Length of work experience	3 years or less	96	34.8
	Between 4 to 9 years	68	24.6
	10 years or more	112	40.6
Nationality	Mainland China	80	29.0
	India	16	5.8
	Myanmar	22	8.0
	Philippines	52	18.8
	Taiwan	86	31.2
	others	20	7.2
Service route	Pan Asia	199	72.1
	Far East/Europe	33	12.0
	Far East/North America	44	15.9
Ship size	Small	199	72.1
	Medium	33	12.0
	Large	44	15.9

accounted for approximately 74.95% of the total variance and thus represented the primary assessment index for evaluating the maritime security implementation derived from seafarers' perceptions. Moreover, an examination of loading factors in Table 2 shows all items on each of the factors at 0.5 or higher, indicating enhanced interpretability (Hair et al., 2006). Four factors were subsequently found to underlie the assessment of the maritime security implementation in the container shipping context based on seafarers' responses.

Factor 1, a security training dimension, contained six items referring to ISPS training perception, therefore, was labeled *security*

Table 2 Exploratory factor analysis with varimax rotation results (N = 276)

Var.	Measures	F1	F2	F3	F4
V46	ISPS training is sufficient to prevent the threat of pirate attacks.	**0.81**	0.22	0.23	0.33
V45	ISPS training is sufficient to prevent the ship from being hijacked.	**0.80**	0.25	0.21	0.32
V41	ISPS training is sufficient to prevent bomb or arson damage to/from destroying my ship.	**0.79**	0.20	0.26	0.21
V44	ISPS training is sufficient to prevent tampering with the ship's cargo, equipment/system, or stores.	**0.76**	0.18	0.36	0.14
V42	ISPS training is sufficient to prevent smuggled weapons or equipment on my ship.	**0.75**	0.17	0.40	0.21
V47	ISPS training is sufficient to prevent the use of my ship itself as a weapon to cause damage or destruction.	**0.73**	0.26	0.31	0.23
V25	I have sufficient capability/knowledge to prevent the ship from being hijacked.	0.21	**0.84**	0.08	0.14
V27	I have sufficient capability/knowledge to prevent the use of my ship itself as a weapon to cause damage or destruction.	0.19	**0.82**	0.18	0.18
V26	I have sufficient capability/knowledge to prevent the threat of pirate attacks.	0.23	**0.81**	0.09	0.26
V22	I have sufficient capability/knowledge to prevent smuggled weapons or equipment on my ship.	0.11	**0.78**	0.09	0.16
V21	I have sufficient capability/knowledge to prevent bomb or arson damage to/from destroying my ship.	0.20	**0.77**	0.14	0.22
V24	I have sufficient capability/knowledge to prevent tampering with the ship's cargo, equipment/system, or stores.	0.11	**0.73**	0.32	0.14
V54	There is sufficient equipment in my ship to prevent tampering with the ship's cargo, equipment/system, or stores.	0.23	0.15	**0.85**	0.16
V52	There is sufficient equipment in my ship to prevent smuggled weapons or equipment on my ship.	0.24	0.17	**0.78**	0.27
V57	There is sufficient equipment in my ship to prevent the use of my ship itself as a weapon to cause damage or destruction.	0.32	0.19	**0.74**	0.22
V51	There is sufficient equipment in my ship to prevent bomb or arson damage to/from destroying my ship.	0.31	0.25	**0.68**	0.28
V55	There is sufficient equipment in my ship to prevent the ship from being hijacked.	0.39	0.17	**0.61**	0.36
V53	There is sufficient equipment in my ship to control stowaways on my ship.	0.29	0.05	**0.53**	0.25
V36	There are sufficient crewmembers in my ship to control the threat of pirate attacks.	0.34	0.29	0.21	**0.80**
V35	There are sufficient crewmembers in my ship to prevent the ship from being hijacked.	0.32	0.28	0.25	**0.78**
V31	There are sufficient crewmembers in my ship to control bomb or arson damage to/from destroying my ship.	0.22	0.30	0.37	**0.72**
V37	There are sufficient crewmembers in my ship to control the use of my ship itself as a weapon to cause damage or destruction.	0.25	0.24	0.37	**0.69**
V32	There are sufficient crewmembers in my ship to control smuggled weapons or equipment on my ship.	0.26	0.30	0.41	**0.65**
Eigenvalues		12.28	2.46	1.38	1.12
Percentage of Variance		20.50	20.08	18.43	15.94
Accumulated percentage variance		20.50	40.58	59.00	74.95
Cronbach's Alpha		0.94	0.92	0.91	0.94

training. It accounted for 20.50% of the total variance.

Factor 2, a security knowledge and capability dimension, comprised six items relating to security knowledge and capability perception. It was therefore labeled *security knowledge and capability* and accounted for 20.08% of the total variance.

Factor 3, a security equipment dimension, consisted of six items related to security equipment in the ship. It was therefore labeled *security equipment* and accounted for 18.43% of the total variance.

Factor 4, a security manpower dimension, contained five items related to security manpower perception. It was therefore labeled security manpower and accounted for 15.94% of the total variance.

A reliability test was employed to ensure consistent measurement across time and across the various items in the research instrument (Sekaran, 2003), and to indicate the extent to which it measured without bias. Corrected item-total correlation (CITC) and Cronbach's alpha coefficient were employed to measure the internal consistency and stability of each construct of the seafarers' perception dimensions. Table 3 shows that Cronbach's alpha values for all the seafarers' perception dimensions were 0.94, 0.92, 0.91, and 0.94, respectively, well above the suggested threshold of 0.7 (Nunnally, 1978; Churchill and Iacobucci, 2004). All the corrected item-total correlation values were greater than the recommended value of 0.5 (Koufteros, 1999; Churchill and Iacobucci, 2004) and, therefore, each dimension of seafarers' perception of the maritime security performance assessment was acceptable (Kessler, 1998; Lauder et al., 2000).

Table 3 Reliability test results

Dimension	Items	Mean	S.D.	Cronbach's α	Corrected item-total correlation
Security training	6	3.55	0.15	0.94	0.74 - 0.86
Security knowledge and capability	6	3.36	0.13	0.92	0.69 - 0.81
Security equipment	6	3.14	0.32	0.91	0.76 - 0.83
Security manpower	5	3.30	0.16	0.94	0.67 - 0.85

4.3 Confirmatory Factor Analysis

Several researchers (Segars, 1997; O'Leary-Kelly and Vokurka, 1998) have indicated that EFA, CITC and Cronbach's alpha do not assess unidimensionality, nor can unidimensionality be explained by either mathematical or practical examinations (Gerbing and Anderson, 1988; Koufteros, 1999). Confirmatory factor analysis (CFA) with multiple indicator measurement models was therefore employed to assess unidimensionality (Anderson et al., 1987; Segars, 1997). The hypothesized maritime security evaluation model with four latent variables, namely, security training, security manpower, security equipment, and security knowledge and capability, was made up of their correspondent multiple indicators. Both absolute fit indices containing the χ^2-statistic, the ratio of χ^2 to degrees of freedom of a model, the root mean square error of approximation (RMSEA), the root mean square residual (RMR or SRMR), goodness-of-index (GFI), and adjusted goodness-of-index (AGFI), and incremental fit indices includingnormed fit index (NFI), non-normed fit index (NNFI or TLI) and comparative fit index (CFI), have been recommended for assessing model adequacy (Marsh et al., 1988; Haynes et al., 1995; Shah and Goldstein, 2006) .

The proposed maritime security implementation evaluation model, which included four constructs with 23 indicators, had a statistically significant χ^2 value (χ^2 (203) = 882.69, $p < 0.001$) at the 1% significance level. Because the χ^2 -statistic is sensitive to sample size (Bentler and Bonnet, 1980; Shah and Goldstein, 2006), the model modification decision was not based on this goodness-of-fit index. Referring to other goodness-of-fit indices, the absolute fit index, i.e. the ratio of χ^2 to degrees of freedom of a model (χ^2 /df) was 4.35; goodness-of-index (GFI) was 0.73; adjusted goodness-of-index (AGFI) was 0.67; the root mean square residual (RMR) was 0.06; the root mean square error of approximation (RMSEA) was 0.11; the incremental fit index, i.e. non-normed fit index (NNFI or TLI), was 0.87, and the comparative fit index (CFI) was 0.88. All the aforementioned fit indices (see Table 4) were not well within the recommended values; even all the variables had squared correlation values greater than the recommended cut-off value of 0.3 (Hair et al., 2006). Accordingly, the results implied that the initial maritime security evaluation model needed to be modified (Gerbing and Anderson, 1988; Marsh et al., 1988; Tanaka, 1993; Hu and Bentler, 1998).

Apart from the aforementioned overall model fit indices, other statistical criteria for model modification decisions include offending estimate, square multiple correlations, and standardized residual covariance. The process of assessing the proposed maritime security implementation evaluation model resulted in one item and four items being dropped from the security training dimension and the security knowledge and capability dimension, respectively, and three items being dropped from both the security manpower dimension and security equipment dimension. These items were deleted iteratively based on criteria such as large standardized residuals in absolute terms greater than 2.58 (Hair et al., 2006) and completely standardized expected changes greater than 0.3 (Koufteros, 1999).

The resulting proposed measurement model of maritime security had an acceptable model-to-data fit (see Table 4). The Chi-square (χ^2) value was 85.78 at 48 degrees of freedom, and had a statistical significance at $p < 0.001$, below the minimum level of 0.05. Because the Chi-square value is sensitive to sample size (Bentler and Bonnet, 1980; Shah and Goldstein, 2006), other indices were examined (Hu and Bentler, 1998; Koufteros, 1999). The normed Chi-square ratio (χ^2 /df) had a value of 1.79, an acceptable value. The root mean square residual (RMR) indicated that the average residual correlation was 0.04, which was smaller than the threshold value of 0.05. The root mean square error of approximation (RMSEA) was a reasonable value of 0.05 and it was fair fit. Goodness-of-fit-index (GFI) was 0.95 and the adjusted goodness-of-fit-index (AGFI) was 0.92, both fitness values are good. The comparative fit index (CFI) was 0.99 and the Tucker Lewis Index (TLI) was 0.98, higher than the recommended level of 0.90. No items exhibited completely standardized expected changes greater than 0.3 (Browne and Mels, 1990; Koufteros, 1999). The results therefore did not justify an alternative specification.

Convergent validity can be confirmed if t-values are all statistically significant on the factor loading (Dunn et al., 1994). The completely standardized coefficients and t-values for the measurement model were all statistically significant at $p < 0.001$. Therefore, all indicators were significantly related to their specified constructs, verifying the posited relationships among the indicators and constructs.

Construct reliability is the degree

Table 4 Modification of the implementation evaluation model of the maritime security

	No. of Var. deleted	χ^2	χ^2/df	GFI	AGFI	CFI	RMR	RMSEA	P Value
Initial model	–	882.69	4.35	0.73	0.67	0.88	0.06	0.11	0.00
Final model	10	85.78	1.79	0.95	0.92	0.99	0.04	0.05	0.00

to which a set of two or more indicators shares the measurement of a construct. Highly reliable constructs are those in which the indicators are highly intercorrelated, indicating that they are all measuring the same latent construct. The composite reliability estimates are shown in Table 5. The reliability of the security knowledge and capability, security manpower, security training, and security equipment constructs were 0.91, 0.93, 0.94, and 0.88, respectively. All constructs exceeded the recommended level of 0.70 (Hair et al., 2006).

The variance extracted value is a complementary measure for the construct reliability value (Koufteros, 1999). The average variance extracted (AVE) statistic measures the amount of variance in the specified indicators accounted for by the latent construct. When the indicators are truly representative of the latent construct, variance extracted values are high. All variance extracted values were greater than 0.71, indicating that at least 71% of the variance in the specified indicators was accounted for by the latent construct and greater than the recommended level of 50% (Fornell and Larcker, 1981). All items correlated most strongly with their intended construct/dimension, and the square root of AVE for these constructs was larger than any respective inter construct correlations, providing evidence of discriminant validity. A test of discriminant validity of maritime security implementation evaluation constructs (see Table 5) provided further evidence that mono-method bias was not an issue, and that multicollinearity was not a potential confound. The results therefore provided further evidence to support the proposed model.

The CFA results confirmed that all indicators measured the same construct and provided satisfactory evidence of the unidimensionality of each construct (Anderson and Gerbing, 1988). As shown in Table 5, the construct reliability of the constructs of security knowledge and capability, security manpower, security training, and security equipment was 0.91, 0.93, 0.94, and 0.88, respectively. The final maritime security implementation evaluation model was therefore yielded through modification and a string of tests, i.e. the standardized covariance residuals, the modification indices, convergent validity, discriminant validity, and composite reliability. Such tests provided evidence that the model had been purified and was satisfactory.

Table 5 Construct reliability, average variance extracted measures, and correlations among the dimensions of the maritime security implementation evaluation model

Constructs	No. of items	Mean[a]	S.D.[b]	Construct reliability	(1)	(2)	(3)	(4)
(1) Security knowledge and capability	2	3.23	1.10	0.91	0.83[d]			
(2) Security manpower	2	3.16	1.24	0.93	0.54**[e]	0.87		
(3) Security training	5	3.49	1.02	0.94	0.49**	0.67**	0.75	
(4) Security equipment	3	3.10	1.07	0.88	0.45**	0.66**	0.71**	0.71

Note:
[a] The mean score is based on a five-point scale where 1 = strongly disagree to 5 = strongly agree.
[b] S.D. = standard deviation.
[c] Internal consistency of the reflective constructs.
[d] The average variance extracted (AVE) value.
[e] Correlation coefficient.
** $p < 0.01$

4.4 One-way Analysis of Variance

An ANOVA was conducted to compare differences in seafarers' perceptions of maritime security implementation evaluation based on their personal characteristics. No statistically significant difference was found for age, whereas one dimension, security manpower, and another dimension, security training, showed a statistically significant difference for job level and for working experience, respectively. When comparing differences in seafarers' perceptions based on nationality, the four dimensions were all found to significantly differ at the $p < 0.05$ significance level (see in Table 6). Results revealed that respondents from the Philippines had a higher mean score on the security knowledge and capability, security manpower, and security equipment dimensions than respondents from Mainland China, India, Myanmar, and Taiwan. Respondents from India and Myanmar had the highest mean score on the security training dimension. Respondents from Mainland China had the lowest mean score on all four dimensions. The results implied that seafarers from India and Myanmar were lack of the training referring to maritime security and the seafarers from Mainland China were overlooking the maritime security issues on board ship.

ANOVA tests were conducted to examine if differences existed in respondents' perceptions of the maritime security implementation according to the ship service route and ship size. Table 7 indicates that all

Table 6 Comparison of differences in seafarers' perceptions of the four primary dimensions based on nationality

Dimension	(1) Mainland China		(2) India and Myanmar		(3) Philippines		(4) Taiwan		F Ratio	Scheffe test
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Security knowledge and capability	2.78	1.17	3.45	0.99	3.64	0.94	3.32	1.02	6.13**	(1,2) (1,3) (1,4)
Security manpower	2.66	1.40	3.58	1.14	3.91	1.00	2.90	0.89	12.52**	(1,2) (1,3) (3,4)
Security training	3.16	1.05	3.85	0.83	3.84	0.99	3.40	0.85	5.44**	(1,2) (1,3)
Security equipment	2.74	1.10	3.37	0.96	3.40	1.11	3.04	0.88	4.76**	(1,3)

Note: ** $p < 0.01$

dimensions were found to significantly differ at the 5% significance level. Respondents whose ship service route was the Far East/Europe had the highest mean score (3.83) on the security knowledge and capability dimension, respondents whose ship service route was the Far East/North America had the highest mean score on the security manpower, security training, and security equipment dimensions. Respondents whose ship service route was the Pan Asia service route had the lowest mean score on all four dimensions. These results implied that the seafarers encountering higher risk of piracy attack threat than other service route. The ship owners should invest some resource to enhance marine security.

Comparing differences in seafarers' perceptions according to ship capacity, results in Table 8 show all four security dimensions

Table 7 Comparisons of differences in seafarers' perceptions of the maritime security implementation based on ship service route

Dimension	(1) LAN1		(2) LAN2		(3) LAN3		F Ratio	Scheffe test
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Security knowledge and capability	3.83	1.01	3.78	0.95	3.01	1.07	16.07**	(1,3)(2,3)
Security manpower	3.56	1.18	3.75	1.16	2.97	1.22	9.61**	(1,3)(2,3)
Security training	3.53	1.24	3.91	0.76	3.39	1.01	4.87*	(2,3)
Security equipment	3.38	1.21	3.56	0.89	2.94	1.05	7.62**	(2,3)

Note: LAN1 = Far East/Europe, LAN2 = Far East/North America, and LAN3 = Pan Asia
**$p < 0.01$; *$p < 0.05$

Table 8 Comparisons of differences in seafarers' perceptions of the maritime security implementation based on ship capacity

Dimension	(1) Small		(2) Medium		(3) Large		F Ratio	Scheffe test
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Security knowledge and capability	3.01	1.07	3.78	0.95	3.83	1.01	16.07**	(1,2)(1,3)
Security manpower	2.97	1.22	3.75	1.16	3.56	1.18	9.61**	(1,2)(1,3)
Security training	3.39	1.01	3.91	0.76	3.53	1.24	4.87*	(1,3)
Security equipment	2.94	1.05	3.56	0.89	3.38	1.21	7.62**	(1,3)

Note: Small < 3,000 TEU, Middle = between 3,000 and 6,500 TEU, and Large > 6,500 TEU
**p < 0.01; *p < 0.05

differed significantly at the 5% significance level. Respondents on small container ships had the lowest mean score on all four dimensions. Respondents on medium size container ships had the highest mean score on security manpower, security training, and security equipment dimensions. Respondents on large container ships had the highest mean score on the security knowledge and capability dimension.

5. CONCLUSIONS AND DISCUSSION

The primary objectives of this study were to develop an effective assessment model for evaluating the maritime security implementation in the container shipping context. Based on a review of literature on security features in the shipping context and both the formal and informal interviews with different levels of seafarer working onboard, twenty-eight effective attributes were presented in a questionnaire distributed to seafarers working on container ships which called at Kaohsiung port. Respondents were asked to express their agreement level with all twenty-eight attributes. Four evaluation dimensions of the maritime security implementation were yielded through exploratory factor analysis and verified by confirmatory factor analysis. The four dimensions were security knowledge and capability, security manpower, security training, and security equipment.

ANOVA tests were carried out to determine whether respondents' demographic characteristics had an influence on their perceptions of the maritime security implementation. Results indicated that seafarers from Mainland China had the lowest mean score on all four security dimensions. Seafarers whose ship service route was the

Pan Asia route also had the lowest mean score on all four security dimensions. Filipino seafarers and those whose ship service route was the Far East/North America service route had the highest means on the security manpower and security equipment dimensions. The study findings thus indicated that seafarers from different countries and working on ships of different capacity and sailing on different service routes had significant differences in perceptions of the maritime security onboard. In general, small container ships whose ships serve in the Pan Asia service route have a slower speed and lower freeboard. They sail coastally around the South China Sea and across the Malacca Strait. Pirate attacks occur frequently in these areas. Small ships with low freeboard and slow sailing speed are easy targets for pirates to board with simple tools. Seafarers working on small container ships sailing in high piracy attack areas felt they were at a high level of risk from pirate attack. In contrast, medium size and large container ships whose service ship routes are the Far East/Europe and Far East/North America routes have higher freeboard and higher speed. Their higher speed makes it more difficult for pirates to catch up with them and their higher freeboard makes it more difficult for pirates to embark on board. Accordingly, seafarers working on board such vessels had higher security confidence and higher perceptions of the maritime security, even though these vessels sail through high piracy risk areas like the Bay of Aden and the Somali coastal area.

Several contributions are made by this research, both to the field of study and security in the container shipping context. First, previous studies have focused on the threats of pirate attack (Vagg, 1995; Abhyankar, 1999, 2002; White and Wydajewski, 2002; Johnson and Pladdet, 2003; Kraska and Wilson, 2008) in the shipping context, the contents of the ISPS Code (Hesse and Charalambous, 2004; Ng, 2009) and cooperation prevention based on the view (Hesse and Charalambous, 2004). This is the first study as far as the researcher is aware to focus on producing an assessment model for evaluating the maritime security implementation onboard, a model which consists of four dimensions, namely, security knowledge and capability, security manpower, security training, and security equipment. The attributes remained in the final model were filtered through EFA and confirmed by CFA. It provides a simple model with few attributes for future research to evaluate the implementation of ISPS Code on board ship. Second, the research contributes theoretically by identifying dimensions for evaluating the maritime security implementation in the container shipping context, which can be employed in future research. Finally, the research found that seafarers' perceptions of the maritime security implementation significantly differed according to nationality, ship service route and ship capacity. Since seafarers play an important role in the container shipping context and stand at the front line to prevent pirate attacks onboard (Burmester, 2005), the research findings suggest that security management content onboard ship should take into account seafarers' and ships' individual characteristics as there is no universal standard fit for all ship sizes and all environments. Therefore, the ship security managements may not only fully implement the requirement of the ISPS Code, but for actual protection from security events. The study findings suggested that ship security management should pay close attention and adjust the equipment and protection structure according to each ship's individual characteristics, crew members, and service route (Lehtinen, 1995; Hesse and Charalambous, 2004; Mennis et al., 2005; Hermans et al., 2008).

This study specifically focused on the container shipping context. Future studies could collect data from seafarers working on different ship types, such as bulk carrier, oil tanker, and cruise vessel. Moreover, as it was difficult to collect information from seafarers working onboard ship, future research should consider cooperation with shipping companies to collect questionnaires at different calling ports. In addition, since this study was based on a cross-sectional survey, future research could conduct a longitudinal study to assess changes in seafarers' perceptions of the maritime security over a longer period of time. However, the maritime security implementation is believed to be influenced by the ship's flag state, the ports of call, and the owners. Future studies could also extend the study results to focus on these issues associated with the maritime security implementation in the shipping context.

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