Journal of Harbin Engineering University
ISSN: 1006-7043

Vol 44 No. 12
December 2023

The Impact of Support Services on Accident Prevention in Chittagong Port and Outer Anchorage, Bangladesh

TamimAhmed[1], Mohammed Ismail Russtam Suhrab[1*], Ahmad Faizal Ahmad Fuad[1], Ranakul Islam[1]
[1]Faculty of Maritime Studies
University Malaysia Terengganu, 21030 Kuala Terengganu Malaysia

Abstract

The maritime sector is the most significant transportation sector in the world, and the Port of Chittagong is the principal port in Bangladesh, contributing significantly to the country's income. However, accidents at seaports are increasing, which is a cause for concern for industry stakeholders. This study adopted a descriptive survey research design to investigate the relationship between operational risk management, maritime support services, simulation training, assessment, and accident reduction in Chittagong Port, Bangladesh. A sample of 100 employees was used in the study. The findings revealed that all three hypotheses were significantly related to accident reduction in Chittagong port and outer anchorage in Bangladesh. Specifically, the study found a significant relationship between operational risk management and accident reduction (r=.858, p < .0005), maritime support services and accident reduction (r = .611), and simulation training, assessment, and accident reduction (r =. 810). Based on these findings, the study recommends that the top management of Chittagong Port in Bangladesh should provide effective training and support services to reduce employee accidents while on duty. Additionally, simulation training should be improved to accumulate knowledge on reducing accidents to achieve organizational objectives.

Keywords*:* Operational Risk Management; Maritime Support services; Simulation Training and Assessment

Introduction

The maritime sector is the most significant transportation sector in the world and the promotion of seaborne. The United Nations Conference on Trade and Development (2018) stated that the degree of seaborne trade had reached 11 billion tons as of 2018. Of course, the seaport has been noted as an integral element in the development of any country and viable income (Fobbe et al., 2018). From an economist's perspective, maritime transportation has been gaining recognition over other means of transportation worldwide. This progress has been related to globalization and growth in demand in the marine sector (Grammenos, 2013). This complete success might not have been possible if capacity enhancement was not considered. In addition, operational safety in seaports, effectiveness, and operational processes depend on capacity enhancement.

As stated by the United Nations Conference on Trade and Development (2018), seaport operations have led to the realization of cargo-handling activities of more than 80% of the world trade activities transported by sea. Al-Shammari and Jin-Seok (2018) opined that the maritime shipping industry is considered one of the vast and high-risk industries. There is great concern about reducing the associated risks in this industry and improving maritime safety. Many parameters contribute to improving maritime safety and minimizing the risk of accidents. Most of these parameters are concerned with improving operational risk-management systems, utilizing advanced technological equipment and machinery, and implementing proper simulation training to reduce accidental demurrage. Humans are one of these parameters, which can be considered the pivot parameter of maritime safety. This is the only life parameter that interacts with and controls most of the other parameters. Therefore, human actions significantly affect ship safety, and most maritime accidents result from human error, which is the main component of the operational risk management system. Therefore, an effective risk management system is vital for preventing accidental demurrage in ports.

River Karnafuli rises in the Lushai Hills falls in the Bay of Bengal after taking a winding course of 120 nautical miles through the districts of Chittagong Hill Tracts and Chittagong. The Port of

Chittagong is the principal Port of the People's Republic of Bangladesh. It is situated on the right bank of the Karnafuli, at a distance of approximately nine nautical miles from the Bay of Bengal shoreline. The Chittagong Port is considered a prime seaport in Bangladesh. However, the outer anchorage of the Chittagong Port Authority (CPA) is very congested with vessels arriving at the anchorage for lighter age operations before entering the river, and there is always a risk of collision for vessels approaching the Chittagong port and anchorages.

Problem Statement

The Chittagong Port is the primary seaport in Bangladesh. It provides a significant gateway to a country's trade with the outside world. According to the Overview of CP (2013), during 2011-2012, Chittagong Port handled over 41 million metric tons of cargo, including 1.34 million TEUs, which is approximately 92% of the total maritime trade in Bangladesh. However, Chittagong Port has the highest accident rate among all the seaports in Bangladesh. Khaled et al. (2018) pointed out that the Bangladesh waterway accident database from 1981-2013 shows 57.96% of accidents were due to collision and grounding, 76.92 % at Chittagong Port (CP). The maximum number of accidents occurred because of human error. Khaled et al. (2018) also mentioned that most accidents from 1981 to 2013 at Chittagong Port occurred due to human errors, and the rate was 75.36% among all the casualties.

As shown in Table 1, human error causes approximately 62% of accidents that occur all over Bangladesh; the environmental factor causes 33% of accidents. The percentage of causes of collision in Chittagong Port was 33 collisions recorded in Chittagong Port since 1981, and navigational accidents caused 80% (Hansen et al., 2008). All these factors affect the performance of employees in Chittagong Port. Al-Shammari and Jin-Seok (2018) pointed out that accidents in the Chittagong anchorage result from maneuvering vessels failing to take into account the variability and strength of the tide and currents, leading to contact between anchored and embarking vessels. It has been observed that most employees quit Chittagong Port to look for jobs with minimal accidents.

Apart from these problems, the researcher noted that Chittagong Port does not provide maritime support, operational risk management, simulation training, or assessment, which should help employees reduce accidents. This serves as a gap to be addressed in this study. Al-Shammari and Jin-Seok (2018) also expressed that the anchoring at Chittagong Port needs well-trained and knowledgeable crews familiar with port operating policies to reduce the risk of risk and accidents. Based on these scenarios, the researcher provided a workable solution for reducing accidents.

Table 1. Percentage of accidents in Chittagong port and outer anchorage, Bangladesh

Factors	In all accidents in Bangladesh	In all accidents at CP	In all collisions at CP
Human error	62%	75.36%	57.57, 87.87%
Environment error	33%	8.7%	33.33%
Technical Error	5%	15.94%	9.09%

Literature Review

Conceptualizing Operational Risk Management

Risk is the chance of financial loss and its expected negative impact on a firm's value due to changes in the underlying model risk assumptions. The concept of risk has significant implications. This concept can be used in various financial, psychological, and organizational settings. Nguyen and Wang (2018) defined operational risk as the existence of risks that may negatively affect the internal ability of the company to maintain its goods/services at a certain level of quality, quantity, or profitability. Harms-Ringdahl (2001) viewed operational risk as something that has to do with the risk of loss emanating from insufficient or absence of internal procedures, systems, individuals, or the outside surroundings. The risk is that the organization fails to deliver optimum shareholder value according to its business plan.

In the same vein, Manuele (2003) looked at risk as the amount of safety articulated by the probability and harshness of the associated consequences for an unwelcome event. This

suggests that Risk (R) = Probability (P) × Consequence (C). Numerous companies have recognized the use of this technique for risk evaluation and control. Mokhtari, Ren, Roberts, and Wang (2012) opined that it is essential for seaport administrators to assess and make sure that a suitable control of risks connected with maritime activities is considered. Operational Risks are concerned with the firm's daily operations, such as recruiting and retaining qualified employees, including crewing increasingly difficult offshore positions.

INTERNALLY-DRIVEN	EXTERNALLY-DRIVEN
HAZARD RISK	**FINANCIAL RISK**
• Marine Hull & Machinery	• Credit & Counterparty Risk
• Perils of the Sea, Assailing Thieves (Piracy)	• Interest Rate Risk
• Fire & Explosion	• Foreign Exchange Risk
• Accidents (Pollution, Collision, etc)	• Liquidity & Cash Flow Risk
• Acts of War, Confiscation, Detainment, Revolution	• Funding & Growth Risk
• Barratry of the Master, Employee Negligence, Human Error	
OPERATIONAL RISK	**BUSINESS (STRATEGIC) RISK**
• Human Capital	• Tonnage Demand
• Recruitment, Employees (incl Crewing)	• Change of Global Macroeconomics
• Knowledge Management	• Changes in Charterers Profile
• Legal & Regulatory Environment (Corporate, such Sarbanes Oxley Act 2002)	• Industry Changes
• Intellectual Capital	• Legal & Regulatory Environment (Maritime, such as US Pollution Act of 1990, etc)
• Safety, Quality & Assurance	• Competition
• Health & Environmnet	• Image & Perception
	• Political & Country Risk

Fig 1. Types of Risk
Source: Basil Karatzas, (2006)

Concept of Maritime Support Services

Maritime services entail engaging ships for the processes meant for a particular port until the ship is finally berthed for cargo operations. This includes the booking arrangement processes by the ship's agent, as well as providing updated information about the pre-arrival to the port authorities (Yang, Wang, & Li, 2013; Moreno, Gonzalez, Muro & Maza, 2022). When it arrives at the port, ships are sometimes provided with pilot age services to the berth or essential to endure at the port's anchorage for berthing prospects—clients' perception of the service delivery standard matters for the business's sustainability and growth. Maritime support is the type of support provided to employees working at the seaport (Moreno, Gonzalez, Muro, & Maza, 2022; Lin & Cheng, 2020; Melnyk, Onyshchenko, Pavlova, Kravchenko, & Borovyk, 2022). This is about the protection of life and property through effective support.

Moreover, maritime support can be regarded as protecting crew, employees, and passengers aboard vessels from accidents or hazards and the risk of fatality (Molchan, 2005; González, Piel, Gross & Glandrup, 2008; Moreno, Gonzalez, Muro & Maza, 2022). Maritime support in the seaport includes personal flotation devices, which keep the person in the water at risk of drowning, death, and hypothermia. Maritime security and safety differ somewhat. Maritime security and safety are used interchangeably among scholars and laymen. People often confuse the actual meanings of the two concepts (Chuah et al., 2013; Chuah, Mokhtar, Bakar, Othman, Osman, Bokhari & Hasan, 2022). Maritime security focuses on securing vessels and cargo from external dangers, such as piracy and smuggling (Lin & Li, 2013; Lin, & Cheng, 2020). On the other side, maritime support aims to protect employees, crew, and the environment where they are against accidents that occur naturally or human-made hazards (Talley, 2013; Melnyk, Onyshchenko,

Pavlova, Kravchenko & Borovyk, 2022). If maritime support is neglected, it may lead to unforeseen disasters.

Meaning of Simulation Training and Assessment

Numerous studies have discussed simulators for training in the maritime industry and their usefulness to employees. Simulators are purposely used to educate crew members and employees in aviation, shipping, and healthcare (Dekker & van Winsen, 2009; Jabbarifar, 2009; Mangga et al., 2021; Nazir et al., 2015; Alessi, 2017). The 1978 STCW Convention suggested a better way to use simulator-based training for maritime education in the maritime sector. The objective of using a simulator for training and assessment is not new in numerous countries. A simulated atmosphere has countless benefits in the maritime sector. This is because this simulator can even provide accurate training and assessment for particular learning results and can be used to increase the capability level of the learners (Maran & Glavin, 2003; Ennen & Satin, 2010; Kim, Sharma, Bustgaard, Gyldensten, Nymoen, Tusher & Nazir, 2021). Therefore, for the STCW Convention, the simulator can provide good results when used for training activities in the maritime sector.

In another development, simulation training or simulation-based training (SBT) encompasses the computer software or essential equipment to model an actual world situation (Aydin, Raison, Khan, Dasgupta & Ahmed, 2016; Sawyer & Gray, 2016). This concerns the interaction between man and technology (Jabbarifar, 2009; Nazir et al., 2015; Mangga et al., 2021). In simulation-based training, employees are taught how to perform certain activities in an accurate word situation to prepare fully for the actual situation. Similarly, simulation training involves professional knowledge, attitudes, and skills while protecting the employees and crew from unnecessary dangers (Alessi, 2017; Sellberg, 2017; Kim, Sharma, Bustgaard, Gyldensten, Nymoen, Tusher & Nazir, 2021). Also, simulation training is the formation of a true-to-life learning situation that resembles or looks like real-life work and situation (Sellberg, 2017; Kim, Sharma, Bustgaard, Gyldensten, Nymoen, Tusher & Nazir, 2021). Trainees can use their knowledge, ideas, and skills through physical tasks or activities. Assessment is the measurement of employees' improvement over a particular time, motivates employees to focus, assesses the efficiency of teaching techniques, and grades the employees' performance in comparison to other colleagues in the organization (Jabbarifar, 2009; Mangga, Tibo-oc, & Montaño, 2021; Nazir, Overgard, & Yang, 2015).

Research objectives

In this study, three research objectives were proposed to guide the study. The objectives of this study were as follows:

RO1: To determine the relationship between operational risk management and accident reduction in Chittagong port and outer anchorage, Bangladesh.

RO2: To determine the relationship between maritime support services and accident reduction in Chittagong port and outer anchorage, Bangladesh.

RO3: To determine the relationship between simulation training and assessment and accident reduction in Chittagong port and outer anchorage, Bangladesh.

Research hypotheses

Based on the research objectives and research questions formulated. The following hypothesis was proposed:

RH1: There is a significant relationship between operational risk management and accident reduction in Chittagong port and outer anchorage in Bangladesh.

RH2: There is a significant relationship between maritime support services and accident reduction in Chittagong port and outer anchorage in Bangladesh.

RH3: There is a significant relationship between simulation training and assessment and accident reduction in Chittagong Port and outer anchorage in Bangladesh.

Conceptual Framework of the Study

This study explores the relationship between support services and accident reduction in Chittagong port and outer anchorage in Bangladesh. This study uses three independent variables and one dependent variable. These

independent variables were operational risk management, maritime support services, and simulation training and assessment, whereas the dependent variable was the risk of an accident. See Figure 2 below.

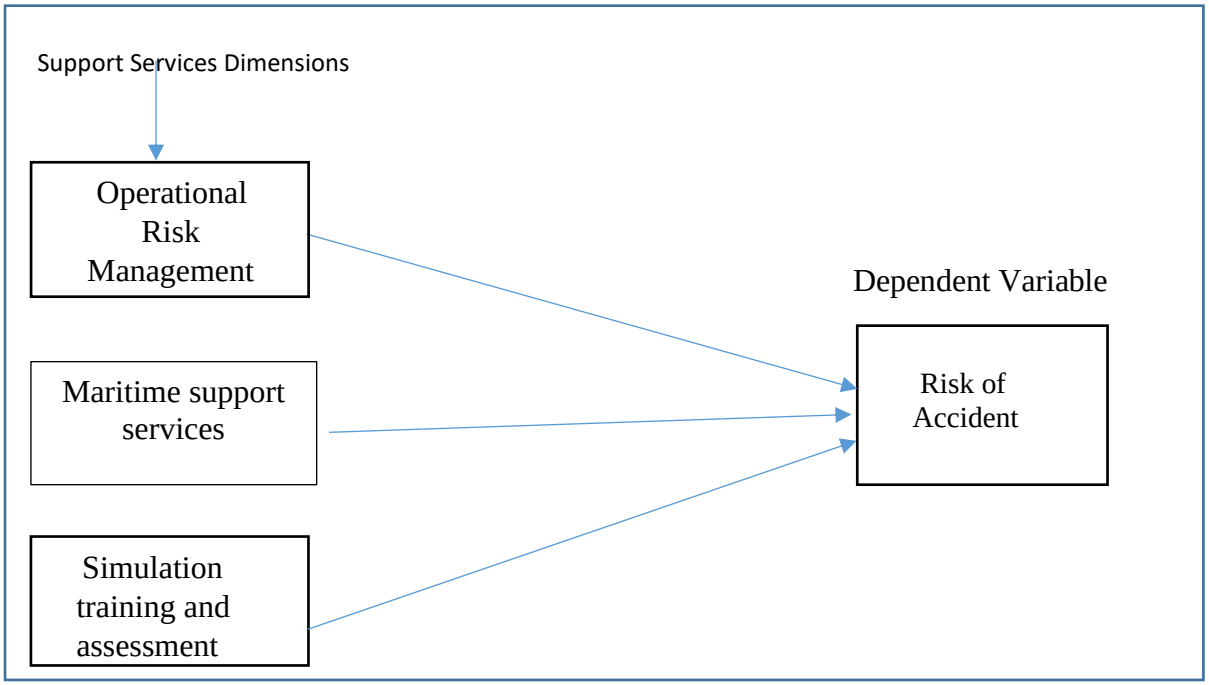

Figure 2. Conceptual Framework of the Study

Methodology

A descriptive survey was conducted. The sample consisted of 100 employees from the Chittagong Port, Bangladesh. Therefore, a simple random sampling technique was used. Three research hypotheses are proposed to guide this study. The data for the hypotheses were analyzed using Pearson's moment correlation coefficient.

Instrumentation

The study used three variables: maritime support services, operational risk management, and simulation training and assessment. The instrument was divided into four parts. The first part contained the respondents' information, such as gender, age, experience, and qualifications. The second part, maritime support, contained six items. A third of the instrument was operational risk management with seven items, and the last was an employee performance instrument with six items, while simulation training and assessment had six items. Therefore, the total number of items used for exercise was 18 for all three variables.

Descriptive statistics were used to analyze the demographic information of all respondents. Three hypotheses were formulated for this study. All the hypotheses were analyzed with the Pearson Moment Correlation Coefficient

Data Analysis and Results

Result of Demographic Information

The respondents' characteristics used in this study are listed in Table 4.8. Some respondents' characteristics included gender, age, work experience, qualifications, and designation. The total number of participants in the final study was 100. According to the analysis, the number of male respondents participating in the study was 70 (70.0%), while the female was 30 (30.0%). This shows that there were more male respondents than female respondents in Chittagong Port, Bangladesh. Concerning the age group, the analysis showed that respondents age group between 20-30 years had a frequency of 16 (16.0%), followed by the age group between 31-40 years with a frequency of 32 (32.0%) group between 41-50 years with a frequency of 29 (29.0%), and the age group between 51-60 years with a frequency of 23 (23.0%). The results indicated that the age group was between 31-40 yrs. exhibits a high frequency in

the distribution. The results of the educational qualifications are also revealed in the analysis. The respondents with diplomas had a frequency of 10 (10.0%), bachelor's degrees (35 (35.0%), master's 44 (44.0%), and PhD 11 (11.0%).

Table 2

Demographic information

Demographic	Categories	Frequency	Percentage
Gender	Male	70	70.0
	Female	30	30.0
Age	20-30yrs	16	16.0
	31-40 yrs.	32	32.0
	41-50 yrs.	29	29.0
	51-60 yrs.	23	23.0
Marital status	Married	75	75.0
	Single	25	25.0
Qualifications	Diploma	10	10.0
	Bachelor	35	35.0
	Masters	44	44.0
	PhD	11	11.0
Years of working Experience	1-10	34	34.0
	11-20 yrs.	19	19.0
	21-30 yrs.	34	34.0
	31-40 yrs.	13	13.0
Designation	Executive	23	23.0
	Technical Supervisor	31	31.0
	Senior Officer	24	24.0
	Junior Staff	22	22.0

In addition, the analysis revealed the results of respondents based on marital status. The married respondents had a frequency of 75 (75.0 %), while single respondents had a distribution of 25 (25.0 %). These results indicate that single respondents dominated Chittagong Port in Bangladesh. Likewise, the results of years of experience revealed that respondents with 1-10 years had a frequency of 34 (34.0%), with 11-20 years had 19 (19.0%), 21-30 years had 34 (34.0%), and 31-40 years had 13 (13.0%). According to these results, respondents between 21-30 years had the highest frequency. The analysis further revealed the impact of the respondents' designations. Executives had a frequency of (23%), technical supervisors 31 (31.0%), senior officers 24 (24.0%), and junior staff 22 (22.0%). Technical supervisors had the highest frequency at 31.

Results of Correlation Analysis

Ho1: The Relationship between operational risk management and accident reduction in Chittagong Port and Outer Anchorage, Bangladesh

A Pearson product-moment correlation was run to assess the relationship between operational risk management and accident reduction in Chittagong Port and outer anchorage in Bangladesh. Chua (2012) suggested a rule of thumb for determining the strength of the relationship. The correlation coefficient size is between .91 to 1.00 or - .91 to -1.00 indicating a very strong correlation, .71 to .91 or -.71 to -90 indicates a strong relationship, between .51 to .70 or -.51 to -.70 is average/medium, .31 to .50 or-.31 to -50 is weak, .01 to .30 or -.01 to -30 is very weak while.00 indicating no correlation. The correlation between the two variables was analyzed, where r = .858, n=100, and P <, indicating a strong correlation between operational risk management and accident reduction. In this positive correlation, the

correlation coefficient indicates a relationship in which the higher the value of ORM, the higher the value of accident reduction.

Table 3

Correlation between operational risk management and Accident Reduction

		Accident reduction	Hypothesis
	Pearson Correlation	.858**	
Operational Risk			H1
Management	Sig. (2-tailed)	.000	Supported
	N	100	

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

Ho2: The Relationship between Maritime Support Services and accidents reduction in Chittagong port and outer anchorage, Bangladesh

The study's Pearson product-moment correlation was run to assess the relationship between operational risk management and accident reduction in Chittagong Port and outer anchorage in Bangladesh. Chua (2012) suggested a rule of thumb for determining the strength of the relationship. The correlation coefficient size is between .91 to 1.00 or - .91 to -1.00 indicating a very strong correlation, .71 to .91 or -.71 to -90 indicates a strong relationship, between .51 to .70 or -.51 to -.70 is average/medium, .31 to .50 or-.31 to -50 is weak, .01 to .30 or -.01 to -30 is very weak while.00 indicating no correlation. The correlation between the two variables was analyzed, with r = .611, n=100, and P < .005 indicating a moderate correlation between maritime support and accident reduction. In this positive correlation, it is observed correlation coefficient indicates a relationship where "the higher the value of maritime support, the higher the value of accident reduction.

Table 4. Correlation between maritime support services and accident reduction

		Accident reduction	Hypothesis
	Pearson Correlation	. 611**	
Maritime Support			H2
	Sig. (2-tailed)	.000	Supported
	N	100	

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

Ho3: The Relationship between simulation training and assessment and accident reduction in Chittagong Port and Outer Anchorage, Bangladesh

As shown in Table 4.1.12, Pearson product-moment correlation was run to assess the relationship between simulation training and assessment and accident reduction in Chittagong port and outer anchorage in Bangladesh. Chua (2012) suggested a rule of thumb for determining the relationship's strength. The correlation coefficient size is between .91 to 1.00 or - .91 to -1.00 indicating a very strong correlation, .71 to .91 or -.71 to -90 indicates a strong relationship, between .51 to .70 or -.51 to -.70 is average/medium, .31 to .50 or-.31 to -50 is weak, .01 to .30 or -.01 to -30 is very weak while.00 indicating no correlation. The correlation between the two variables was analyzed, where r = .810, n=100, and P < .005 indicating a strong correlation between simulation training, assessment, and accident reduction. In this positive correlation, it was observed that the higher the simulation training and assessment value, the higher the accident reduction value.

Table 5. Correlation between simulation training and Assessment and accident reduction

		Accident reduction	Hypothesis
Simulation Training and Assessment	Pearson Correlation	. 810**	H3 Supported
	Sig. (2-tailed)	.000	
	N	100	

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

Discussion

This study explores the relationship between support services and accident reduction in Chittagong port and outer anchorage in Bangladesh. Three hypotheses were formulated for this study. These are operational risk management, maritime support, and simulation training and assessment. The findings of this study confirmed a significant relationship between operational risk management and accident reduction (r^2 =.858. The study's conclusion was similar to Mokhtari, Ren, Roberts, and Wang's (2012) conclusion that top management must consider operational risk management. Operational risk management is the process and method by which managers and those concerned reduce the financial risks surrounding business activities. Manuele (2003) supported the study's finding that operational risk management is the technique to avert any financial problem and accident that might affect the organization.

Similarly, a significant relationship was observed between maritime support and accident reduction (r^2 = .611. Therefore, this finding corroborates the study done by scholars such as Molchan, 2005; Gonzalez, Piel, Gross & Glandrup, 2008; Moreno, Gonzalez, Muro & Maza, 2022 that support is very crucial in the maritime industry because it would increase the productivity of employees and reduction envisaging accident. Maritime security focuses on the security of vessels and cargo from external dangers, such as piracy and smuggling (Lin & Li, 2013; Lin, & Cheng, 2020). The relationship between simulation training, assessment, and accident reduction was also significant (r^2 = .810. The result found in this study was supported by studies investigated by researchers such as Alessi, 2017; Sellberg, 2017; Kim, Sharma, Bustgaard, Gyldensten, Nymoen, Tusher & Nazir, 2021 that

Simulation training involves professional knowledge, attitudes, and skills while protecting the employees and crew from unnecessary dangers. Sellberg (2017) and Kim, Sharma, Bustgaard, Gyldensten, Nymoen, Tusher, and Nazir (2021) pointed out that simulation training is the formation of a true-to-life learning situation that resembles or look-like real-life work and situation, which must be encouraged.

Recommendations

The following recommendations are offered.

1. It is recommended that the Chittagong Port of Bangladesh ensure that the training provided to employees is relevant to their needs and areas of specialization.
2. It is also recommended that scholarships be introduced for employees to study abroad to gain the knowledge and skills needed in the Chittagong port**.**
3. Training committees should be formed to ensure justice in awarding scholarships to employees who want to study abroad.

Conclusion

The research was conducted at the Chittagong Port of Bangladesh. The conceptual framework was developed based on existing leadership theories and relevant materials. Employees' experience working at Chittagong Port reflected that their performance had been hindered. The results confirmed that operational risk management had a significant positive relationship with accident reduction, maritime support services had a significant association with accident reduction, and simulation training and assessment had a significant relationship with accident reduction. This research has shown that employee performance can be supported if provided. The world is changing in a geometric progression, and the maritime sector is also a part of these changes. To meet the changes and innovations in this sector, it is necessary to provide more support services

that would allow them to discharge their duties and reduce accidents in the organization. It has been confirmed and noted that all of these services could reduce the number of accidents in the Chittagong port of Bangladesh to the barest minimum. New technologies are emerging in the maritime sector, and these employees must have the knowledge and skills to use the latest technologies. However, training mechanisms are provided with the help of support services. This would improve employee effectiveness in the rendered service and prevent accidents.

References

[1] Alessi, S. (2017). Simulation design for training and assessment. In *the aviation training* simulation (pp. 47-72). Routledge.

[2] Al-Shammari, N. F. S. H., & OH, J. (2018). Effects of Human Error on Marine Safety: A Case Study. *Journal of Engineering Research and Applications. Ijera*, *8*(11 Part II), 11-19.

[3] Aydin, A., Raison, N., Khan, M. S., Dasgupta, P., & Ahmed, K. (2016). Simulation-based training and assessment in urological surgery. *Nature Reviews Urology*, *13*(9), 503-519.

[4] Chuah, L. F., Mokhtar, K., Bakar, A. A., Othman, M. R., Osman, N. H., Bokhari, A., ... & Hasan, M. (2022). Marine environment and maritime safety assessment using the Port State Control database. *Chemosphere*, *304*, 135245.

[5] Ennen, C. S., & Satin, A. J. (2010). Training and assessment in obstetrics: The role of simulation. *Best practice & research Clinical obstetrics & gynecology*, *24*(6), 747-758.

[6] Fobbe, M. L., Lozano, R., & Carpenter, A. (2018). Sustainability assessment of seaports–Towardsacomprehensiveholisticframework.InBOOKOFABSTRACTS (p.25).

[7] González, A., Piel, E., Gross, H. G., & Glandrup, M. (2008, August). Testing challenges of maritime safety and security systems-of-systems. In *Testing: Academic & Industrial Conference-Practice and Research Techniques (tail part 2008)* (pp. 35-39). IEEE.

[8] Grammenos, C. (Ed.). (2013). The handbook of maritime economics and business. Taylor & Francis.

[9] Harms-Ringdahl, L. (2001). Safety analysis: principles and practice in occupational safety. CRC Press.

[10] Jabbarifar, T. (2009). The Importance of Classroom Assessment and Evaluation in Educational System. Proceedings of the 2nd International Conference of Teaching and Learning, 1-9.

[11] Khaled, M., E., Kawamura, Y., Sayem, M., Banik, A., Faruk, A., K.& Khan, M., R. (2018). Assessment of collision& grounding risk at Chittagong port, Bangladesh, 11thInternationalConferenceonMarineTechnologyMARTEC2018.

[12] Kim, T. E., Sharma, A., Bustgaard, M., Gyldensten, W. C., Nymoen, O. K., Tusher, H. M., & Nazir, S. (2021). The continuum of simulator-based maritime training and education. *WMU Journal of Maritime Affairs*, *20*(2), 135-150.

[13] Lin, W. C., & Cheng, H. H. (2020). Improving maritime safety through enhancing marine process management: The application of balanced scorecard. *Management Decision*, *59*(3), 604-615.

[14] Mangga, C., Tibo-oc, P., & Montaño, R. (2021). Impact of engine room simulator as a tool for training and assessing bsmare students' performance in engine watch keeping. *Педагогика*, *93*(S6), 88-100.

[15] Manuel, M. E. (2018). Safety and Risk Management Considerations for CSR. In *Corporate social responsibility in the maritime industry* (pp. 253-278). Springer, Cham.

[16] Melnyk, O., Onyshchenko, S., Pavlova, N., Kravchenko, O., & Borovyk, S. (2022). Integrated Ship Cybersecurity Management as a Part of Maritime Safety and Security System. *International Journal of Computer Science and Network Security*, *22*(03), 135-140.

[17] Mokhtari, K., Ren, J., Roberts, C., and Wang, J. (2012), "Decision support framework for risk management on seaports and terminals using fuzzy set theory and evidential reasoning approach," ExpertSystemswithApplications,.39 (5),50-87.

[18] Molchan, M. (2005). The role of micro-ROVs in maritime safety and security. *Mochlan Marine Sciences*, *44*.

[19] Moreno, F. C., Gonzalez, J. R., Muro, J. S., &

Maza, J. G. (2022). Relationship between human factors and the safe performance of vessel traffic service operators: a systematic qualitative-based review in maritime safety. *Safety Science*, *155*, 105892.

[20] Nazir, S., Overgård, K. I., & Yang, Z. (2015). Towards effective training for process and maritime industries. *Procedia Manufacturing*, *3*, 1519-1526.

[21] Sawyer, T., & Gray, M. M. (2016, November). Procedural training and assessment of competency utilizing simulation. In *Seminars in Perinatology* (Vol. 40, No. 7, pp. 438-446). WB Saunders.

[22] Sellberg, C. (2017). Simulators in bridge operations training and assessment: a systematic review and qualitative synthesis. *WMU Journal of Maritime Affairs*, *16*(2), 247-263.

[23] Talley, W. (2013). *Maritime safety, security, and piracy*. Informa Law from Routledge.

[24] Yang, Z. L., Wang, J., & Li, K. X. (2013). Maritime safety analysis in retrospect. *Maritime Policy & Management*, *40*(3), 261-277.

[25] Mehraj, H., Jayadevappa, D., Haleem, S. L. A., Parveen, R., Madduri, A., Ayyagari, M. R., & Dhabliya, D. (2021). Protection motivation theory using multi-factor authentication for providing security over social networking sites. Pattern Recognition Letters, 152, 218-224.

[26] Soni, M., Khan, I. R., Babu, K. S., Nasrullah, S., Madduri, A., & Rahin, S. A. (2022). Light weighted healthcare CNN model to detect prostate cancer on multiparametric MRI. Computational Intelligence and Neuroscience, 2022.

[27] Sreenivasu, S. V. N., Gomathi, S., Kumar, M. J., Prathap, L., Madduri, A., Almutairi, K., ... & Jayadhas, S. A. (2022). Dense convolutional neural network for detection of cancer from CT images. BioMed Research International, 2022.

[28] Sharma, D. K., Chakravarthi, D. S., Boddu, R. S. K., Madduri, A., Ayyagari, M. R., & Khaja Mohiddin, M. (2022, June). Effectiveness of machine learning technology in detecting patterns of certain diseases within patient electronic healthcare records. In Proceedings of Second International Conference in Mechanical and Energy Technology: ICMET 2021, India (pp. 73-81). Singapore: Springer Nature Singapore.

[29] Mannepalli, K., Vinoth, K., Mohapatra, S. K., Rahul, R., Gangodkar, D. P., Madduri, A., ... & Mohanavel, V. (2022). Allocation of optimal energy from storage systems using solar energy. Energy Reports, 8, 836-846.

[30] Rubavathy, S. J., Kannan, N., Dhanya, D., Shinde, S. K., Soni, N. B., Madduri, A., ... & Sathyamurthy, R. (2022). Machine Learning Strategy for Solar Energy optimisation in Distributed systems. Energy Reports, 8, 872-881.

[31] Bansal, P., Ansari, M. J., Ayyagari, M. R., Kalidoss, R., Madduri, A., & Kanaoujiya, R. (2023, April). Carbon quantum dots based nanozyme as bio-sensor for enhanced detection of glutathione (U) from cancer cells. In AIP Conference Proceedings (Vol. 2603, No. 1). AIP Publishing.

[32] Kadam, P. S., Rajagopal, N. K., Yadav, A. K., Madduri, A., Ansari, M. J., & Patil, P. Y. (2023, April). Biomedical waste management during pandemics. In AIP Conference Proceedings (Vol. 2603, No. 1). AIP Publishing.

[33] Torres-Cruz, F., Nerkar Charushila, K., Chobe Santosh, S., Subasree, N., Madduri, A., & Pant, B. (2023, April). A review on future prospects on magnetic levitation for disease diagnosis. In AIP Conference Proceedings (Vol. 2603, No. 1). AIP Publishing.

[34] Sugumar, D., Dixit, C. K., Saavedra-Lopez, M. A., Hernandez, R. M., Madduri, A., & Pant, B. (2023, April). White matter microstructural integrity in recovering alcoholic population. In AIP Conference Proceedings (Vol. 2603, No. 1). AIP publishing.

[35] Sign Language Interpretation Using Deep LearningSuguna Mallika, S., Sanjana, A., Vani Gayatri, A., Veena Naga Sai, S.Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) this link is disabled, 2023, 14078 LNAI, pp. 692–703

[36] C. Sarada, V. Dattatreya and K. V. Lakshmi, "Deep Learning based Breast Image Classification Study for Cancer Detection," 2023 IEEE International Conference on Integrated Circuits and Communication

Systems (ICICACS), Raichur, India, 2023, pp. 01-08, doi: 10.1109/ICICACS57338.2023.10100206.

[37] C. Sarada, K. V. Lakshmi and M. Padmavathamma, "Spatial Intuitionistic Fuzzy C-means with Calcifications enhancement based on Nonsubsampled Shearlet Transform to detect Masses and Microcalcifications from MLO Mammograms," 2023 Advanced Computing and Communication Technologies for High Performance Applications (ACCTHPA), Ernakulam, India, 2023, pp. 1-10, doi: 10.1109/ACCTHPA57160.2023.10083338

[38] Mutation Testing and Web Applications—A Test Driven Development Approach for Web Applications Built with Java Script Suguna Mallika, S., Rajya Lakshmi, D.Intelligent Systems Reference Librarythis link is disabled, 2022, 210, pp. 243–259

[39] Mutation Testing and Its Analysis on Web Applications for Defect Prevention and Performance Improvement Suguna Mallika, S., Rajya Lakshmi, D.International Journal of e-Collaboration, 2021, 17(1), pp. 71–88

[40] MUTWEB-A testing tool for performing mutation testing of java and servlet based web applications Suguna Mallika, S., Rajya Lakshmi, D.International Journal of Innovative Technology and Exploring Engineering, 2019, 8(12), pp. 5406–5413

[41] Nayomi, B. D. D. ., Mallika, S. S. ., T., S. ., G., J. ., Laxmikanth, P. ., & Bhavsingh, M. . (2023). A Cloud-Assisted Framework Utilizing Blockchain, Machine Learning, and Artificial Intelligence to Countermeasure Phishing Attacks in Smart Cities. International Journal of Intelligent Systems and Applications in Engineering, 12(1s), 313–327. Retrieved from https://ijisae.org/index.php/IJISAE/article/view/3419