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Article

The Influence of Shipboard Safety Factors on Quality of Safety Supervision: Croatian Seafarer's Attitudes

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Abstract: According to the European Maritime Safety Agency (EMSA), 70% of accidents on board were caused by human error, and almost one-fifth of these accidents have been related to inadequate supervision. Therefore, the aim of this study is to investigate which of the safety factors can influence the quality of safety supervision. For this purpose, a questionnaire with 24 statements was distributed to professional seafarers. Two exploratory factor analyses were conducted to identify the underlying factor structure. The first analysis yielded one factor, quality of safety supervision, and the second analysis yielded four factors, namely: safety communication, safety training, safety compliance, and safety rules and procedures. Hierarchical multiple regression analysis was applied to examine the influence of seafarers' demographic characteristics and the four identified factors on the quality of safety supervision. The results revealed the following two statistically significant predictors of safety supervision quality: safety communication and safety training. The theoretical and practical implications of the results in terms of improving the quality of safety supervision in the maritime industry were discussed and compared with results in other industries.

Keywords: maritime industry; safety management; ISM Code; safety supervision; shipboard safety

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1. Introduction

According to Bhatacharya [1], work-related accidents and occupational injuries are challenging areas in any industry, including maritime. According to published data from European Maritime Safety Agency (EMSA), 58% of all reported accidental events between 2011 and 2017 were attributed to human error [2]. Furthermore, 70% of all accidents caused by human error were related to shipboard operations and in 19.6% of cases, inadequate supervision was a decisive factor.

In order to enhance maritime safety, the International Maritime Organization (IMO) has introduced a whole range of regulations and standardized training for seafarers in recent decades. A series of accidents in the 1980s, caused by both human error and management mistakes, led to the development of the International Safety Management Code (ISM) in 1998. One of the main objectives of the ISM Code was to prevent human injuries and fatalities, i.e., to lay the foundation for a new safety culture [3,4]. On the other hand, the Code only provides general guidelines that can be interpreted in different ways, i.e., company-specific according to management's commitment, values, and beliefs [3,5].

The Maritime Labour Convention (MLC) states that national laws, regulations, and other measures must clearly define the responsibilities of all parties to implement and comply with the occupational safety and health (OSH) policy in order to ensure that the shipboard working environment promotes occupational safety and health [6] (p.60). In addition, the company is required to ensure adequate supervision of the employee's work practices [7,8].

The management structure should provide guidance and motivation for safe working practices through their supervisors. In the shipping industry, supervision is based on two different levels of hierarchy: (a) a designated person or persons ashore who have the responsibility and authority to overseesafety aspects and provide adequate resources and shore-based support; and (b) the ship's master who has the responsibility to implement the company's safety and environmental policy and to motivate the crew to carry out that policy [4].

Although shipping companies are required to implement the ISM [4] and MLC (2006) guidelines [7], which elaborate on the duties of supervisors, available statistical data points to the disturbing situation in the maritime industry [2]. Following maritime accidents and incidents, numerous studies have been conducted and human error and management mistakes have been identified as the root cause (e.g., [9,10]). Numerous recommendations are made, but accidents and incidents still occur. The question that still arises is which factors influence onboard safety supervision practices.

The study presented here is based on a quantitative methodological approach with the aim of investigating and determining the quality level of safety supervision, as well as the inherent shipboard safety factors, i.e., their enforcement in real life from the seafarers' point of view. The objectives and requirements stated in the ISM Code were considered along with the results of previous studies to identify factors related to the ship environment. Finally, the influence of the inherent shipboard safety factors and the demographic characteristics of the respondents (age, cumulative sea service time, and company tenure) on the quality of safety supervision in the maritime industry will be investigated.

This paper is organized as follows. Section 2 provides a literature review and theoretical background. The methodological process, including data collection and methods used to achieve the study objectives, is described in Section 3. The results of the study are presented in Section 4 and the significance of the results is discussed in Section 5. The conclusion is presented in Section 6.

2. Theoretical Background

2.1. Safety Climate

The construct of safety climate is well explained in the literature and described as a "sub-component" of safety culture (e.g., [11]). One of the most commonly cited definitions defines safety climate as "shared perceptions with regard to the priority of safety policies, procedures and practices and the extent to which safety compliant or enhancing behavior is supported and rewarded at the workplace" [12] (p. 318). According to Beus et al. [13], safety climate plays a crucial role in workplace safety. However, disputes regarding the dimensions of safety climate are still present [14]. In his early study, Zohar [15] identified eight factors: the importance of safety training, work pace effect on safety, the status of the safety committee, the status of the safety officer, the effect of safe conduct on promotion, risk in the workplace, management attitudes toward safety, and the effect of safe conduct on social status (p. 100). Flin et al. [16] conducted a thematic analysis of the literature and identified the existence of three core dimensions: management, risk, and safety arrangements. Likewise, three additional dimensions were highlighted: work pressure, competence, and procedures. Beus et al. [13] conducted a meta-analysis of safety climate and related injuries and identified six dimensions: management commitment to safety, priority of safety, management safety practices, safety procedures, safety communication, safety reporting, and employee safety involvement (p. 721).

In addition, the results of previous studies indicate a positive relationship between safety climate and safety performance [15,17], safety behavior [11],and shipboard safety [18].

2.2. Shipboard Safety Factors and Safety Supervision

Looking at the shipboard environment, it is clear that the safety climate is influenced by other factors, such as each company's official safety policy, management commitment, and especially the company's own SMS, which is based on the ISM. Among other general requirements, the ISM Code emphasizes the importance of safety communication, safety rules and procedures, safety training, and compliance with safety regulations [4].

Communication is an essential aspect of any organization as it leads to trust between all stakeholders and its importance for positive safety performance has been highlighted [19]. An open and constructive atmosphere must be created where all team members can talk freely about all work-related aspects and work together to solve problems [20]. Vredenburgh [19] studied the impact of safety communication on injury rates and found no significant relationship. Other research has shown that poor communication is a major cause of poor safety performance, productivity, and morale (e.g., [21]).

The IMO has recognized the importance of safety training and has set the requirements accordingly in the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW). In addition to the mandatory requirements that every seafarer must meet, additional measures for specific safety training are also specified. One of the ISM Code provisions states that a "Company should establish and maintain procedures for identifying any training which may be required in support of the SMS and ensure that such training is provided for all personnel concerned" [4] (p. 4). The above requirement is of great importance as ship crews change frequently and new employees do not have sufficient practical knowledge of the company's SMS. Such training should enable each crew member to acquire the necessary knowledge and skills, i.e., to understand the meaning and importance of the safety rules and procedures and thus to react properly in critical and dangerous situations in real life. According to Vinodkumar and Bhasi [22], safety training can predict safety compliance, participation, and motivation. Lu and Yang [23] found a positive relationship between safety training and emergency preparedness, safety compliance, and safety participation.

According to the objectives of the ISM Code, shipping companies should establish safe work practices for ship operations to eliminate significant hazards and work-related risks. To achieve these objectives, companies should provide written rules, procedures, and methods that describe ways to reduce risks. A study by Vinodkumar and Bhasi [22] has shown that there is a positive relationship between safety rules and procedures and safe work practices in high-risk facilities.

The basic requirement for any organization should be to ensure that all employees comply with mandatory safety rules and regulations, i.e., to bring employee behavior in line with safety standards. According to Neal and Griffin [24], the term safety compliance refers to the "core activities that individuals need to carry out to maintain workplace safety" (p.947). According to Puah et al. [25], organizational and fellow worker support is positively related to safety compliance. The results of the study by Heyes et al. [26] show that management safety practices are the best predictors of safety compliance.

The role of supervisors has become the subject of research addressing the issue of organizational safety. The way supervisors behave in the performance of their duties is critical. According to [27], one of a supervisor's responsibilities is to communicate OSH policies and procedures to employees. Due to their direct contact with subordinates and their presence on the worksite, supervisors have a significant influence on safety-related behavior [27,28]. When the supervisor's safe work practices deviate from the company's safety policies and procedures, adverse events may occur [18]. Zohar notes that a consistent supervisor attitude towards safety, especially in "safety vs. efficiency" situations, promotes safety as a priority in the group [28]. Furthermore, it is the supervisor's responsibility to support the safety of his subordinates. In the literature, safety support is defined as "the extent to which supervisors encourage safe working practices among their subordinates" [29] (p. 485). Several studies have shown that greater safety support correlates with fewer workplace injuries and negative outcomes (e.g., [26,29]).

In addition, previous studies investigating the cause of accidents on board ships have pointed to age as a potential risk factor on board, i.e., they have found that a higher risk of accidents is associated with younger seafarers [30,31].

3. Methodology

The methodology used in this study, the analyses performed, and the presentation of results are in accordance with available scientific guidelines and recommendations [32–34].

3.1. Measures

The identification of safety climate measures was based on a review of the scientific literature. For the purposes of this study, the selection of items was based on the provisions of the ISM Code [4] and MLC guidelines [7], as well as the expert opinions of the authors, which together describe the key elements necessary for successful shipboard operations. To ensure validity, items were selected based on questionnaires already used in the maritime industry [35–37] and generic safety climate questionnaires [17,38–40]. A total of 24 items on safety climate were selected from previous studies. The first set of four items contains the main requirements for shipboard safety supervision. In practice, safety supervision tasks are assigned to the ship's captain, safety officer, and department heads, so the phrase 'Ship's management structure' was used.

The second group of 20 items refers to the main objectives stated in the ISM, especially the requirements contained in the chapters: 5. master's responsibility and authority; 6. resources and personnel; 7. shipboard operations; and 8. emergency preparedness. Basically, the above requirements can be expressed as issues related to communication, training, safety compliance, and safety rules and procedures that create a specific onboard environment. Translation of selected items, along with minor modifications, was done by the authors and an English language expert.

3.2. Data Collection

The data used for this study were obtained from a survey conducted on the premises of accredited training institutions in Dubrovnik, Split, Šibenik, and Rijeka (Croatia), where respondents attended STCW courses, from October 2019 to January 2020. Before the questionnaires were distributed, the purpose of the survey was explained to the respondents. To avoid biased participation, the survey was anonymous and confidential. In addition, no incentives were offered to avoid hasty participation. To avoid directing or influencing participants' responses, all statements in the survey were worded as neutrally as possible. The minimum requirement for participation in the survey was that the respondent had completed a tour of duty onboard, regardless of rank.

A five-point Likert scale (1—strongly disagree to 5—strongly agree) was used for all statements. In addition, statements were scattered throughout the questionnaire and a certain number of statements were reverse coded, i.e., higher values indicated higher negative perception of the subject matter. The questionnaire was administered and collected by the authors. A total of 413 questionnaires were collected. An initial review was conducted to discard copies with obvious inconsistencies, i.e., respondents checked all statements as either "1" or "5", or questionnaires contained incomplete responses; 27 copies. Further analysis of the data was conducted to ensure normality and reliability of the data, i.e., to identify possible outliers. In this process, described in Section 3.4, a total of 86 responses were discarded.

3.3. Survey Sample

Background variables of respondents included the following six questions: nationality, age, rank on board, sea time experience, type of vessel they work on, and tenure with the current company. All respondents were of Croatian nationality, $n = 300$. The largest part of the sample consisted of deck officers (64.3%), followed by engineers (24.7%), electro-technical officers (8%), and other crew members (3%). Regarding respondents' age, the largest part-declared age group "26–35" (41.7%), followed by "36–45" (22.7%), "46–55" (16.6%), "18–25" (11.7%), and "56–65" (7.3%). In terms of sea service, the largest part (31.7%) stated ">15" years of sea service, followed by "1–5" years (23%), "6–10" years (21%), "<1" year (13%), and "11–15" years (11.3%). Regarding the vessel type where respondents were engaged, 35.3% reported tankers (all types), 22.7% container vessels, 16.3% passenger vessels, 16% cargo vessels (bulk carrier, general cargo, Ro-Ro), and 9.7% stated other types of vessels. In terms of tenure with the current company, the largest group (45.7%) declared ">4 years" with the company, followed by "<1 year" (23.3%), "2–3 years" (13.3%), "1–2 years" (9%), and the smallest group (8.7%) declared "3–4 years". Considering the respondents' background details, it can be concluded that respondents had enough practical experience to provide qualified answers on the subject matter.

3.4. Method of Data Analysis

All reverse-scored items were reverse coded so that the numerical scoring scale ran in the opposite direction; e.g., responses with a low-value score such as "1 strongly disagree" were transformed into a higher value, "5 strongly agree".

Given the nature of the data collected, factor analysis was chosen among the available multivariate methods. Factor analysis itself offers two main possibilities. For hypothesis testing procedures, confirmatory factor analysis is recommended, the aim of which is to test hypotheses about the structures of the latent variables and their relationships. In cases where exploration of the data is required and the aim of the study is to generalize the results to the population, exploratory factor analysis is recommended. Among the available extraction methods, principal component analysis (PCA) is recommended, given the study objective [33]. The only limitation of the mentioned method is that the results cannot be extrapolated beyond this particular sample, i.e., in this case beyond seafarers of Croatian nationality. Therefore, two exploratory factor analyses (EFA) were performed to reduce the number of variables to a manageable size and to define the underlying factor structure [33]. In order to determine the factor structure, the principal component analysis (PCA) was used as the extraction method. The objectives of PCA are: extracting information from the variables used, compressing their size, simplifying the data description, and analyzing the structure of the observations. During the process, PCA creates new variables called principal components. The first principal component accounted for the largest amount of variability in the data. The second and any other components that were not correlated with each other contributed to the next largest remaining variability whenever possible [34]. To better interpret the factor model obtained, the model was rotated. The rotation method used was varimax rotation, which preserves the original structure while allowing for easier interpretation of the factors [33].

Following EFA, factor scores were calculated for each component obtained. A mean value of the variables used was calculated for each component. The internal consistency (reliability) of the construct, the assigned items, and the summated scales were then assessed using Cronbach's Alpha. Following the EFA, confirmatory factor analysis (CFA) was performed to confirm the un-dimensionality structure of the model, including the convergent validity survey and the discriminant validity inspection. A bivariate correlation analysis (Pearson) was conducted to examine the relationship between all factors in the study. Finally, hierarchical multiple regression analysis was used to explore the influence of independent variables on dependent variables [34]. Prior to the analysis, the assumptions underlying regression analysis were tested, as recommended [33]. All calculations were performed using IBM SPSS and AMOS V26.0.

4. Results

The common method bias was assessed before the EFA's. For this purpose, Hartman's single factor test was applied. According to [41,42], bias is present when the extraction of a single factor results in explaining most of the variance of the variables tested; the threshold is 0.50. The results obtained show that the total variance (38.36%) of all the variables used is below the threshold, therefore the common method variance is acceptable.

4.1. Exploratory Factor Analysis of Safety Supervision Related Variables

Exploratory factor analysis was conducted to examine the factor structure of four safety supervision-related variables. The following analytic criteria were applied: (a) list-wise deletion, (b) Eigen-value higher than 1.0, and (c) cut-off value for factor loadings below 0.5 to ensure practical significance [34].

The statements used are from the Zohar and Luria questionnaire [17]. The wording of the statements used was slightly modified to fit the purpose of the study. Statements used are:

- "The ship's management structure supervises that the assigned operations are performed safely in accordance with the procedures provided",
- "The ship's management structure often checks that all crew members adhere to safety rules and procedures",
- "The ship's management structure requires strict adherence to the procedure even when we are tired or stressed",
- "The ship's management structure supervises the use of protective devices and equipment strictly".

Obtained test results indicated that the data were suitable for factor analysis; Bartlett's test (approx. Chi-square) was 459.559 ($p < 0.001$) and Kaiser-Mayer-Olkin's measure of sampling adequacy was 0.755. The final result yielded one component with an Eigen-value of 2.640, explaining a total of 66% of the variance.

Obtained factors included four items relating to the perceived supervision of assigned jobs and safety procedures adherence. Therefore, it can be referred to as the *quality of safety supervision* (Cronbach's Alpha = 0.820).

4.2. Exploratory Factor Analysis of Shipboard Environment Related Variables

The exploratory factor analysis was carried out to examine the factor structure of 20 shipboard environment-related variables. The same analytical criteria as in the previous analysis were used. Bartlett's test (approx. Chi-square) was 3396.204 ($p < 0.001$) and Kaiser-Mayer-Olkin's measure of sampling adequacy was 0.893 indicating that the data were suitable for factor analyses.

Based on the set criteria, the initial analysis yielded four components and three items were found without loading, i.e., variables failed to load on any component. The analysis was repeated without the mentioned items. The final result yielded four components with an Eigen-value higher than 1, explaining a total of 68.2% of the variance.

Excluded items in the analysis were: "Working with defective equipment is not permitted under any circumstances" [38], "Safety rules and procedures are prepared and available for use" [40], and "Safety rules and procedures contain all important safety information" [40].

All components were checked for reliability using Cronbach's Alpha (>0.70), as recommended [33,34]. Therefore, a four-factor solution was accepted, as presented in Table 1.

Table 1. Exploratory factor analysis of shipboard environment related variables ($n = 300$).

Statements	F1	F2	F3	F4
Communication between superior and subordinate officers, regarding safety, is good [35]. (M)	0.788			
There is a sense of freedom while communicating with superiors [35].	0.787			
Communication with designated person/s ashore, regarding safety, is good [35].	0.745			
Communication between all crew members, regarding safety, is good [35]. (M)	0.734			
Communication with superior officers, regarding safety, is good [35].	0.723			
Resolving conflict situations on board is at a good level [35].	0.719			
Company provides safety staff with "force" required to perform their job [35].	0.691			
Superior officer always closely explains the work plan and procedures before certain actions (e.g., mooring) [35].	0.574			
I have received the training that is necessary in order to handle critical or dangerous situations [37].		0.872		
I have received the training that is necessary in order to work safely [39].		0.824		
Through training, I got acquainted with all safety rules and procedures [35].		0.814		

Table 1. *Cont.*

Statements	F1	F2	F3	F4
After the start of employment, I was provided with all the necessary theoretical and practical knowledge in order to be able to follow the rules and procedures on board [35].		0.551		
I am able to use the required protective equipment according to the nature of the work [35].			0.868	
According to training sessions, I can actively participate in the workplace hazard elimination [35].			0.723	
I think our (group) duty is to maintain a safe working environment [36].			0.602	
I feel that it is difficult to know which procedures are applicable in practice [36]. (R, M)				0.928
The procedures are difficult to understand or are poorly written [36]. (R)				0.920
Eigenvalues	7.09	1.76	1.48	1.28
Accumulative variance	41.68	52.05	60.73	68.23
Cronbach's Alpha	0.901	0.861	0.716	0.854

M-modified (wording); R-recoded.

Factor 1 included eight items related to the perceived safety and daily communication between all levels of the ship's complement and "ship-to-shore" communication. Therefore, it can be referred to as *safety communication* (Cronbach's Alpha = 0.901).

Factor 2 included four items related to the perceived quality of safety training. Therefore, it can be referred to as *safety training* (Cronbach's Alpha = 0.861).

Factor 3 included three items related to the perceived safety compliance. Therefore, it can be referred to as *safety compliance* (Cronbach's Alpha = 0.716).

Factor 4 included two items related to the perceived quality of safety rules and procedures and their applicability in practice. Therefore, it can be referred to as *safety rules and procedures* (Cronbach's Alpha = 0854).

4.3. Model Fitness, Canvergent and Discriminant Validity

To test the validity and relationship of the identified factors and to verify the model fitness, a confirmatory factor analysis was conducted along with maximum likelihood estimation. The results of the model fit test prove that the model is acceptable; chi-square/DF = 1.644, goodness-of-fit index (GFI) = 0.901, adjusted goodness-of-fit index (AGFI) = 0.875, comparative fit index (CFI) = 0.970, and root mean square error of approximation (RMSA) = 0.051.

The convergent and discriminant validity were tested using the same analysis. For this purpose, the following recommendations were adopted; (a) all standardized factor loadings should be greater than 0.5 (ideally > 0.7), (b) average variance extracted (AVE) should be greater than 0.5 to suggest adequate convergent reliability, (c) composite reliability (CR) should be 0.7 or higher to prove adequate convergent reliability, and (d) square root of AVE should be greater than the inter-construct correlations [34,43].

The standardized factor loadings obtained are well above set minimum value (the lowest was 0.665 and the highest was 0.922) indicating that this requirement is fulfilled. The values of AVE and CR are above set values indicating that the model has satisfactory composite and convergent validity. The discriminant validity was also verified; all square roots of AVE, presented on diagonal, were higher than other inter-construct correlations (Table 2). Thus, it can be concluded that the model has satisfactory convergent and discriminant validity.

Table 2. Inter-construct correlations, convergent, and discriminant validity.

Construct	CR	AV	1	2	3	4	5
1. Compliance	0.714	0.515	**0.718**				
2. Safety rules and procedures	0.854	0.746	0.256	**0.864**			
3. Safety supervision	0.830	0.659	0.590	0.080	**0.812**		
4. Safety training	0.875	0.641	0.536	0.126	0.607	**0.800**	
5. Safety communication	0.905	0.633	0.650	0.182	0.790	0.627	**0.796**

4.4. Pearson Correlation Analysis

Table 3 shows the means, standard deviations, and the correlations between all of the variables included, based on EFA analysis. The perceptions of safety supervision were strongly positively correlated with the perceptions of safety communication ($r = 0.70$, $p < 0.01$) and moderately positively correlated with the perceptions of safety training ($r = 0.56$, $p < 0.01$) and safety compliance ($r = 0.44$, $p < 0.01$). Moderate significant inverse correlations were also found between the perceptions of safety communication and safety training ($r = 0.62$, $p < 0.01$), safety communication, and safety compliance ($r = 0.50$, $p < 0.01$) and between the safety training and safety compliance ($r = 0.46$, $p < 0.01$).

Table 3. Means, standard deviations, and correlations among study variables ($n = 300$).

	M	SD	1.	2.	3.	4.	5.	6.	7.	8.
1. Age	2.66	1.11	-							
2. Sea Service	3.26	1.44	0.79 **	-						
3. Company tenure	3.44	1.66	0.47 **	0.63 **	-					
4. Safety supervision	3.93	0.76	0.13 **	0.16 **	0.01	-				
5. Safety communication	4.06	0.66	0.20 **	0.23 **	0.04	0.70 **	-			
6. Safety training	4.21	0.69	0.11	0.18 **	0.06	0.56 **	0.62 **	-		
7. Safety compliance	4.50	0.52	0.18 **	0.31 **	0.19 **	0.44 **	0.50 **	0.46 **	-	
8. Safety rules and procedures	3.39	1.19	0.11	0.15 **	0.19 **	0.05	0.15**	0.15 *	0.20 **	-

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

4.5. Testing the Assumptions

The assumptions for hierarchical multiple regression analysis were tested before the analysis. The assumptions for linearity, influential cases, homoscedasticity, and residuals were screened using the scatterplots and the plots of standardized predicted values versus standardized residuals. It was concluded that the data were approximately normally distributed. The assumption of independent errors, i.e., whether the values of residuals were independent, was tested using the Durbin-Watson test. The obtained value of 1.887 indicated that residuals were uncorrelated [33]. In order to investigate the problem of possible multicollinearity, the inflation factor (VIF) and tolerance values were examined. According to Field [33], there is no problem with multicollinearity when the tolerance value is above 0.2 and the VIF value is below 10. The minimum tolerance value determined was 0.382 and the maximum VIF value was 2.621, indicating that the assumption was fulfilled. Furthermore, the assumption of no influential cases was tested by calculating Cook's distance; values below 1 had no influence on the model [32]. The maximum value obtained was 0.06, indicating that there are no influential cases.

4.6. Hierarchical Multiple Regression Analysis

Hierarchical multiple regression analysis was used to estimate the influence of independent variables on dependent variables. Independent variables were included in successive steps to explore the influence of respondents' age, sea service, company tenure, perceived communication, safety training, safety compliance, and quality of safety rules and procedures on the quality of safety supervision (Table 4).

Table 4. Hierarchical multiple regression analysis predicting quality of safety supervision (standardized Beta coefficients).

Factors	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Age	0.127 *	0.001	−0.009	−0.032	−0.011	0.002	0.002
Sea service		0.160	0.270 *	0.051	0.028	0.005	0.004
Company tenure			−0.161 *	−0.038	−0.042	−0.047	−0.035
Communication				0.696 **	0.565 **	0.536 **	0.540 **
Safety training					0.214 **	0.195 **	0.199 **
Safety compliance						0.085	0.094
Safety rules and procedures							−0.069
R	0.127	0.161	0.204	0.700	0.720	0.724	0.727
R^2	0.016	0.026	0.041	0.491	0519	0.524	0.528
Adjusted R^2	0.013	0.019	0.032	0.484	0.510	0.514	0.517

* $p < 0.05$; ** $p < 0.001$.

In the first three steps, the analysis revealed that the respondents' age [$F(1,298) = 4.885$, $p < 0.05$], sea service [$F(2,297) = 3.950$, $p < 0.05$], and tenure [$F(3,296) = 4.271$, $p < 0.01$] contributed significantly to the model and accounted for 3.2% of the variance. In the fourth step, communication was introduced in the model [$F(4,295) = 71.057$, $p < 0.001$], and the amount of explained variance increased by 45.1%. In the next steps, safety training perceptions [$F(5,294) = 63.356$, $p < 0.001$] and safety compliance [$F(6,293) = 53.651$, $p < 0.001$] were added, which explained 2.6% and 0.4% of the variance, respectively. In the final step, perceptions of safety rules and procedures quality were added [$F(7,292) = 46.650$, $p < 0.001$] and an additional 0.3% of the variance in the model was explained. Perceived communication was the strongest predictor of the quality of safety supervision.

5. Discussion

Previous studies that have looked at improving safety on board ships have concluded that safety can be improved through a variety of measures, such as the proper implementation of the ISM Code [44–46], development of safety systems (e.g., [47]), improvement of audit systems [48], and provision of adequate safety resources [49,50].

The aim of this study was to identify the shipboard safety factors, ISM-related [4], that may influence safety supervision practices, i.e., to investigate their impact on the quality of safety supervision in the maritime industry. From a practical point of view, safety supervision can be considered the last line of defense against occupational accidents and incidents. Therefore, these results have both theoretical and practical importance. The results showed that the variables explaining perceived safety communication and safety training can theoretically be considered statistically significant predictors of the quality of safety supervision.

The results of this study are consistent with previous research studies that emphasize the importance of safety communication for workplace safety in manufacturing facilities [21]. Furthermore, these findings support the results of a study that looked at accidents and incidents in the shipping industry and identified poor communication as one of the main causes [45,51]. However, the results of this study differ from those of other studies that have looked at safety-related incidents and in particular the importance of safety communication (e.g., [19,52]). The explanation for the different results could lie in the measures used in the questionnaires. The focus of the research on safety communication mentioned above was on the "communication atmosphere" within organizations, while the questionnaire used for this study included additional measures that were confirmed by the exploratory factor analysis, such as: the issue of resolving conflict situations on board, communication about safety rules and procedures at the start of employment for new staff, and communication in the form of praise for those who work in a safe manner and vice versa.

Based on the authors' expert opinions, the issue of resolving conflict situations on board is particularly important as modern merchant ships have a minimum crew, usually around 20–25 seafarers. If conflict situations are not resolved in a timely and appropriate manner, all forms of communication, including communication on safety issues, between the crew members concerned may be disrupted and the quality of safety supervision could be compromised.

Safety training was identified as the second most important predictor of safety supervision in this study. The explanation for safety training is straightforward and logical. If crew members are well trained in following safety rules and procedures or are able to use the appropriate personal protective equipment, it is reasonable to assume that the quality of safety supervision will be high. Although it is assumed that all seafarers are well trained, actual cases often show the opposite. This finding is consistent with the results of previous studies and suggests that the quality of safety training should be of a high level to prepare seafarers for the hazards on board [18,53]. In addition, the results of a recent study suggest that safety managers should improve the safety theory and theoretical background of training and emergency preparedness to achieve a better understanding of safety issues [54]. In addition, the results of the same study showed that safety training and emergency preparedness can improve crew routines, but not necessarily crew members' safety consciousness.

A recent study in two Chinese shipping companies looking at onboard safety supervision found that management efforts to improve safety compliance were perceived by crewmembers as a tool that led to increased workload, psychological pressure, and fatigue [55]. The results are similar to those where crewmembers perceived SMS compliance as less useful or irrelevant [45]. According to [54], it is safety communication that influences crewmember safety consciousness and the recommendation of the study is consistent adherence to ISM and MLC guidelines by safety managers. However, there is no clear evidence that safety managers do not implement these guidelines in practice.

The key may lie in individuals' perceived importance of safety. Due to the shortage of seafarers in the maritime industry and with the goal of saving time and resources, companies often outsource this task to crewing agencies. A recent study investigated this issue and concluded that the selection of crewing agencies, i.e., individual seafarers, should be based on the nature of the company culture [56]. According to the same authors, a successful relationship between the parties should lead to effective communication onboard, fewer misunderstandings, and effective training. Therefore, the recruitment policy of the industry should also be considered.

The study also aimed to investigate whether demographic characteristics (age of respondents, cumulative sea service time, and company tenure) can influence the quality of safety supervision. The results obtained showed that the regression coefficients of the demographic variables fell from statistically significant to not significant, indicating full mediation in the model.

6. Conclusions

As previous studies have shown, safety climate plays an important role in organizational efforts to improve workplace safety and promote safety behaviors in the maritime industry [11,18], as in other industries [13,14]. Our findings suggest that improved safety communication and safety training could influence the quality of safety supervision and consequently increase workplace safety on ships.

These findings highlight the importance of the ISM Code guidelines, which serve as guiding principles for all shipping organizations to make ships a safer workplace. In addition, the results of the study may be of importance to both management and practitioners. As Anderson [3] noted, the task of implementing ISM and developing a safety culture depends largely on the commitment of management structures. The task of management structures is thus twofold: first, to select employees who perceive safety communication and safety training as an important part of their daily work, and second, to create the necessary conditions for uninterrupted communication that contributes to a stronger safety culture throughout the shipping company. The model presented can serve as a guiding principle and can be applied not only in the shipping industry but also in all other high-risk industries.

However, a possible limitation of the study is that the respondents were only Croatian nationals. The reason why we state this as a possible limitation of the study lies in two facts: (1) there are only a few Croatian shipping companies that operate their ships worldwide, and (2) all the shipping companies mentioned have registered their ships under flags of convenience, which enables them to employ seafarers of other nationalities and cultures. Accordingly, it can be concluded that the vast majority of respondents work in a multicultural environment and that some cross-cultural influence among them is to be expected. Therefore, cross-cultural differences remain unknown. Recent studies have shown that there are cultural differences between different nationalities (e.g., [57]). Furthermore, future research should consider including additional variables such as safety motivation and safety consciousness to examine their influence on safety supervision.

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