WMU Journal of Maritime Affairs (2018) 17:461–474
https://doi.org/10.1007/s13437-018-0153-4

ARTICLE

ISM Code implementation: an investigation of safety issues in the shipping industry

Maria Karakasnaki[1] · Periklis Vlachopoulos[1] · Angelos Pantouvakis[1] · Nancy Bouranta[2]

Received: 8 March 2018 / Accepted: 24 August 2018 / Published online: 3 September 2018

Abstract

Acknowledging that shipping safety continues to be a major topic of interest in the maritime community, the present study attempts to identify the critical factors of International Safety Management (ISM) Code implementation, to identify the dimensions that describe whether the ISM Code has fulfilled its intended purpose as well as to assess their interrelationships. Moreover, the present study aims to explore whether the fulfillment of the Code's intended purpose is associated with accident reduction. Evidence was drawn from a sample of 63 masters and chief officers who have hands-on onboard experience on ISM Code implementation and data were analyzed through the use of Exploratory Factor Analysis (EFA), correlation analysis, and binomial logistic regression. Findings indicate that the critical factors of ISM Code implementation can be categorized in the crew-related and the company-related dimensions. Also, the fulfillment of the intended purpose of the ISM Code consists of the factors of safety management system efficiency and increased safety, which were also found to be significantly associated with the crew-related dimension of ISM Code implementation. Finally, results showed that both safety management system efficiency and increased safety increase the probability of accident reduction at the highest level.

Keywords ISM code · Maritime accidents · Shipping safety · Maritime industry

✉ Maria Karakasnaki
mkarakasnaki@gmail.com

Angelos Pantouvakis
angelos@pantouvakis.eu

Nancy Bouranta
nbouranta@upatras.gr

[1] Department of Maritime Studies, University of Piraeus, Grigoriou Labraki 21 and Distomou, 18533 Piraeus, Greece

[2] Department of Business Administration of Food and Agricultural Enterprises, University of Patras, Patras, Greece

1 Introduction

The shipping industry constitutes one of the most important determinants of world economic development, as over 80% of global trade in terms of volume and over 70% of it in terms of value is carried by sea (UNCTAD 2017). It is worthwhile to be noted that the world fleet increased by 3.2% in 2016, while the world seaborne trade volumes also grew by 2.6% (UNCTAD 2017). In order to ensure the safe and efficient transportation of goods, the operations in the shipping industry are dominated by a series of regulations that are mandatory for all shipping companies and aim at increasing the safety and quality standards in the maritime sector (Mukherjee 2007; Thai and Grewal 2006). In fact, shipping safety involves the implementation of international as well as national regulations with the ultimate aim to decrease the risk to humans, property, and the environment (Veiga 2002). In this vein, the International Safety Management (ISM) Code was explicitly designed for ensuring the safe operations of ships, as well as pollution prevention (IMO 2010). The implementation of the ISM Code is obligatory for all shipping companies, includes general principles and objectives, and requires the design of a safety management system (SMS), which ensures that the relevant rules, standards, and guidelines are followed.

Acknowledging the significance of the ISM Code, various authors have attempted to evaluate its effectiveness (Pantouvakis and Karakasnaki 2016) or assess its contribution to the minimization of maritime casualties (Tzannatos and Kokotos 2009). Despite some interesting findings on accident reduction after the introduction of the ISM Code (Tzannatos and Kokotos 2009), a closer look at the relevant literature indicates that in some cases, the ISM Code fails to fulfill its intended purpose (Bhattacharya 2012). Furthermore, other research studies reveal the inability of shipping companies to align their operations to certain clauses of the ISM Code resulting in casualties or incidents (Batalden and Sydnes 2014). This finding has led the academic community to identify the specific factors that facilitate (Tunidau and Thai 2010) or inhibit the successful implementation of the ISM Code (Pun et al. 2003).

With divergent findings regarding the successful implementation of the ISM Code, a detailed investigation of the critical factors that determine its application by shipping companies (Tunidau and Thai 2010) becomes even more imperative. While existing research on this topic is promising, more empirical evidence is needed (Tunidau and Thai 2010). Thus, firstly, the current study attempts to answer to this call in the literature. Moreover, building on recent studies that have questioned the proper implementation of the ISM Code (Bhattacharya 2012; Knapp and Franses 2010), the second aim of this study is to identify the dimensions that describe whether the ISM Code has fulfilled its intended purpose as well as to assess their interrelationships with the critical factors of its implementation. Finally, following the evidence in the literature that associates the implementation of the ISM Code with maritime casualties (Batalden and Sydnes 2014), we explore whether perceptions on the intended purpose of the ISM Code are associated with accident reduction in the shipping industry.

2 Theoretical background and research questions

2.1 International Safety Management Code: an overview

The ISM Code is a global regulatory framework that aims at upgrading the safety and quality levels in the shipping industry. The ISM Code became mandatory in 1998 as a response to poor management practices and errors as well as to major shipping accidents (IMO 2010). According to the International Maritime Organization (IMO 2010), the ISM Code has three major objectives, which address sea safety, human safety, and avoidance of environmental damage (Mukherjee 2007). The ISM Code requires every shipping company to establish and implement a safety management system (SMS), which should include structured documentation procedures and assists seagoing and shore-based personnel to effectively implement the shipping company's quality, safety, and environmental policy (Batalden and Sydnes 2014; IMO 2010).

Specifically, the ISM Code is composed of two parts that describe the various requirements that a shipping company should meet in order to ensure the implementation of an efficient SMS and the execution of safe shipping operations (IMO 2010). In general, the first part (part A) concerns the implementation of the ISM Code by the shipping companies and includes 12 clauses. These clauses articulate the requirements that must be met by firms and address a number of different issues that range from the company and master's responsibility and authority to the maintenance of the ship and the need for documentation. The second part (part B) of the ISM Code is comprised of four clauses that highlight the need of certification and verification and as such provides a number of requirements on these issues.

More specifically, with regard to the first part of the ISM Code (part A), its first clause presents a list of definitions that apply to different maritime terms and concern both parts (part A and part B). These definitions, for example, refer to the SMS or the safety management certificate and the document of compliance. Also, in this part, it becomes clear that the maritime firm should articulate its objectives regarding its safety management. This aim is accomplished through developing as well as implementing an effective SMS. Through this SMS, the maritime company is committed to adhering to obligatory regulations, to assessing all risks and to ensuring that all organizational members (that include both on-shore personnel and crew) are capable of successfully corresponding to the safety management prescriptions (IMO 2010). Moreover, in the second clause of part A, the Code focuses on the requirements on how to implement a SMS, as well as it stresses the need to create and follow a policy for promoting safety and environmental protection in all parts of the organization.

The next three clauses (clauses 3, 4, and 5) refer to the responsibilities of the maritime firm, the duties of the designated person(s) and the ship master respectively. The ISM Code highlights that the designated person is primarily engaged in procedures that concern safety as well as environmental pollution prevention. Moreover, this person (or persons) acts as the mediator between the employees in the office and personnel on-board vessels, while in general he/she has the duty to continuously check the safety processes. Apart from assigning to a person the abovementioned duties, the maritime firm should ensure that the master's responsibilities and power are articulated in detail and that all crew members understand the safety and environmental protection

policy and stick to its rules, as well as they maintain an efficient communication with managers in the office in order to provide information on potential failures (IMO 2010).

Furthermore, clause 6 of part A refers to the resources and the quality of employees of the maritime firm, clause 7 reveals the need to design procedures for shipboard operations, while the next clauses (clauses 8 and 9) state that any shipping organization should be prepared in order to confront emergency situations and be able to list non-conformities, accidents/near misses, or hazardous occurrences respectively. The fact that the maritime firm should maintain its vessel and technical equipment in good condition and proceed to frequent inspections is highlighted in clause 10 of part A. Clause 11 emphasizes data documentation and clause 12 refers to the evaluation of the SMS effectiveness, the compliance to the mandatory regulations, and the implementation of corrective plans. All these can be achieved through developing verification and review mechanisms (IMO 2010).

Part B of the ISM Code deals with certification and verification issues. The certification issues are analyzed in clauses 13 and 14, while the clause 15 focuses on the verification procedures. In more detail, the certification as well as the verification stages of both the document of compliance (issued to a maritime firm that follows the ISM Code's mandatory requirements) and the safety management certificate (issued to a vessel that is operated by a maritime firm, the operations of which are characterized by the implementation of the SMS) are described in clause 13. In this clause, more information is given with regard to the procedures followed by the relevant regulatory bodies and the necessary time limits (IMO 2010). Also, clause 14 of part B presents the interim document of compliance and the interim safety management certificate, as the Code acknowledges that there exist newly founded maritime firms, new ships, or changes in the vessel flag. Last but not least, the forms/templates of the abovementioned documents are provided in clause 16 of the ISM Code.

2.2 Critical factors that influence the implementation of the ISM Code

The above discussion reveals that the application of the ISM Code should aim at promoting and disseminating a safety culture in the maritime industry (IMO 2010; Veiga 2002). To achieve this aim and in order for the maritime firms to be successful in fostering this safety culture in all organizational departments, certain conditions should be met. For example, studies in the literature have emphasized that all organizational members should possess high levels of commitment, as well as adopt certain values and beliefs that will lead to the successful implementation of the ISM Code, while the commitment of managers in key organizational positions with regard to developing the appropriate safety management policy is also a prerequisite to achieve the above goal (IMO 2010; Tunidau and Thai 2010). Following this rationale, a number of studies have dealt with the examination of these crucial factors that can influence the successful implementation of the ISM Code, while other authors have attempted to assess the Code's intended purpose.

For instance, Pun et al. (2003) focused on recommending a specific strategy through which a shipping organization would be able to verify that its SMS is in accordance with the obligatory terms of the ISM Code. This strategy involves 15 stages and underscores the importance of top managers' commitment to continuous improvement endeavors, the formulation of a committee that would be responsible for safety

management matters, the appointment of the designated person ashore, and the training and development of all employees that are in charge of safety issues in order for the latter to acquire the necessary expertise and abilities. In a different study, Tunidau and Thai (2010) proceeded to an evaluation of the crucial factors that determine the successful implementation of the ISM Code. According to the authors, these factors comprise leadership and management commitment, the cultivation of both quality management and safety management principles, employees' stance and motivation for safety culture diffusion, and personnel empowerment and skills/knowledge. Apart from these factors, Tunidau and Thai (2010) also mentioned the reduction of the level of documentation, cost of/financial resources for compliance, the promotion of shipping safety awareness initiatives and finally lack of crew fatigue.

On the other hand, other factors, which adversely affect the successful implementation of the ISM Code, may include the high degree of bureaucracy and need for documentation, as well as inconsistencies in the interpretation of the Code's clauses and requirements (Lappalainen et al. 2012). In this vein, Lappalainen et al. (2012) also mentioned the lack of precise instructions for implementing the ISM Code and monitoring safety performance. Bhattacharya (2012) emphasized that the different perceptions on the Code's underlying meaning among crew staff and on-shore managers is an important reason for the Code's unsuccessful implementation. Finally, shore-based employees' and crew's hesitation to accept changes, absence of capable and skilled human resources to follow the safety processes, lack of successful communication between the different departments of the maritime firm, low levels of crew quality and education, and high turnover rate of seagoing personnel have also been documented as significant factors that hinder the proper implementation of the ISM Code (Pun et al. 2003).

To sum up, it becomes evident that the promotion of a safety management philosophy in shipping organizations that will be characterized by the fulfillment of ISM Code's requirements is not easy; rather the continuous efforts by top managers and leaders, employee involvement, and the instilment of safety attitudes throughout the maritime firm are essential factors for success (Pun et al. 2003). However, a critical question still remains dominant among academics and maritime professionals: *Has the ISM Code managed to fulfill its intended purpose?*

In order to shed light on this matter, authors have provided a number of interesting findings. In their study, Lappalainen et al. (2012) utilized a number of evaluation criteria for an effective shipping safety policy as they attempted to ascertain whether the ISM Code has achieved its intended goals in the Finnish maritime industry. Their list of criteria included effectiveness and appropriateness, economic efficiency, acceptability, enforcement, and incentive and innovation. Their results revealed the upgrading of safety levels in the maritime sector after the introduction of the ISM Code, the heightened awareness with regard to safety matters, improvements in communication, and the ability of the shipping company to achieve a better organization and management of daily responsibilities and tasks. Although Lappalainen et al. (2012) noticed some difficulties regarding the Code's implementation, the authors reached the conclusion that firms in the Finnish shipping industry have accepted the ISM Code as an efficient safety instrument and have managed to successfully meet its requirements. In a different study, Pantouvakis and Karakasnaki (2016) described ISM Code effectiveness using the dimensions of continuous

improvement and customer satisfaction focus by drawing analogy from ISO 9000 effectiveness, while Bhattacharya (2012), after conducting a case study, concluded that the diverse perceptions, which office managers and crew hold on ISM Code's goals, actually resulted in undermining its true scope. Finally, Mejia (2001) identified two sets of performance criteria in order to describe ISM Code's effectiveness, which were labeled as output (i.e., non-compliance and deficiencies reporting by the crew) and outcome (i.e., accident rates).

The above synthesis of the literature reveals a vast amount of critical factors that may have a positive or negative contribution to the proper and successful implementation of the ISM Code. However, the variety and range of these dimensions has led to the absence of consensus on which are the most crucial factors of ISM Code implementation and how they ensure that the Code actually meets its intended purpose. Based on the above considerations, we formulated the following research questions:

Research question 1: Which are the critical factors of ISM Code implementation?

Research question 2: Which dimensions can be used to describe that the ISM Code has fulfilled its intended purpose?

Research question 3: Which are the interrelationships between the critical factors of ISM Code implementation and the fulfillment of its intended purpose?

2.3 Maritime accidents and the ISM Code

Marine casualties involve any event that is related to vessel operation and has resulted in a number of unfortunate conditions, such as human death or injury, vessel loss, damage to a ship or to the environment (caused by a damage to the ship) or to marine infrastructure, and ship involvement in a collision (EMSA 2015). In terms of their severity, maritime accidents can belong to one of the following categories. Firstly, very serious casualties refer to total ship loss, death or huge damage to the environment (EMSA 2015). Secondly, serious casualties involve for instance fire, grounding, or collision (EMSA 2015). Less serious casualties are those that do not belong to either of the above categories (EMSA 2015). Finally, incidents refer to certain events that cannot be characterized as casualties. However, these events "… have occurred directly in connection with the operations of a ship that endangered, or, if not corrected, would endanger the safety of the ship, its occupants or any person or the environment" (EMSA 2015 p. 16).

In the literature, it has been proven that the enforcement of the ISM Code resulted in higher safety levels in the shipping industry and thus its effectiveness is revealed. For example, some authors demonstrated that the introduction of the Code has contributed to a reduced number of maritime accidents that are attributed to the human factor (Tzannatos 2010; Tzannatos and Kokotos 2009). In particular, Tzannatos and Kokotos (2009) carried out an investigation of all casualties involving Greek-flagged ships from 1993 to 2006 and noticed a reduction in maritime accidents after the ISM Code. Moreover, Kokotos and Linardatos (2011) also focused on maritime casualties of Greek-flagged ships in the period 1995–2006 only in navigational restricted waters and provided corroborating evidence for the ISM Code's effectiveness, as it led to the reduction of accidents whose main cause was the human factor.

However, other authors argue that despite the existence of various measures that target safety enhancement, maritime accidents are still present during shipping

operations (Chauvin et al. 2013). For instance, Batalden and Sydnes (2014) analyzed 94 maritime cases, in order to find out whether the causes of shipping accidents are associated with the inability of shipping organizations to meet the Code's functional requirements. The authors utilized data from the UK Maritime Accident Investigation Branch and provided some interesting findings. In some circumstances, the crew lacked adequate knowledge and expertise to operate the vessel in a safe manner, implying thus an irresponsible behavior on behalf of the managers in the maritime company as they did not verify that the crew was properly trained and qualified. According to Batalden and Sydnes (2014), the majority of causal factors for accidents concerned clauses 5, 6, 7, and 12 of the ISM Code. In their study, firms encountered problems with providing adequate instructions to masters, with recognizing that the implemented practices depart from required standards, as well as with efficiently organizing on-board operations. Furthermore, Chauvin et al. (2013) analyzed the factors that led to collisions and were reported by the Marine Accident and Investigation Branch in UK and the Transportation Safety Board in Canada, and found that, among other things, non-compliance with the SMS constitutes a cause of collisions.

Given the contradictory nature of the above findings, the degree to which the ISM Code and its implementation are associated with accident reduction merits further investigation. Through our last research question, we aim to explore whether the fulfillment of the intended purpose of the ISM Code is associated with perceptions on accident reduction.

Research question 4: Has the fulfillment of the intended purpose of the ISM Code led to a reduction in maritime accidents?

3 Methodology

The instruments used to measure the constructs under consideration were developed after reviewing the literature on the relevant topics. Firstly, as regards the critical factors of ISM Code implementation, 10 items were utilized that asked the respondents their opinion on the degree to which certain variables play an important role in implementing the ISM Code (5-point Likert type scale, ranging from 1 = Not at all to 5 = Very much). These factors are trust between seagoing and shore-based personnel, communication difficulties, long time at sea, fatigue, daily routine, boredom/laziness, leadership, bureaucracy, additional costs, and training/education. These critical factors have been extensively cited by researchers (Asyali and Bastug 2014; Bhattacharya 2012; Pun et al. 2003; Tunidau and Thai 2010) as influencing the implementation of the ISM Code. Furthermore, the fulfillment of the intended purpose of the ISM Code was captured by six items addressing the establishment of the safe management system (SMS) or the implementation of the ISM Code in general. It should be noted that SMS has been found to be of paramount importance in securing safe practices (Chauvin et al. 2013). The six items were measured on a 5-point Likert type scale (1 = Not at all, 5 = Very much). Finally, as our aim was to evaluate respondents' perceptions on accident reduction, one item ("From your experience, has the number of accidents (or near accidents) been reduced since the enforcement of the ISM Code?") was utilized and also measured on a 5-point Likert type scale. The use of only this one question is deemed appropriate for the purposes of our study, as we are interested in capturing the

respondents' overall perceptions and "feelings" on safety increase, as expressed by number of accidents. This question gives respondents the opportunity to move away from simply focusing on statistics and published reports on accident reduction, which would probably be insufficient to address their true opinions. Instead, using their experience on ISM Code implementation onboard vessels, respondents feel free to form and express their perceptions even after taking into account near accidents or incidents that in some cases are not reported. Therefore, the single-item scale gives us the opportunity to have a clearer and overall picture of respondents' assessments that are not limited to strict interpretations of their vessel's or company's safety performance but incorporate their broader view on the Code's contribution to a decline in maritime accidents.

The target respondents of our structured questionnaire were chief officers of merchant vessels who have hands-on experience on ISM Code implementation onboard. A chief officer in a merchant vessel acts as the head of the deck department and reports directly to the ship master. The duties of a chief officer extend from undertaking vessel navigation watch tasks to cargo-related activities in ports, as well as from ensuring compliance to international regulations, such as MARPOL and SOLAS, to being responsible for the stability of the vessel. Given the breadth of chief officers' duties, their critical role in ensuring safety onboard and their long-term service at sea to reach the second place in command, it becomes obvious that they constitute an appropriate target group for our study. A pre-pilot study of 24 chief officers was initially conducted in order to ensure that the questions were comprehensible, to identify misunderstandings and to make any necessary changes. As no significant problems were detected, our final questionnaire was administered to a number of chief officers. Finally, 63 responses suitable for further analysis were collected from masters and chief officers of Greek nationality that have at least 1 year experience in ISM Code application. In more detail, the majority of the respondents (63.5%) have 1 to 5 years of experience with regard to the implementation of the ISM Code, while the rest ones have over 5 years of experience.

Data were analyzed through exploratory factor analysis (EFA), correlation analysis, and binomial logistic regression. To accommodate reservations on the small sample size to conduct our analysis, we took the following precautions (Hair et al. 2009): our sample size exceeds the minimum threshold for EFA (at least 50 observations), our sample size is at least five times the number of variables to be analyzed (per EFA), and there are at least 10 observations per estimated parameter for both categories of the dependent variable in the binomial logistic regression.

4 Results and discussion

4.1 ISM Code: critical factors and the fulfillment of its intended purpose (research questions 1, 2, and 3)

In the first stage of our analysis, EFA was performed using the method of principal component analysis and varimax rotation in order to yield the underlying pattern of the critical factors that describe the implementation of the ISM Code. Cronbach's alpha equals 0.804, which denotes a satisfactory level of reliability. After the deletion of two

items that exhibited rather low or multifactor loadings, we ended up in two distinct dimensions, which explain 58% of the total variance. Table 1 below summarizes the results.

According to Table 1, the first extracted dimension includes six items. Sample items include for example "Fatigue has an impact on the implementation of the ISM Code" or "Daily routine has an impact on the implementation of the ISM Code". It becomes obvious that these items are mainly associated with the implementation of the ISM Code by the seagoing personnel or the vessel's crew. As a result, the first factor as produced by EFA represents the "Crew-related" dimension of ISM Code implementation. On the other hand, the second factor, which is comprised of two items, primarily refers to various shipping company's aspects or in other words represents the "Company-related" dimension. All in all, as regards our first research question, the critical parameters that have a noteworthy impact on the implementation of the ISM Code can be summarized in two different categories; the first one addresses the "Crew-related" dimension, while the second one refers to the "Company-related" dimension of ISM Code implementation.

In the second stage of our analysis, an attempt was made to produce a parsimonious set of the items that characterize the fulfillment of the intended purpose of the ISM Code. In order to achieve this objective, EFA was run again and the results are presented in Table 2. Two factors were produced with an eigenvalue greater than one that account for the 58.631% of the total variability. It should be noted that the Cronbach's alpha value is 0.743 signaling acceptable levels of construct reliability.

Table 2 indicates that the fulfillment of the intended purpose of the ISM can be described by two separate dimensions (research question 2). The first factor as extracted by EFA characterizes the shipping company's ability to develop and implement an efficient safety management system (sample item: "The procedures included in our

Table 1 EFA of the critical factors of ISM Code implementation

KMO measure of sample adequacy		0.752	Factor 1	Factor 2
Bartlett's Test of Sphericity	Approx. chi-square	155,304		
	df	28		
	Sig.	0.000		
Fatigue has an impact on the implementation of the ISM Code.			0.842	
Long time at sea has an impact on the implementation of the ISM Code.			0.824	
Training and education have an impact on the implementation of the ISM Code.			0.751	
Daily routine has an impact on the implementation of the ISM Code.			0.659	
Bureaucracy has an impact on the implementation of the ISM Code.			0.550	
Trust between seagoing and shore-based personnel has an impact on the implementation of the ISM Code.			0.544	
Additional costs for ensuring that the ISM Code's requirements are met influence its implementation by a shipping company.				0.808
Communication difficulties between seagoing and shore-based personnel influence the implementation of the ISM Code by a shipping company.				0.759

Table 2 EFA of the intended purpose of the ISM Code

KMO measure of sample adequacy		0.735	Factor 1	Factor 2
Bartlett's Test of Sphericity	Approx. chi-square	113,453		
	df	21		
	Sig.	0.000		
The Safety Management System (SMS) of our shipping company ensures safe vessel operation.			0.887	
The procedures included in our SMS are comprehensible and available to the crew.			0.880	
Managers in our shipping company are committed to following the processes of our SMS and implementing the ISM Code.			0.807	
Our shipping company invests a remarkable amount of resources in upgrading safety levels.				0.697
The successful implementation of the ISM Code leads to the efficient execution of our operations and to the development of a safety climate in our company.				0.682
From our experience, the ISM Code has fulfilled its intended aims.				0.670
The ISM Code is of utmost importance for managers in our company.				0.492

SMS are comprehensible and available to the crew"), while the second factor is comprised of more general statements of the shipping company's ability to ensure shipping safety through the implementation of the ISM Code (sample item: "Our shipping company invests a remarkable amount of resources in upgrading safety levels"). Following the previous interpretation of the factors, it becomes easily understood that the first dimension depicts "Safety management system efficiency," whereas the second factor stands for "Increased safety."

In order to assess the interrelationships among the two critical factors of ISM Code implementation and the two dimensions that describe the fulfillment of its intended purpose, we performed correlation analysis after creating the summated scales of the items of each individual factor. Table 3 shows the Pearson correlation coefficients as well as their statistical significance.

As expected, the crew-related dimension of ISM Code implementation is significantly associated both with safety management system efficiency and increased safety. These three factors are negatively correlated as the crew-related dimension is

Table 3 Correlations

	Crew-related dimension	Company-related dimension	Safety management system efficiency	Increased safety
Crew-related dimension	1	0.301*	− 0.351**	− 0.295*
Company-related dimension	0.301*	1	− 0.006 (ns)	− 0.062 (ns)
Safety management system efficiency	− 0.351**	− 0.006 (ns)	1	0.383**
Increased safety	− 0.295*	− 0.062 (ns)	0.383**	1

ns non-significant

*Significant at the 0.05 level; **significant at the 0.01 level

dominated by items (i.e., fatigue, routine, bureaucracy) which—it is reasonable to assume—would be adversely linked with upgraded levels of safety. The company-related dimension seems not to be significantly interrelated with either of the factors that characterize the intended purpose of the ISM Code.

4.2 The relationship between the fulfillment of the intended purpose of the ISM Code and accident reduction (research question 4)

Binomial logistic regression was conducted in order to examine our research question 4 and investigate whether the fulfillment of the intended purpose of the ISM Code determines accident reduction. First of all, the variable "From your experience, has the number of accidents (or near accidents) been reduced since the enforcement of the ISM Code?", which was originally measured in a 5-point scale, was collapsed in a 2-point scale. The responses of "not at all" ($n = 1$), "moderately" ($n = 2$), and "much" ($n = 33$) were merged into one category (category 1, $n = 36$), while the category of "very much" (category 2, $n = 28$) was retained. As it is obvious, the first category is dominated by the "much" response, while the second category refers to the "very much" response. Although these two responses are conceptually very close to each other, they can be utilized as a basis for creating two distinct groups for the following reason. The very objective of the ISM Code is to increase safety at sea, which means to minimize accident rates. In other words, achieving the *highest level* of casualty minimizations should be the main target of any shipping company from the implementation of the ISM Code. Thus, it is reasonable to assume that respondents' perceptions on the degree of accident reduction represent a clear difference between the "much" and "very much" responses. The first one may be considered to correspond to a less successful application of the ISM Code guidelines when compared to the second category, which reflects that the predefined objective of (almost) absence of accidents has been met.

Category 1 was used as the reference category, while the factor scores of the two factors of the Code's intended purpose (as extracted by the second EFA) were used as covariates. The relationship between the fulfillment of the intended purpose of the ISM Code and accident reduction can be depicted as

$$Y = a + b1X1 + b2X2$$

where Y = accident reduction (dependent variable), a = constant, $b1$ and $b2$ = coefficients, and $X1$ and $X2$ = safety management efficiency, increased safety (independent variables).

We assessed model significance by examining the chi-square test for $-2LL$ value change and we evaluated overall model fit by utilizing two of the available tests, which are Cox and Snell's and Nagelkerke's pseudo R^2. Table 4 presents the model fitting information. The last line of Table 4 shows the percentage of the correctly classified cases. The values in Table 4 indicate that there is a high hit ratio of correctly classified cases and the model has high predictive ability.

Finally, Table 5 displays the estimated regression coefficients and related statistics. Data in Table 5 indicate that both safety management system efficiency and increased safety have positive signs; thus, they increase the probability of encountering an

Table 4 Model fitting results

Change in $-2LL$	18.398
Sig.	0.000
Cox and Snell's pseudo R^2	0.253
Nagelkerke's pseudo R^2	0.339
Total percentage of correctly classified cases	76.2%

accident reduction at the highest level ("very much" level). Increased safety has a greater impact on the likelihood of accident reduction at the highest level ("very much" level). A one-unit change in the safety management efficiency and in increased safety increases the odds by 129 and 162% respectively.

5 Conclusions

Shipping safety constitutes one of the major concerns of the academic community and maritime professionals (Celik 2009; Hetherington et al. 2006; Schröder-Hinrichs et al. 2013). Despite the introduction of the mandatory ISM Code, accidents still happen (Kuronen and Tapaninen 2010) and the proper implementation of the ISM Code by shipping organizations continues to be a challenging task. Thus, the purpose of the current study was to identify the critical factors of ISM Code implementation and the dimensions that describe the fulfillment of its intended purpose, as well as to assess their interrelationships. Moreover, the present study aimed to explore whether the fulfillment of the intended purpose of the ISM Code has led to a reduction in maritime accidents.

According to the findings, the critical factors that characterize the implementation of the ISM Code can be categorized in two axes, namely the crew-related dimension and the company-related dimension. Moreover, the study found that the fulfillment of the intended purpose of the ISM Code includes the factors of safety management system efficiency and increased safety, which were also found to be significantly correlated with the crew-related dimension of ISM Code implementation. Finally, as regards the association among the fulfillment of the intended purpose of ISM Code and maritime casualties, our findings indicated that safety management system efficiency and increased safety increase the probability of encountering an accident reduction at the highest level. Overall, our study highlights the significant factors of the proper implementation of the ISM Code, emphasizes the need to fulfill its intended purpose, and

Table 5 Coefficients

	B	Error	Wald	Sig.	Exp. (B)
Accident reduction: category 2					
Intercept	−0.273	0.298	0.840	0.359	
Safety management efficiency	0.830	0.305	7.409	0.006	2.292
Increased safety	0.962	0.325	8.761	0.003	2.618

Reference category: category 1

associates this fulfillment with accident reduction as perceived by chief officers in the shipping industry.

5.1 Limitations and suggestions for future research

In spite of study's contributions, a few limitations should be acknowledged. First of all, our findings should be interpreted with caution due to the limited number of respondents. However, it is common practice in the literature to extract useful results from a small sample size (e.g., Tunidau and Thai 2010). Moreover, before beginning our analysis, we took the necessary precautions in order to accommodate sample size's concerns. Future studies could employ larger sample sizes. Secondly, our respondents were only of Greek nationality and thus further generalization needs caution. Although several studies in the literature tend to draw evidence from one country (Yang 2018), future research could replicate our study by using data from different countries. Future studies could also utilize data not only from chief officers, but also from DPAs or safety managers and compare the results. Additionally, future studies could test for the moderating effects of shipping firm's characteristics on the examined relationship.

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