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Research Paper

Comparative Analysis of the Effectiveness of the Marine Evacuation System (MES) and Lifeboats for Passenger Evacuation in Emergency Situations on MV. Dobonsolo

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Abstract

Ships are a preferred mode of transportation for Indonesian society due to their consistent focus on safety and security. In ship emergencies, the use of safety equipment such as the Marine Evacuation System (MES) and lifeboats is the primary factor in ensuring the successful evacuation of crew and passengers. However, there has been limited empirical research comparing the effectiveness of the Marine Evacuation System (MES) and lifeboats, despite the fact that delays in the evacuation process can have fatal consequences. Therefore, this study aims to analyze the comparative effectiveness of the Marine Evacuation System (MES) versus lifeboats in evacuating passengers during emergency conditions on MV. Dobonsolo. This research employs a quantitative method to compare two variables using descriptive comparative analysis techniques. The sample consists of 83 crew members from the MV. Dobonsolo. Data processing and hypothesis testing were conducted using SPSS version 26. The research results indicate that the Marine Evacuation System (MES) achieved an average effectiveness score of 4.37, while lifeboats achieved 3.89. Based on the hypothesis test results, there was a significant difference between the effectiveness of the Marine Evacuation System (MES) and lifeboats, with a two-tailed significance value of $p < 0.001$; therefore, H_a was accepted. The Wilcoxon signed-rank test showed that MES received higher effectiveness ratings than lifeboats, as indicated by the higher mean rank of 38.71 compared to 15.50. Therefore, it can be concluded that the MES is more effective to use than lifeboats.

Keywords: *Comparative, Effectiveness, Marine Evacuation System (MES), Lifeboats, Evacuation*

INTRODUCTION

Indonesia is an archipelagic country; therefore, its people rely on ships as a primary mode of transportation. Safety in maritime navigation is a top priority (Sholichah et al., 2023). According to data from the International Air Transport Association (IATA), the National Safety Council (NSC), and the National Highway Traffic Safety Administration (NHTSA), ships are among the safest modes of transportation. Nevertheless, ships still face the risk of emergencies. In such circumstances, onboard safety equipment serves as the primary means of protecting passengers and crew and is generally classified into two categories: Life Saving Appliances (LSA) and Personal Protective Equipment (PPE). Examples of Life-Saving Appliances (LSAs) on board include the Marine Evacuation System (MES), liferafts, lifeboats, and others.

According to Santosh (2025), the Marine Evacuation System (MES) is an innovative safety device that can reduce evacuation time by up to 40% compared to lifeboats on large vessels. The Marine Evacuation System (MES) and lifeboats each present distinct advantages and limitations in passenger evacuation, with evacuation effectiveness in emergencies being strongly influenced by passenger density and environmental conditions (Andreadakis & Dalaklis, 2024).

Ships carrying large numbers of passengers tend to have complex, slow evacuation processes. One example is the 2012 Costa Concordia cruise ship disaster off the coast of Giglio

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Island, Italy. This accident occurred when the ship deviated from its designated shipping route and struck an underwater reef, causing serious damage to the hull. Although the ship did not immediately sink, the evacuation process encountered several obstacles, including a delayed emergency declaration, a lack of coordination between the crew and passengers, and confusion over evacuation routes. Many passengers did not immediately realize the extent of the danger because the information provided by the crew at the start of the incident was unclear and often underestimated the severity of the situation. This condition led to a slower, less effective evacuation, resulting in the deaths of 32 people.

Another incident that underscored the importance of an effective evacuation system was the 1994 sinking of the MS Estonia ferry in the Baltic Sea. The accident occurred when a bow visor was released, allowing a large volume of seawater to enter the vehicle deck. The influx of water drastically reduced the ship's stability, causing it to list sharply and sink within a relatively short time. The incident occurred at night, in poor weather, with extremely cold water temperatures and limited time to evacuate, preventing most passengers from reaching safety equipment or assembly points. Furthermore, many passengers had difficulty moving as the ship's tilt increased. As a result, of the 989 people on board, only 137 were rescued, while 852 were declared dead or missing.

These two incidents demonstrate that the success of an evacuation depends not only on the availability of safety equipment but also on the speed of response, the effectiveness of the evacuation system, environmental conditions, and the readiness and competence of the ship's crew in handling emergencies. Overcrowding, delayed decision-making, inadequate crew training, and limited evacuation time can increase the risk of loss of life. Therefore, the effective use of safety equipment, such as the Marine Evacuation System (MES) and lifeboats, must be supported by sound evacuation procedures, regular crew training, and swift, precise coordination to ensure optimal passenger rescue in emergencies (Hasil et al., 2024).

During the researcher's sea training aboard the MV. Dobonsolo, which is equipped with both a Marine Evacuation System (MES) and lifeboats, no empirical study was found that directly compares the effectiveness of MES and lifeboats, even though both are critical evacuation systems for ensuring the safety of passengers and crew. This study aims to compare the effectiveness of the Marine Evacuation System (MES) and lifeboats for passenger evacuation during emergencies, with particular attention to operational and safety aspects from the perspectives of crew members who operate these safety devices. The research was conducted on MV Dobonsolo, a passenger vessel owned by PT PELNI that operates under unstable weather conditions and is equipped with both MES and lifeboats. By analyzing the differences in the effectiveness of these two evacuation systems, the findings are expected to contribute to the development of more effective emergency evacuation policies and to strengthen public confidence in the national maritime industry.

LITERATURE REVIEW

Comparison is a method for identifying similarities and differences between two or more objects based on specific criteria. In research, comparative analysis is used to evaluate differences among variables or groups in order to determine relative performance according to predetermined indicators (Sugiyono, 2019). In this study, a comparative approach is used to examine the effectiveness of the Marine Evacuation System (MES) and lifeboats in supporting passenger evacuation during emergencies.

Effectiveness is the degree to which an activity, system, or tool achieves its predetermined objectives (Julianto et al., 2021). It is oriented toward outcomes and evaluates whether planned objectives can be achieved optimally. According to Gehringer (2024), factors influencing effectiveness include the characteristics of safety equipment, the conditions in which it is used, the characteristics of the operators, and the characteristics of ship safety management. In the context

of this study, effectiveness is defined as the degree to which safety equipment achieves its primary objective: evacuating passengers safely and in accordance with established procedures. Optimal utilization of all safety equipment resources is also a factor in effectiveness (Querido, 2023). According to Wardhana and Si (2024), effectiveness refers to the extent to which planned objectives are achieved accurately and efficiently, particularly in relation to speed and timeliness. Similarly, the Organisation for Economic Co-operation and Development (OECD) (2024) defines effectiveness as the level of success of a system in achieving predetermined objectives by considering processes, timeliness, capability, and resource readiness. From this perspective, the indicators of effectiveness can be assessed in several aspects, namely adaptability, ease of operation, equipment readiness, and reliability.

According to Changle et al. (2022), the Marine Evacuation System (MES) is an innovative safety device designed to rapidly transfer or evacuate people from a ship's passenger deck to survival craft (liferafts). MES can operate under conditions of up to 20° list and 10° trim. There are two types of MES used on ships: the chute type (vertical or zigzag descent with control) and the slide type (similar to a playground slide). According to Koimtzoglou and Michelis (2021), the main components of MES include a control panel and operating system, a stowage container, an inflatable slide or chute, and inflatable liferafts. Furthermore, MES components are equipped with emergency lighting, designed with anti-slip surfaces, are tear-resistant, and feature a structured design, as noted by Nie et al. (2023). These technical features are intended to ensure that the MES can be deployed effectively during emergencies when operated according to established procedures. In the context of PT PELNI, the Marine Evacuation System (MES) is operated according to the manual as follows: after the ship's captain presses the emergency button, the crew releases the liferaft winch locking pin and the locking hook, allowing the rubber boat to deploy into the sea. After the rubber boat plunges into the water, the crew will pull the painter line until the rubber boat opens, then turn the winch on the control panel until the rubber boat is directly under the MES container. When the rubber boat is under the container, the crew will open the container's front and rear doors, and the bottom will be levered with a crowbar. The guide rope is held, and the rescue slide (slide/inflatable channel) is pushed down, landing directly above the rubber boat. After the passengers land in the MES liferaft, the crew will direct the passengers to move to another rubber boat. Harwood and Farrow (2012) examined the use of the Vertical Chute Marine Evacuation System (MES) on passenger ships and found that the system's effectiveness was influenced by the ship's physical characteristics and the user's preparedness for evacuation. The results indicated that adequate training is necessary to minimize the risk of injury and increase the success of MES use.

A lifeboat is a safety appliance designed to accommodate and protect individuals during ship abandonment in emergency situations, thereby supporting survival at sea. Lifeboats are available in various sizes and capacities, depending on the number of people they are designed to carry, and are equipped with essential survival equipment (Pratama et al., 2022). Based on their launching mechanisms, lifeboats are generally classified into two types: free-fall lifeboats and davit-launched lifeboats (Yan et al., 2025). Alongside these functional characteristics, advances in maritime technology have contributed to significant innovations in lifeboat safety features, construction materials, launching systems, and operational performance. In particular, the application of Artificial Intelligence (AI), which has increasingly expanded across various sectors, including shipping, has further supported the development of modern lifeboat operations and safety systems (Noah & Kilinc, 2025; Winardi et al., 2025).

Lifeboat equipment can be classified into three main categories: communication, survival, and navigation equipment. Communication equipment includes whistles, flashlights, and pyrotechnic signals, while survival equipment consists of drinking water, food, medical supplies,

blankets, hand pumps, buckets, ropes, knives or axes, first aid kits, and fishing gear. Navigation equipment includes compasses, rudders, oars, lighting devices, propulsion engines with fuel, and floating anchors. The presence of these items indicates that the lifeboat serves not only as an evacuation tool but also as a means of survival, as stated by Aksal (2023). Velez and Wallace (2025) examined the allocation of passengers to lifeboats on cruise ships. The results showed that optimally managing passenger distribution to lifeboats can reduce congestion on evacuation routes and expedite the rescue process.

The Marine Evacuation System (MES) and lifeboats are used to evacuate passengers. Evacuation is the action of rescuing or moving victims from a dangerous area to a safe location. In emergencies, the evacuation process must be carried out quickly, accurately, and in a coordinated manner, as it involves the safety of human lives. Evacuation on board must be conducted in accordance with the emergency plan and muster list to prevent confusion among passengers and crew members (Ambarsari et al., 2025). To optimize the effectiveness of safety equipment during evacuation, all Life Saving Appliances (LSAs) must be kept in good condition. LSAs must be regularly maintained to prevent damage and ensure they are ready for use at any time. In addition to the LSAs, the crew's preparedness and ability to respond to emergencies are key factors in ensuring a smooth evacuation process. Regular drills will improve the crew's skills and reflexes in evacuating passengers, thereby reducing potential confusion and increasing the efficiency of the rescue process. In general, types of emergencies on board include fire, collision, sinking, grounding, explosion, engine failure, man overboard, and leakage (Burhanuddin et al., 2024). In emergency situations, evacuation success is strongly influenced by the speed of response and the effectiveness of safety equipment. Therefore, the selection, placement, and operation of evacuation equipment, such as the Marine Evacuation System (MES) and lifeboats, must comply with the safety standards established by the International Maritime Organization (IMO) and SOLAS. Based on this consideration, the present study formulates two hypotheses to examine whether there is a significant difference in the effectiveness of MES and lifeboats in passenger evacuation (Yam & Taufik, 2021).

H_0: There is no difference in effectiveness between MES and lifeboats for evacuating passengers.
H_a: There is a difference in effectiveness between MES and lifeboats for evacuating passengers in emergencies.

RESEARCH METHOD

According to Adil et al. (2023), a research method is a scientific approach to collecting data with specific goals and functions that can be explained, described, proven, developed, and used to discover knowledge and theories to solve and understand various problems. The data obtained in research is empirical data that meets valid criteria. Validity describes the degree of accuracy of the data obtained by the researcher relative to the object's actual conditions. The collected data must undergo reliability and objectivity testing to ensure its accuracy. The entire research process must be grounded in scientific principles, including rationality, systematic organization, and empirical evidence. Quantitative analysis is used to objectively test relationships, comparisons, differences, or the influence of a variable using numerical data and statistical tests (Sianipar, 2021). This research adopts a quantitative approach using a comparative method. The comparative method is a research approach that compares one variable with another to identify differences and similarities between them (Iskandar et al., 2023).

In this study, the comparative method is used to assess the effectiveness of the Marine Evacuation System (MES) and lifeboats as emergency evacuation equipment on board a ship.

During data processing and analysis, IBM SPSS version 26 and Microsoft Excel were used to obtain objective, measurable results. The research was conducted aboard the MV. Dobonsolo from August 1, 2024, to August 2, 2025, over a period of one year and one day.

According to Sugiyono (2021), the population is the entire set of objects to be measured in this study, consisting of all crew members of MV. Dobonsolo. The research employed purposive sampling, and the sample size was calculated using the Slovin formula with a 5% margin of error. The formula used to determine the sample size is as follows:

$$\boldsymbol{n = \frac{N}{1 + (N \times e^2)}}$$

Where:
n = sample size
N = population size
e = margin of error

Given:
$\boldsymbol{N = 104}$
$\boldsymbol{e = 0.05}$

The sample size is calculated as follows:

$$\begin{aligned} \boldsymbol{n} &= \boldsymbol{\frac{104}{1 + (104 \times 0.05^2)}} \\ &= \boldsymbol{\frac{104}{1 + (104 \times 0.0025)}} \\ &= \boldsymbol{\frac{104}{1 + 0.26}} \\ &= \boldsymbol{\frac{104}{1.26}} \\ &= \boldsymbol{82.53} \end{aligned}$$

Based on the Slovin formula, the study included 83 respondents, selected from a population of 104 crew members of the MV. Dobonsolo, who has experience operating both types of safety equipment. According to Ardiansyah et al. (2023), data collection techniques refer to the procedures used to obtain the data needed to address research problems and achieve research objectives. In this study, data were collected through a questionnaire developed based on the indicators of the research variables (Amalia et al., 2022). Respondents' answers were measured using a five-point Likert scale, ranging from 1 = strongly disagree to 5 = strongly agree (Hidayat, 2021), as presented in Table 1.

Table 1. Likert scale

Scale Code	Response	Value
VA	Very Agree	5
A	Agree	4
Do	Doubt	3
D	Disagree	2
VD	Very Disagree	1

According to Sugiyono (2019), validity testing can be determined by calculating the r-count value and comparing it with the r-table value, as well as by using correlation values. In addition to using the r-table, validity can also be assessed through correlation values. If the significance value (sig) ≥ 0.05, the questionnaire is considered not valid; if the significance value (sig) ≤ 0.05, it is considered valid. The results of the research analysis will be more accurate if the collected data is first processed through the stages of cleaning, filtering, and normality testing before analysis (Saidu et al., 2023). Reliability testing is assessed using Cronbach's Alpha coefficient (Arbeni et al., 2025), whereas descriptive statistical analysis in this study is conducted by calculating the mean, minimum, maximum, and percentage (Handayani, 2023). Prior to hypothesis testing, the normality of the paired data was assessed using the Kolmogorov–Smirnov test, as the sample size exceeded 50 respondents.

Because the study involved paired data from the same respondents, a homogeneity test was not required; therefore, assumption testing focused on data normality (Muliana et al., 2025). The normality test was used to determine the appropriate statistical procedure, with data considered normally distributed when the significance value (Sig.) is greater than 0.05 and not normally distributed when it is less than 0.05. Hypothesis testing was conducted to examine whether the Marine Evacuation System (MES) and lifeboats differed in effectiveness, with the same respondents assessing both systems. If the data were normally distributed, the Paired Sample t-Test was applied as a parametric test to compare the mean scores of the two related measurements. However, if the data were not normally distributed, the Wilcoxon signed-rank test was used as the non-parametric alternative (Anuraga et al., 2021).

FINDINGS AND DISCUSSION

Respondent characteristics

a. Respondent characteristics based on gender

Table 2. Respondent characteristics based on gender

Gender	Frequency	Percentage
Men	82	99%
Women	1	1%
Total	83	100%

Based on the research results, 82 respondents were male, accounting for 99%. One respondent was female, representing 1%. This indicates that the majority of respondents in this study were male.

b. Respondent characteristics based on position on board ship

Table 3. Respondent characteristics based on position on board ship

Position	Frequency	Percentage
Deck Officer	9	11%
Deck Rating	17	20%
Doctors / Nurses	2	2%
Engine Officer	11	13%
Engine Rating	7	8%
Catering Officer	4	5%
Chef	6	7%
Waiter	27	33%

Total	83	100%

Based on the research results, 9 respondents held the position of Deck Officers, representing 11%. There were 17 Deck Ratings (bosun, mister, sailor, captain, helmsman, security guard, and P.U.K.) representing 20%. There were 2 Doctors, representing 2%. There were 11 Engine Officers, representing 13%. There were 7 Engine Ratings, representing 8%. There were 4 Catering Officers (Jenang and Butler), representing 5%. There were 6 Chefs, representing 7%. There were 27 Waiters, representing 33%. This indicates that the majority of respondents in this study held waiter positions. This also means that the catering/hotel department was the dominant one, with 37 respondents (45%).

c. Respondent characteristics based on sailing experience

Table 4. Respondent characteristics based on sailing experience

Sailing Experience	Frequency	Presentation
Less Than 5 Years	0	0%
5 - 10 Year	27	33%
More Than 10 Years	56	67%
Total	83	100%

Based on the research results, 0 respondents had less than 5 years of sailing experience. 27 respondents had 5-10 years of sailing experience, representing 33%. 56 respondents had more than 10 years of sailing experience, representing 67%. Based on these data, the majority of respondents have more than 10 years of sailing experience. This indicates that most respondents have extensive experience on ships, enabling them to provide objective assessments of both variables studied.

Code Item for A Question in A Questionnaire

Table 5. Code item for a question in a questionnaire

No	Research Variables	Indicator	Item
1.	Marine Evacuation System (MES)	Equipment Speed	X1.1
			X1.2
		Adaptability	X1.3
			X1.4
		Ease of Operation	X1.5
			X1.6
		Equipment readiness	X1.7
			X1.8
		Equipment Reliability	X1.9
			X1.10
2	Lifeboat	Equipment Speed	X2.1
			X2.2
		Adaptability	X2.3
			X2.4
		Ease of Operation	X2.5
			X2.6
		Equipment readiness	X2.7
			X2.8
		Equipment Reliability	X2.9
			X2.10

Recapitulation of Responses for the Marine Evacuation System (MES) Variable (X1)

Table 6. Recapitulation of Responses for the Marine Evacuation System (MES) Variable

Item	Responses					Total Weight	Mean	Criteria
	STS	TS	R	S	SS			
X1.1	0	0	21	164	175	360	4,3	Very Good
X1.2	0	0	12	144	215	371	4,5	Very Good
X1.3	1	0	39	156	150	346	4,2	Good
X1.4	1	0	27	172	150	350	4,2	Good
X1.5	0	2	18	144	200	364	4,4	Very Good
X1.6	0	0	12	156	200	368	4,4	Very Good
X1.7	0	0	12	148	210	370	4,5	Very Good
X1.8	0	0	18	144	205	367	4,4	Very Good
X1.9	0	0	30	140	190	360	4,3	Very Good
X1.10	0	0	21	124	225	370	4,5	Very Good
Total						3.628	43,7	
Mean							4,37	Very Good

Based on Table 6, which presents respondents' answers to the MES (X1) variable, the average score is 4,37, which falls into the "very good" category according to the Likert interpretation (Sugiyono, 2022).

Table 7. Likert Scale

Score Average	Interpretation
1,00 – 1,80	Not Good
1,81 – 2,60	Not Good Enough
2,61 – 3,40	Quite Good
3,41 – 4,20	Good
4,21 – 5,00	Very Good

This result indicates that the majority of the crew members have a highly positive perception of the MES, reflecting that the system is considered effective, reliable, and easy to operate in supporting emergency evacuation procedures on board. The high average score also suggests a consistent level of agreement among respondents regarding the performance of the MES across the measured indicators.

Recapitulation of Responses for the Lifeboat Variable (X2)

Table 8. Recapitulation of Responses for the Lifeboat Variable

Item	Responses					Total Weight	Mean	Criteria
	STS	TS	R	S	SS			
X2.1	3	6	42	124	160	335	4,0	Good
X2.2	3	8	45	160	105	321	3,8	Good
X2.3	7	14	39	156	85	301	3,6	Good
X2.4	2	12	45	140	125	324	3,9	Good
X2.5	4	8	66	124	110	312	3,8	Good
X2.6	3	6	78	108	120	315	3,8	Good
X2.7	1	6	69	108	145	329	4,0	Good
X2.8	0	2	51	132	160	345	4,2	Good
X2.9	2	14	42	156	105	319	3,8	Good

X2.10	2	8	54	132	130	326	4,0	Good
		Total				3.227	38,9	
		Mean					**3,89**	**Good**

Based on Table 8, which presents respondents' answers to the lifeboat variable (X2), the mean score is 3,89. This value falls within the "good" category according to the Likert scale interpretation. This indicates that the majority of respondents provided a positive assessment of the lifeboat as an emergency evacuation facility. Furthermore, the result suggests that lifeboats are generally considered adequate and functional in supporting evacuation procedures on board, although their performance is perceived to be slightly lower than that of other evacuation systems. Overall, the responses reflect a consistent level of agreement among respondents regarding the effectiveness, usability, and readiness of lifeboats in emergencies.

Validity Test

Validity testing aims to determine the extent to which a research instrument accurately measures the variables under study. An instrument is said to be valid if the questions in the questionnaire can reveal data that corresponds to the variables being measured. Validity testing in this study was conducted using SPSS. The basis for making decisions about validity testing is that if the calculated r > r table, it is valid; if the calculated r < r table, it is invalid. In addition to using the table r, a method for calculating validity can use the correlation value. If the sig value ≥ 0.05, then the questionnaire is declared invalid. If the sig value is ≤ 0.05, it is declared valid.

Table 9. Validity test of the Marine Evacuation System (MES) (X1)

Question Items	*r* count	*r* table	Condition	Sig value	Inf.
X1.1	0.565	0.213	*r* count > *r* table	<0.001	valid
X1.2	0.609	0.213	*r* count > *r* table	<0.001	valid
X1.3	0.611	0.213	*r* count > *r* table	<0.001	valid
X1.4	0.606	0.213	*r* count > *r* table	<0.001	valid
X1.5	0.568	0.213	*r* count > *r* table	<0.001	valid
X1.6	0.618	0.213	*r* count > *r* table	<0.001	valid
X1.7	0.544	0.213	*r* count > *r* table	<0.001	valid
X1.8	0.533	0.213	*r* count > *r* table	<0.001	valid
X1.9	0.588	0.213	*r* count > *r* table	<0.001	valid
X1.10	0.597	0.213	*r* count > *r* table	<0.001	valid

According to Table 9, the validity test for the Marine Evacuation System (MES) indicates that all questionnaire items are valid because the calculated *r*-values (*r*-count) exceed the *r*-table values. This finding is further supported by the significance values for all questionnaire items, which were reported as p < 0,001. Because these values are below the 0.05 significance level and the calculated *r*-values exceed the *r*-table value, all MES questionnaire items can be considered valid and appropriate for use as research instruments.

Table 10. Validity test of the lifeboat (X2)

Question Items	*r* count	*r* table	Condition	Sig value	Inf.
X2.1	0.818	0.213	*r* count > *r* table	<0.001	valid
X2.2	0.858	0.213	*r* count > *r* table	<0.001	valid
X2.3	0.651	0.213	*r* count > *r* table	<0.001	valid
X2.4	0.570	0.213	*r* count > *r* table	<0.001	valid
X2.5	0.811	0.213	*r* count > *r* table	<0.001	valid
X2.6	0.800	0.213	*r* count > *r* table	<0.001	valid
X2.7	0.547	0.213	*r* count > *r* table	<0.001	valid
X2.8	0.526	0.213	*r* count > *r* table	<0.001	valid
X2.9	0.738	0.213	*r* count > *r* table	<0.001	valid
X2.10	0.718	0.213	*r* count > *r* table	<0.001	valid

Based on Table 10, the validity test results for the lifeboat variable indicate that each questionnaire item is valid, as the calculated *r*-values (*r*-count) exceed the *r*-table values and the significance values (sig.) are less than 0,05. This result is further supported by the significance values for all questionnaire items, which were $p < 0,001$, indicating they were below the 0,05-significance level.

Reliability test

Reliability testing evaluates the consistency of research instruments in measuring variables. An instrument is considered reliable when it yields consistent results for the same object across different periods. In this study, reliability was assessed using Cronbach's alpha in IBM SPSS Statistics, and a variable was considered reliable if Cronbach's alpha value was greater than 0.60.

Table 11. Reliability test

Variable	Value Cronbach Alpha	Information
MES	0.783	Good
Lifeboat	0.888	Very Good

Based on the table above, the reliability test results for the Marine Evacuation System (MES) and lifeboat variables are 0.783 and 0.888, respectively. Cronbach's alpha values of 0.7–0.8 are considered good, while values of 0.8–0.9 are considered very good. Therefore, it can be concluded that all measurement variables in the questionnaire are reliable and that all items within each variable are valid measurement instruments.

Descriptive Statistical Analysis

Table 12. Descriptive Statistical Analysis

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
MES	83	16.00	34.00	50.00	43.6867	3.83160	14.681
Lifeboat	83	28.00	22.00	50.00	38.8795	7.01114	49.156
Valid N (listwise)	83						

Based on the results of the descriptive statistical analysis, among 83 respondents, the mean score for the Marine Evacuation System (MES) is 43.6867, with a range of 16.00. The minimum MES

value is 34, and the maximum value is 50, with a variance of 14.681 and a standard deviation of 3.83160. For the lifeboat variable, the mean score is 38.8795, with a range of 28.00. The minimum value is 22.00, and the maximum value is 50, with a variance of 49.156 and a standard deviation of 7.01114.

Normality Test

Table 13. Normality Test

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Variables	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Result	MES	0.113	83	0.011	0.958	83	0.009
	Lifeboat	0.148	83	<0.001	0.943	83	0.001

a. Lilliefors Significance Correction

Based on Table 13, the results of the normality test using the Kolmogorov–Smirnov and Shapiro–Wilk methods are presented. The significance value of the Kolmogorov–Smirnov test is < 0.05 for both groups (MES and lifeboat). This indicates that the data are not normally distributed, even after data transformation and outlier treatment. Therefore, the Paired Sample t-Test was not appropriate for hypothesis testing. Accordingly, the Wilcoxon signed-rank test was applied as a non-parametric alternative to examine differences between the paired measurements.

Hypothesis Testing (Wilcoxon Signed Rank Test)

Table 14. Ranks

		N	**Mean Rank**	**Sum of Ranks**
Lifeboat - MES	Negative Ranks	49[a]	38.71	1897.00
	Positive Ranks	16[b]	15.50	248.00
	Ties	18[c]		
	Total	83		

a. Lifeboat < MES
b. Lifeboat > MES
c. Lifeboat = MES

Table 15. Test Statistics[a]

	Lifeboat - MES
Z	-5.396[b]
Asymp. Sig. (2-tailed)	<.001

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks

Based on the Wilcoxon signed-rank test, the result was statistically significant, $p < 0.001$; therefore, H_0 was rejected, and H_a was accepted. It can be concluded that there is a significant difference in effectiveness between the Marine Evacuation System (MES) and lifeboats. The Wilcoxon signed-rank test indicated that the paired differences tended to favor MES over lifeboats, as reflected in the higher mean rank of 38.71 compared with 15.50. Based on these values, it can be concluded that the use of MES is more effective than lifeboats for evacuating passengers in

emergencies on board MV. Dobonsolo.

The Effectiveness of the Use of the Marine Evacuation System (MES) on MV. Dobonsolo

Based on the descriptive analysis, the average effectiveness score for the Marine Evacuation System (MES) is 43.7. This aligns with the recapitulation of respondents' answers, which yielded an average score of 4.37. This value falls into the "very high" (very good) category. This indicates that the Marine Evacuation System (MES) is effective for evacuating passengers in emergencies on board MV. Dobonsolo.

Based on the research findings, the indicators with the highest average scores are ease of operation and equipment readiness, at 88.5%. Overall, the Marine Evacuation System (MES) is a modern evacuation system designed to accelerate passenger evacuation in emergencies. With a launching system that uses a slide or chute, it supports rapid and safe evacuation procedures.

The Effectiveness of Lifeboat Use on MV. Dobonsolo

Based on the descriptive analysis, the average effectiveness score for lifeboats is 38.9. This aligns with the recapitulation of respondents' answers, which yielded an average score of 3.89. This value falls into the "high" (good) category. This indicates that lifeboats are also effective for evacuating passengers in emergencies on board the MV. Dobonsolo.

Based on the research findings, the indicator with the highest average score is equipment readiness, at 81%. However, the indicators with the lowest average scores are adaptability and ease of operation, both at 75.5%. Overall, lifeboats remain an effective safety device due to their high safety standards and their role as a means of survival at sea. Therefore, lifeboats continue to serve as the primary evacuation equipment on board ships, despite the availability of modern safety systems such as the Marine Evacuation System (MES).

Comparison of the Effectiveness of the Marine Evacuation System (MES) and Lifeboats on MV. Dobonsolo

Based on the Wilcoxon signed-rank test, the significance value was $p < 0.001$, indicating a statistically significant difference between the two evacuation systems. Therefore, it can be concluded that there is a significant difference in effectiveness between the Marine Evacuation System (MES) and lifeboats on MV Dobonsolo.

Furthermore, the paired differences tended to favor the Marine Evacuation System (MES) over lifeboats, as indicated by the higher mean rank of 38.7 compared with 15.5, suggesting that MES is more effective for passenger evacuation during emergencies on board MV Dobonsolo due to its perceived advantages in evacuation speed and reliability.

CONCLUSIONS

The effectiveness of the Marine Evacuation System (MES) on MV. Dobonsolo has an average score of 43.7, which falls into the "very high" category. Therefore, the MES is highly effective for use in emergency evacuation processes. The effectiveness of lifeboats on MV. Dobonsolo has an average score of 38.9, which falls into the "high" (good) category based on the Likert scale (Sugiyono, 2022). Thus, lifeboats are also suitable for use during emergency evacuations. Based on the comparison of mean values and the results of the hypothesis test, there is a difference in effectiveness between the MES and lifeboats. In the Wilcoxon signed-rank test, the paired differences tended to favor the Marine Evacuation System (MES) over lifeboats, as reflected in the higher mean rank of 38.71 compared with 15.50. This is also supported by the recapitulation results, which are consistent with the descriptive statistical analysis, with an MES score of 4.37 and a lifeboat score of 3.89. Therefore, the Marine Evacuation System (MES) is more effective for evacuating passengers in emergencies

on board the MV. Dobonsolo.

LIMITATION & FURTHER RESEARCH

This study still has several limitations, including the number and characteristics of respondents, the limited scope, the limited research variables, and the limited research duration. Therefore, future studies are recommended to further develop this research by increasing the number of respondents to provide more comprehensive results.

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