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Enhancing Safety Behavior through Safety Awareness and Safety Knowledge: A Meta-Analysis Model for Musi River Transport

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Abstract

Safety issues are always a top priority because they involve human lives. Empirically, safety can reduce accidents. However, despite ongoing efforts to improve transportation safety, ship accidents still occur. For example, during the 2023-2024 period, 16 river vessel accidents occurred along the Musi River in Palembang, Indonesia. This situation likely occurred because ship crews exhibited substandard safety behavior, with limited safety awareness and knowledge. Therefore, this study aims to investigate the influence of safety awareness and safety knowledge on safety behavior. The study employs a quantitative methodology grounded in literature reviews, subsequently analyzed by meta-analysis. The literature review entailed the selection of 15 relevant publications indexed in Google Scholar Scopus, and SINTA, from 2015 to 2024. A meta-analysis conducted with JASP 19.0 software revealed that safety awareness and safety knowledge significantly influence safety behavior, with correlation coefficients (r) of 0.739 and 0.275, respectively, at a p-value of less than 0.01. Safety knowledge has a minimal impact on safety behavior, whereas safety awareness exerts a significant influence. This study demonstrates the absence of publication bias, indicating that the examined papers accurately reflect the actual circumstances. This evidence corroborates and enhances prior research that supports the meta-analysis. It offers a fresh viewpoint on the influence of safety awareness and knowledge on safety behavior. In the future, scholars and professionals, especially those who work in river transportation services, need to talk about it more.

Keywords
Safety issues, safety awareness, safety knowledge, safety behavior, meta-analysis.

1. Introduction

Between 2019 and 2023, 75 maritime accidents occurred in Indonesia. These incidents included collisions (39%), fires and explosions (24%), sinkings (20%), groundings (8%), and other accidents (9%). This figure does not include 16 river vessel accidents along the Musi River in Palembang, Indonesia, during the 2023-2024 period. This is why safety remains a crucial concern for practitioners and researchers. Safety issues will continue to be a topic of discussion, study, and investigation as long as accidents occur, particularly regarding contributing factors such as safety knowledge and awareness. For example, crew members on the Musi River in Palembang, Indonesia, lack adequate safety knowledge because most have not received formal maritime transportation education or safety training/workshops. This, in turn, leads to a lack of safety awareness, a crucial predisposition for safety behavior.

In many cases, human error is a major cause of maritime accidents. Apriani et al. (2020) determined that human factors are the principal cause of accidents in river transportation. Neal and Griffin (2006) contend that safety behavior influences accidents. As a result, safety behavior is an important topic that needs more research. Safety behavior refers

to actions that promote a work environment centered on safety (Schopf et al., 2021). Winarsunu (2018) characterizes safety behavior as individual actions pertaining to the work environment, namely the formulation of safe practices that improve occupational safety and health, alongside the creation of safe behaviors that could result in workplace mishaps. Safety behavior is what employees do when they see anything unsafe at work (Saleem et al., 2022). Zhao et al. (2022) elucidated that safety behavior emerges in diverse forms, encompassing worker collaboration, provision of safety feedback and support, safety citizenship behavior, engagement in safety activities, and proactive safety conduct. In the realm of transportation, including river transport, despite strict regulations and shipping requirements, ship accidents frequently occur due to crew members' lack of attention to safety during navigation. The question is: why cannot crew safety behavior guarantee the safety of the ship and its passengers?

Empirically, safety behavior that fails to ensure the ship and its passengers' safety can be influenced by both safety awareness and safety knowledge. Therefore, this study aims to investigate the influence of safety awareness and safety knowledge on safety behavior.

2. Literature Review

Researchers contend that safety awareness significantly affects safety behavior (Widyanty et al., 2021; Septian & Haryanto, 2023; Mujahid, 2024). It showed that knowing about safety is a very important factor in how people act safely. Safety awareness is when a person knows about safety problems (Kiani & Khodabakhsh, 2014; Wang et al., 2018). It acknowledges the significance of safety concerns (Fung et al., 2016) and encompasses cognitive skills relevant to safety assessments and potential workplace risks (Korkmaz & Park, 2019). Chung and Noh (2021) asserted that safety awareness is the primary impetus for preparing community members for crisis situations. Mohammadfam et al. (2021) contend that safety awareness functions as a criterion for safety performance, requiring the identification and examination of many factors that can influence it, both at the individual and organizational levels. Personal elements encompass (1) comprehensive, precise, and factual information pertaining to an occurrence; (2) adequate knowledge; (3) experience; (4) temperament; (5) the placement of security control; (6) fatigue; and (7) sleep disorders. In terms of organizational dimensions, these include: (a) system architecture, (b) system-operator dynamics, (c) workload distribution, (d) leadership style, and (e) person-organization alignment and mutual support. Therefore, safety awareness denotes an individual's comprehension of the rights and responsibilities pertaining to safety concerns and potential risks in the workplace, assessed by cognitive, behavioral, and evaluative criteria (Prasetiawan et al., 2024). These signs can improve safety behavior when conditions are right. So, it can come up with a hypothesis: Awareness of safety affects how people act safely.

Additional research indicates that safety knowledge significantly affects safety behavior (Uzuntarla et al., 2020; Widyanty et al., 2021; Yun & Oh, 2022). To avoid any dangers and accidents at work, it is very important to know the safety standards. Safety knowledge refers to employees' understanding of the organization's safety rules and procedures that are meant to keep them safe at work (Pratiwi et al., 2024). Bunner et al. (2018) defined safety knowledge as an individual's understanding and abilities related to adherence to safety standards or engagement in safety measures to ensure personal safety. Employees need to know the rules and procedures for safety at work (Umrani et al., 2019). Employees need to learn about safety, so they don't get hurt on the job and are comfortable while they work. A firm leader who understands and puts into practice staff safety awareness makes it better (Seo & Lee, 2022). Septian and Haryanto (2023) contend that safety knowledge encompasses the comprehension of pertinent facts related to safety and security in the execution of one's duties. Understanding safety can improve safety behavior, which leads to the creation of a hypothesis: Safety information affects how people act safely.

3. Methods

This study employed quantitative meta-analysis. This statistical method combines two or more relevant studies to get a quantitative overview of the data (Mueller et al., 2018). A meta-analysis is a kind of observational study that examines historical occurrences and aggregates the data without altering it. The combined data came from research articles that looked at how safety knowledge, safety awareness, and safety behavior are connected. The objective of the meta-analysis is to identify papers that are appropriate for inclusion (Tawfik et al., 2019). The meta-analysis hypothesis tells us which papers to include and which to leave out (Higgins et al., 2019). Research articles were chosen using the following criteria in order to summarize the results of this extensive study: Articles published in English between 2015 and 2024, studies utilizing employee samples, publications found in online international journal databases such as DOAJ and Google Scholar, publications indexed in Scopus, SINTA, and Google Scholar, and

articles with sample sizes of 15 or more that display values of R2, r, t, or F that explain the relationship between safety awareness, safety knowledge, and safety behavior.

4. Data Collection, Coding, and Analysis

In meta-analysis, programming is required for data gathering and processing (Malički et al., 2021). The primary analytical tool in this meta-analysis was a coding category sheet. Standard error, R^2, Z statistics, correlation coefficient (r), t-value, sample size (n), publication date, and study location are all included in the coding. There is also information on international journals. The distance between the papers utilised in this meta-analysis is shown in Table 1.

Table 1. 22 Studies Compared Using n, r, t, and R2 Values, 2015–2024

No	Study	Country	n	R	t	R^2	Z	SE
Safety Awareness on Safety Behavior								
1	Prasetiawan et al. (2024)	Indonesia	250	0.227	3.67		0.231	0.064
2	Uzuntarla et al. (2020)	Turkey	418	0.762		0.58	1	0.049
3	Wang et al. (2018)	China	96	0.856	16.058		1.278	0.104
4	Widyanty et al. (2021)	Indonesia	95	0.284	2.861		0.292	0.104
5	Yun & Oh (2022)	Korea	263	0.705		0.497	0.877	0.062
6	Park et al. (2016)	Korea	182	0.767		0.588	1.013	0.075
7	Park & Eo (2015).	Korea	132	0.469		0.22	0.509	0.088
8	Han-Mong et al (2018)	Korea	222	0.721		0.52	0.91	0.068
9	Kim (2015)	Korea	294	0.595			0.685	0.059
10	Song et al. (2019)	Korea	282	0.531	10.49		0.592	0.06
Safety Knowledge on Safety Behavior								
1	Shi et al (2020)	China	1373	0.580			0.662	0.027
2	Mujahid (2024)	Indonesia	792	0.044	1.23		0.044	0.036
3	Kim (2020)	Korea	492	0.126	2.819		0.127	0.045
4	Septian & Haryanto (2023)	Indonesia	100	0.246	2.509		0.251	0.102
5	Widyanty et al. (2021)	Indonesia	95	0.278	2.794		0.286	0.104

Characteristic analysis of the research sample, data coding, hypothesis testing, converting t and F values into r correlation coefficients, assessing effect size heterogeneity, creating funnel and forest plots, calculating the mean effect size or summary effect, and evaluating publication bias were all carried out. Information from 15 studies from Google Scholar, SINTA, and Scopus was used to do a correlation meta-analysis. The impact size criterion established by Cohen et al. (2020) enumerates effect sizes ranging from 0 to 1. The effects are categorized based on their magnitude: a negligible effect is represented by a value of less than 0±0.1, a moderate effect by a value of less than 0±0.3, a significant effect by a value of less than 0±0.5, a considerable effect by a value of less than 0±0.8, and a pronounced effect by a value exceeding 0±0.8. Anyone who wants to learn about and interact with data can utilize the JASP 19.0 research tool that was used in this study. It helps with the testing of your ideas, allowing you to set Cohen's criteria, and is compatible with a range of computer operating systems.

5. Results and Discussion

5.1. Safety Awareness on Safety Behavior

By assessing ten publications based on predetermined criteria, a range of r and t values was obtained for each question. Before doing the heterogeneity test, the researchers converted all research publications with missing r values from t

values to r values. While Table 3 shows the residual heterogeneity estimates, Table 2 shows the results of the heterogeneity test.

Table 2. Result Test Heterogeneity

	Q	**df**	**p**
Omnibus test of Model Coefficients	49.833	1	< .001
Test of Residual Heterogeneity	174.629	9	< .001

Table 3. Residual Estimates of Heterogeneity

		95% Confidence Interval	
	Estimate	**Lower**	**Upper**
τ^2	0.104	0.046	0.369
τ	0.322	0.215	0.608
I^2 (%)	95.711	90.838	98.755
H^2	23.315	10.915	80.299

Q = 174.629 with $p < 0.001$, τ^2 or $\tau > 0$, and I^2 (%) were close to 100% in the heterogeneity test. This suggests that the 10 effect sizes identified in the relevant studies differ from one another. After utilizing a random effects model to analyze publication bias, the overall effect or mean effect size is examined. The results of the summary effect or mean impact magnitude research are shown in Table 4.

Table 4. Summary Effect or Mean Effect Size

					95% Confidence Interval	
	Estimate (r_{RE})	**Standard Error**	**Z**	**p**	**Lower**	**Upper**
intercept	0.739	0.105	7.059	< .001	0.534	0.944

The random effects model showed a strong positive link (Z = 7.059; 95% confidence interval [0.534; 0.944]) between being aware of safety and acting safely. Researchers say that a p-value of less than 0.001 shows a robust link between being conscious of safety and acting safely. Most people think that H1 is fine. In the robust category, there was a link (rRE = 0.739) between knowing about safety and taking safety measures. The study's results are also shown in an innovative fashion, employing a type of graph called a forest plot. Researchers can compare their results using forest plots, which depict the estimated total influence (the dots) at different dates.

The forest structure for each of the ten experiments examined is depicted in Figure 1. The study's effect size ranged from 0.23 to 1.48, as the forest plot demonstrates. A funnel plan was created at that time. Even if the study samples are perfectly symmetrical, Begg's funnel plot is a scatter plot used in meta-analyses to show that the samples can have publication bias. The funnel plots for the ten studies that were looked at are shown in Figure 2. More research needs to be done on the Egger test because the model could be either symmetric or asymmetric. Using the funnel diagram alone would make it hard to find publication bias. The Egger test findings are shown in Table 5.

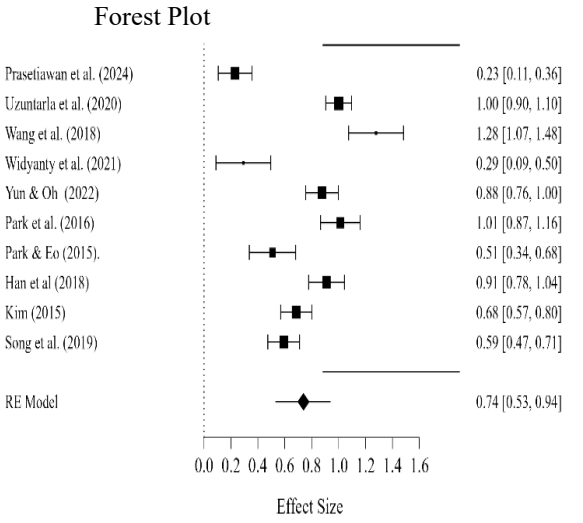

Figure 1. Forest Plot (all 10 studies)

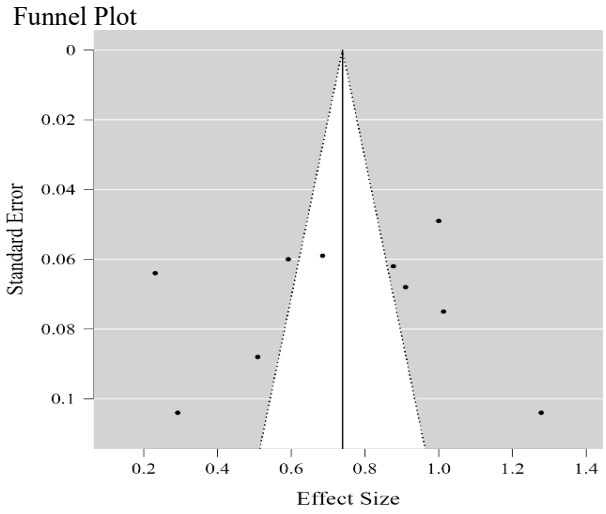

Figure 2. Funnel Plot After Trim-Fill Diagnosis (all 10 studies)

Table 5. Asymmetric Funnel Plot Regression Test

	Z	**p**
sei	-0.080	0.936

Z = -0.08, according to Table 5, for $p > 0.05$. It validates the symmetry of the funnel plot. This meta-analysis study does not show any signs of publication bias.

5.2. Safety Knowledge on Safety Behavior

The heterogeneity test results are shown in Table 6, and the residual heterogeneity estimates are displayed in Table 7. According to the previous heterogeneity test, Q = 232.058, τ^2 or $\tau > 0$, a p-value of less than 0.001, and I^2 (%) are all close to 100%. This indicates that none of the ten effect sizes examined in the experiments were identical.

Table 6. Result Test of Heterogeneity

	Q	**df**	**p**
Omnibus test of Model Coefficients	5.942	1	0.015
Test of Residual Heterogeneity	232.058	4	< .001

Table 7. Residual Heterogeneity Estimates

		95% Confidence Interval	
	Estimate	**Lower**	**Upper**
τ^2	0.059	0.019	0.466
τ	0.243	0.139	0.683
I^2 (%)	96.501	90.009	99.542
H^2	28.577	10.009	218.369

To ensure that there was no publication bias, we used a random effects approach to evaluate the precision of our estimate of the mean impact magnitude or summary effect. The study's findings about the mean impact magnitude or summary effect are displayed in Table 8. The results of the study employing the random effects model show a small positive correlation (Z = 2.438; 95% CI [0.054; 0.497]) between safety awareness and safety behaviour. It is evident from this study's p-value of less than 0.001 that safety behaviour and safety knowledge are strongly correlated. So, H_2 is true. The weak group (rRE= 0.275) shows the link between knowing about safety and acting safely.

Table 8. Summarized Effect or Average Impact Size

					95% Confidence Interval	
	Estimate (r_{RE})	**Standard Error**	**Z**	**p**	**Lower**	**Upper**
intercept	0.275	0.113	2.438	0.015	0.054	0.497

The study's results are shown in a way that is easy on the eyes, employing forest plots. Using forest plots makes it easy to compare studies since they show how the plots (dots) have changed over time. Figure 3 shows the forest pattern for all five studies that were looked at. The forest plot showed that the effect sizes of the research looked at were between -0.03 and 0.72. A funnel scheme was put into place at that time. Begg's funnel plots, which are a sort of scatter plot, are used in meta-analysis to find what looks like publication bias. It reveals if the study samples are symmetrical or not. Figure 4 displays the funnel plot for each of the five investigated studies. The Egger test needs a more thorough review because the model it generates may be symmetrical or asymmetrical. As a result, it is becoming more difficult to detect publication bias with the funnel plot alone. The Egger test results are shown in Table 9.

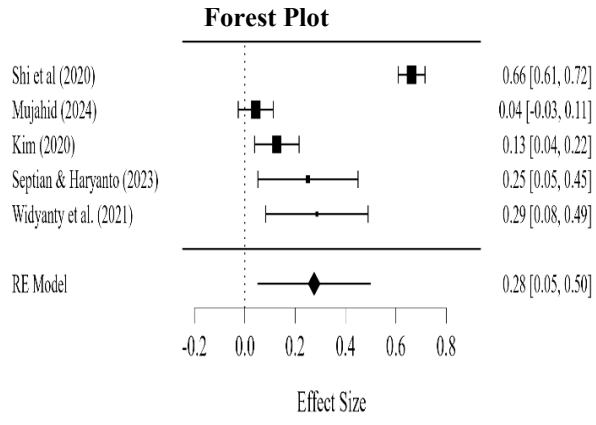

Figure 3. Forest Plot (five studies)

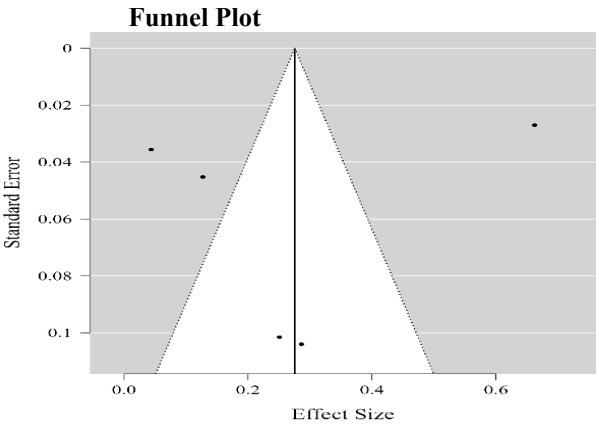

Figure 4. Funnel Plot After Trim-Fill Diagnosis (five studies)

Table 9. Funnel Plot Asymmetry Regression Test

	Z	**p**
sei	-0.278	0.781

p is more than 0.05 and z is equal to -0.278, as shown in Table 9. It indicates that the funnel plot is same on both sides. As a result, our meta-analysis is not biased in the publication process.

5.3. Discussion

A meta-analysis of 15 studies found that being aware of and knowledgeable about safety had a big effect on how people acted safely. Improved safety knowledge and understanding can result in enhanced safety behavior. The study on effect size indicated that being aware of safety has a big effect on how safe people act, whereas knowing about safety has a small effect. This indicates that individuals' safety behaviors are more significantly influenced by their

awareness of safety than by their comprehension of it. So, safety awareness is regarded to be a bigger part of figuring out how to behave safely than safety knowledge. Safety awareness is the ability to understand the rights and responsibilities that come with occupational safety issues and possible dangers, as shown by cognitive, behavioral, and evaluative assessments (Prasetiawan et al., 2024). These factors are closely related to the creation of safe practices that make the workplace safer and healthier, as well as the creation of safe behaviors that could lead to accidents at work. They can encourage safe behaviors, especially how a person interacts with their work environment (Winarsunu, 2018). Collaboration among employees, feedback, and instruction on safety, safety citizenship behavior, participation in safety initiatives, and proactive safety practices are all evident (Zhao et al., 2022). Research shows that people's safety awareness affects how safe they act (Widyanty et al., 2021; Septian & Haryanto, 2023; Mujahid, 2024). These numbers support that idea. In a comparable context, safety knowledge characterized as an understanding of safety and security information pertinent to job performance (Septian & Haryanto, 2023) may influence safety behavior under advantageous conditions. This aligns with and corroborates prior studies indicating that safety knowledge affects safety behavior (Uzuntarla et al., 2020; Widyanty et al., 2021; Yun & Oh, 2022). The funnel plot's symmetrical organization and the results of Egger's test analysis indicated an absence of publication bias in the study. It is very important to look at publication bias in order to figure out how important the sources used are, how good the research technique is, how accurate the study findings are, and how different the sample sizes are. These factors will have an effect on the results with little bias (Nair, 2019). Consequently, the findings of the research excluded from this analysis were comparable to those of the research incorporated in this meta-analysis.

6. Conclusion

This study conducted a meta-analysis to investigate the impact of safety knowledge and awareness on the safety behaviors of individuals. The findings indicate that individuals' safety behaviors are significantly influenced by their awareness and comprehension of safety (rRE: 0,739; 0.275). Safety behavior is significantly influenced by safety awareness, whereas safety knowledge has a minimal effect. This research demonstrates that the articles under examination accurately reflect the actual situation, as there is no publication bias. Although the papers originate from a variety of scientific disciplines, the characteristics of the papers demonstrate identical samples. This data reinforces and expands upon prior research that was crucial to the meta-analysis. It also provides us with new information regarding the impact of safety awareness and knowledge acquired from numerous prior relevant studies. Future researchers can develop additional theories regarding the relationship between safety awareness, safety knowledge, and safety behavior by combining the results of this meta-analysis with samples from a range of research publications and larger cohorts. This meta-analysis provides practical suggestions for businesses and supervisors to enhance staff safety behavior, with particular emphasis on river transportation services, including those on the Musi River in Palembang, Indonesia. For example, by conducting safety training or workshops with experts, using adequate materials and facilities.

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Biographies

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