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Passenger Attitudes and Waste Management on Ships

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ABSTRACT

The problem of waste management on passenger ships is often observed due to the continuous disposal of rubbish on the deck and into the sea irrespective of the bin provided on each side of the railings. This leads to the collection and sorting of various waste by the ship crew, including plastic, paper, food, cans, and coating materials, which impacts safety management, as well as environmental pollution. Passengers are also not required to commonly have competency and proficiency in ship waste management. Therefore, this study aimed to analyze the effects of passenger attitudes on ship waste management, using a Structural Equation Modeling-Partial Least Squares (SEM-PLS) and 160 participants in Tanjung Perak Port, Indonesia. The results showed that environmental concerns, as well as passenger perceptions and attitudes strongly influenced solid waste management on ships.

1. INTRODUCTION

An increase in the number of ship visits is consistently affecting the marine environment [1], with approximately 11% of the sea waste-based pollution originating from water vessels [2]. This waste often increases when the number of passengers is increasing [3], impacting the environment and requiring more efforts to enhance management strategies [4]. Therefore, ship waste management requires an effective strategy to reduce the influence of garbage produced from human activities on health and the environment, specifically in stopping illegal sea pollution [5]. This effective strategy includes sorting, collection, transportation, and processing [6], with the most performed approaches on passenger ships consisting of separation, acquisition, and carriage [3]. In Indonesia, ship waste management commonly prioritizes the provisions for sea garbage disposal outside special areas, based on the Annex V MARPOL 1973/1978 regulation prohibiting the dumping of plastic debris in a marine environment. The regulation also states that waste from packaging materials and coatings should be aquatically disposed at a distance of ≥25 Nautical Mile from the closest land. Additionally, the remaining food, paper, glass, metal, or similar garbage are expected to be disposed at a distance of ≥12 Nautical Mile from the closest land. The garbage should also be disposed at a distance ≥3 Nautical Mile from the closest land when chopped or ground within a 25mm grid [7, 8]. These perspectives prove that the reduction of plastic impact on the marine environment is only conducted by managing, controlling, and recycling [9]. The management of ship waste is also carried out through burning and appropriate disposal at port reception facilities [10].

Several problems are commonly observed in ship waste management because people are continuously disposing garbage into the sea or on the deck. These passenger actions are always carried out irrespective of the provision of appropriate disposal facilities on each side of the railing. The perspective was not in line with a relevant previous report [11], where sea pollution prevention prioritized the availability of adequate waste storage facilities at ports to reduce aquatic garbage disposal. Furthermore, sea waste is mostly observed through human behaviors [12], impacting marine toxicity due to the danger posed by several disposed plastic and ship garbage within the aquatic environment [13]. This is similar to the management problems caused by careless waste disposal on the ship deck, such as work accidents during garbage collection and sorting. From the description, inappropriate collection strongly impacts the environment and disrupts people lives [14]. Besides, the composition of waste produced by passengers is also inseparable due to type, enabling relevant management difficulties. This waste commonly consists of plastic, paper, organic waste, glass, metal, and leftover food [15], with excessive edibles often influenced by community culture [16].

Based on waste management literature, several people caring about the environment had good sustainability attitudes [17], with environmental awareness strongly influencing good behavior [18]. This proved that a collective awareness of the ecosystem significantly impacted environmental sustainability [19]. Pro-environmental concern and behavior was also influenced by individual and social factors, such as knowledge, experience, education, objectives, and personal responsibility [20]. Furthermore, awareness included the ability to perceive, people and the environment interaction, as well as the existence of objectives and challenges [21]. This ability influenced ship waste management [8], with perceived

comfort strongly related to garbage recycling. The improvement of appropriate habits also required significant information for adequate management on ships [22]. Knowledge level subsequently influenced passenger perceptions [23], with the public having an unclear perspective prioritizing the impact of ship waste on the environment [24]. This was accompanied by the effects of comfort, time, and benefits on individual waste management attitude [25, 26]. Therefore, this study aims to analyze and identify the main influential variables of passenger attitudes on ship waste management. The results are expected to provide input for passenger ships regarding the improvement of waste management.

2. METHODOLOGY

The study was conducted at the Port of Tanjung Perak, where the highest number of passengers departures and arrivals were observed in Indonesia [27]. A structural equation model (SEM) analysis was also experimentally implemented with partial least squares (PLS) 3.29. In this analysis, the recommended number of samples used the Maximum Likelihood Estimation approach with estimates between 100-200 participants [28]. Therefore, a total of 160 participants were selected as the study sample, with 16 manifest variables implemented in the experimental model, with 160 passengers randomly selected on three Indonesian ships stopping at the Tanjung Perak Port in January-May 2023, as shown in Table 1.

The questionnaire implemented was established due to the indicators selected through reference sources, regarding environmental concerns, perceptions, and attitudes in solid waste management. The Pearson Correlation Coefficient was also used to measure the validity of the questionnaire [29], with Table 2 showing the indicators and variables.

The validity and reliability of the questionnaire was analyzed on 30 ship passengers before distribution, using the IBM SPSS Statistics 26 program. The results showed that the data collection instrument was valid and reliable because the significance and Cronbach values of each question were <0.05 and >0.6, respectively. Table 3 presents the validity test of the questionnaire distributed to 30 ship passengers.

Table 1. Passenger ship data for research locations

No.	Ship's Name	Route	Number of Samples
1	Passenger ship A	Round Trip of Surabaya-Makassar-Baubau-Namlea-Ambon-Sorong-Manokwari-Serui-Jayapura	60 Passengers
2	Passenger ship B	Round Trip of Surabaya-Makassar-Baubau-Namlea-Ambon-Ternate-Bitung	50 Passengers
3	Passenger ship C	Round Trip of Surabaya-Batulicin-Pare-Pare-Bontang	50 Passengers

Source: Secondary Data Research, 2023

Table 2. Variable indicators of solid waste management on passenger ships

Research Variable	Research Indicators	Source
Environmental Concern	Knowledge (X1.1)	[20]
	Experience (X1.2)	[20]
	Destination (X1.3)	[21]
	Environment (X1.4)	[19-21]
Passenger Perception	Passenger comfort (X2.1)	[22]
	Habit (X2.2)	[22]
	Availability of Information (X2.3)	[22, 23]
	Presence of placards/posters (X2.4)	[7, 22]
Passenger Attitude	Availability of waste Management facilities (Y1.1)	[11, 25]
	Time (Y1.2)	[26]
	Profit (Y1.3)	[26]
	Culture (Y1.4)	[16]
Management of Solid Waste on Passenger Ships	Disaggregation (Y2.1)	[1, 6]
	Combustion (Y2.2)	[10]
	Dumping garbage into the sea (Y2.3)	[10]
	Collection (Y2.4)	[1, 6-8]

Table 3. Validity test results

Variable	Questionnaire	Correlation	Sig.	Validity
Environmental Concern	Do passengers have a sense of environmental awareness on board due to knowledge? (X1.1)	0.887	0.000	Valid
	Do passengers have a sense of environmental concern based on experience? (X1.2)	0.902	0.000	Valid
	Does understanding the purpose of waste management mean that passengers have a sense of environmental awareness on board? (X1.3)	0.931	0.000	Valid
	Do the supporting environmental conditions mean that passengers have a sense of environmental awareness on board? (X1.4)	0,886	0.000	Valid
Passenger Perception	Does comfort influence ship waste management? (X2.1)	0.858	0.000	Valid
	Do passengers habits affect waste management on ships? (X2.2)	0.786	0.000	Valid
	Can information from the crew about waste handling improve ship management? (X2.3)	0.770	0.000	Valid
	Can having placards/posters about waste handling improve ship management?	0.682	0.000	Valid

	(X2.4)			
	Can the availability of waste disposal facilities on ships support management practices? (Y1.1)	0.569	0.001	Valid
	Does time influence waste management on ships? (Y1.2)	0.693	0.000	Valid
Passenger Attitude	Will passengers appropriately manage waste by obtaining profits/benefits? (Y1.3)	0.657	0.000	Valid
	Does passenger culture influence solid waste management on ships? (Y2.4)	0.747	0.000	Valid
	Does sorting affect the improvement of solid waste management on ships? (Y2.1)	0605	0.000	Valid
	Does burning impact the improvement of solid waste management on ships? (Y2.2)	0.667	0.000	Valid
Management of Solid Waste on Passenger Ships	Does sea waste disposal, both the type and the distance from the nearest land affect the improvement of solid waste management on ships, according to the provisions of pollution prevention regulations? (Y2.3)	0.619	0.000	Valid
	Does waste collection impact the improvement of solid waste management on ships? (Y2.4)	6.28	0.000	Valid

Source: Output SPSS, 2023

According to Table 3, all questionnaire items were validated with values <0.05, prioritizing experimental viability for every question related to the variables. Each variable was also subjected to a reliability test, as shown in Table 4.

Table 4. Reliability test results

Variable	Cronbach's Alpha	Conclusion
Environmental Concern	0.740	Reliable
Passenger Perception	0.841	Reliable
Passenger Attitude	0.807	Reliable
Management of Solid Waste on Passenger Ships	0.762	Reliable

Source: Output SPSS, 2023

In Table 4, all the questionnaire variables were reliable due to having the Cronbach Alpha value >0.60. This proved that all the variables were valid and reliable for experimental performance. Questionnaires were also distributed to 160 ship passengers, with responses analyzed using the SEM-PLS approach and the Smart PLS. Furthermore, an outer model test was conducted to validly and reliably determine the factors influencing environmental awareness, passenger perceptions and attitudes, as well as solid waste management on ships. This test was performed with convergent validity, where viability was declared when Outer Loadings, Cronbach Alpha, Composite Reliability, and Average Variance Extracted (AVE) were >0.7, >0.6, ≥0.7, and >0.5, respectively [30]. The valid and reliable data were also tested for inner models, to determine the influence of environmental concern, as well as passenger perceptions and attitudes on ship solid waste management. This test showed that the relationship between variables was significant when P values <0.05 or T Statistics >1.96. The inner model was also tested to determine the relationship between variables, with R square >0.75, >0.50, and >0.25 were strong, moderate, and weak, respectively [29].

3. RESULT

All indicators for ship solid waste management were invalid in the first round of the SEM-PLS model implementation for convergent validity or factor loading analysis, including burning (Y2.2) and sea disposal (Y2.3). This invalidity was due to the convergent validity outcomes showing outer loading values <0.70 (invalid), leading to the need for appropriate reduction. The convergent validity was subsequently re-conducted with the SEM-PLS analysis in the second round after the indicators were reduced, as shown in Table 5.

Table 5. Convergent validity test results for solid waste management on passenger ships

Research Variables	Research Indicators	Outer Loadings	Validity
Environmental Concerns	Knowledge	0.873	Valid
	Experience	0.911	Valid
	Objective	0.913	Valid
	Environment	0.872	Valid
	Passenger comfort	0.921	Valid
Passenger Perception	Habit, Information exists	0.861	Valid
	Placards/posters	0.834	Valid
	Availability	0.826	Valid
Passenger Attitude	Availability of facilities	0.914	Valid
	Time	0.913	Valid
	Profit	0.778	Valid
	Culture	0.778	Valid
Management of Solid Waste on Passenger Ships	Sorting	0.895	Valid
	Collection	0.841	Valid

Source: Outer Loadings, SEM-PLS Report, 2023

Table 6. Value of Cronbach's Alpha, Rho_A, Composite Reliability and AVE solid waste management on passenger ships

Research Variable	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
Environmental Concern	0.915	0.924	0.940	0.797
Passenger Perception	0.884	0.897	0.920	0.742
Passenger Attitude	0.868	0.873	0.911	0.720
Management of Solid Waste on Passenger Ships	0.676	0.693	0.850	0.754

Source: Construct Reliability and Validity, SEM-PLS Report, 2023

The outer model analysis implemented the SEM-PLS approach to confirm the reliability and validity of indicators related to solid waste management, environmental concern, as well as passenger perceptions and attitudes. These valid and reliable declarations were due to the Cronbach Alpha, Composite Reliability, and Average Variance Extracted (AVE) values of >0.6, ≥0.7, and >0.5, respectively, as shown in Table 6.

The inner model test was carried out to determine the relationship between variables, after performing the outer analysis. Table 7 presents the outcomes of the inner test and path coefficient in ship solid waste management.

Table 7. Path coefficients for ship solid waste management

	O	STDEV	|O/STDEV|	P Values
Environmental Concern ->Solid Waste Management on Passenger Ships	0.127	0.047	2.689	0.007
Environmental Concern ->Passenger Attitude	0.764	0.057	13.441	0.000
Passenger Perception ->Solid Waste Management on Passenger Ships	-0.240	0.032	7.573	0.000
Passenger Perception ->Passenger Attitude	0.185	0.065	2.857	0.005
Attitude of Passengers ->Management of Solid Waste on Passenger Ships	1.032	0. 055	18.692	0.000

Source: Final Results, Path Coefficient, SEM-PLS Report, 2023

Based on Table 7, environmental concern positively and significantly affected solid waste management because P values <0.05 and O/STDEV|>1.96 had scores of 0.007 and 2.689, respectively. This was accompanied by the positive and significant effects of environmental concern on passenger attitudes, as p-value and O/STDEV| were 0.000 and 13.411>1.96, respectively. Passenger perceptions also directly, positively, and significantly impacted ship solid waste management with a p-value =0.000 and O/STDEV| =7,573>1.96. In addition, passenger attitudes positively and significantly influenced ship solid waste management with p-value =0.005 and O/STDEV =2.857|>1.96.

According to the inner model test, the indirect influence of environmental concern and passenger perceptions were observed through variables between commuter attitudes toward ship solid waste management, as presented in Table 8.

In Table 8, environmental concern indirectly, positively, and significantly affected shop solid waste management through the variable between passenger attitudes, at a p-value of 0.000. Passenger perceptions also positively and significantly influenced ship solid waste management at a p-value of 0.005. Furthermore, the R-square value was >0.75, showing that the ship solid waste management was strongly categorized, as described in Table 9.

Table 8. Specific indirect effects of solid waste management on passenger ships

	O	STDEV	|O/STDEV|	P Value
Environmental Concern ->Passenger Attitude ->Solid Waste Management on Passenger Ships	0.789	0.073	10.738	0.000
Passenger Perception ->Passenger Attitude ->Solid Waste Management on Passenger Ships	0.191	0.068	2.804	0.005

Source: Final Result, Specific Indirect Effect, SEM-PLS Report, 2023

Table 9. R-Square ship solid waste management

	R Square
Passenger Attitude	0.840
Management of Solid Waste on Passenger Ships	0.941

Source: R Square, SEM-PLS Report, 2023

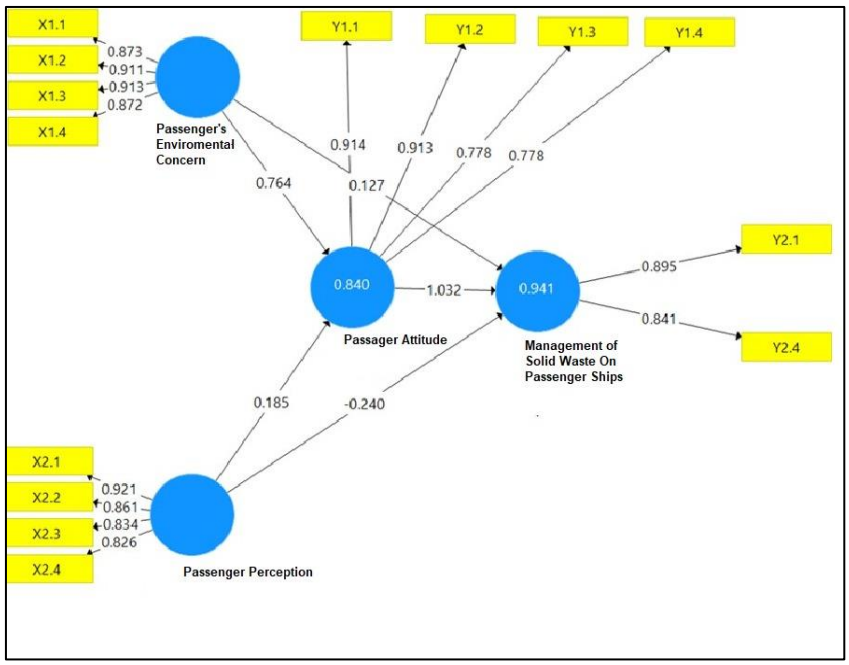

Figure 1. Solid waste management model on passenger ships
Source: Results of SEM-PLS Analysis Round 2, 2023

Figure 1 shows the waste management model having environmental concerns, as well as passenger perceptions and attitudes. This diagrammatic representation was observed at the Port of Tanjung Perak, Indonesia, using the SEM-PLS approach.

Based on the results, the analysis of solid waste management models was useful for ship crews in avoiding environmental pollution, health, and safety problems. The implementation of pollution prevention regulations was also considered by increasing awareness, perceptions, and attitudes of passengers in waste management. Furthermore, environmental awareness should be mainly increased due to strongly influencing ship waste management. This increase was expected to stimulate company-based ship crews toward improving passengers knowledge about ship waste management. The improvement processes should be carried out by increasing familiarization, waste management information, and issuance of relevant regulations to sanction violators.

4. DISCUSSIONS

According to the SEM-PLS outer model and convergent validity analyses, all the factors influencing environmental concern were passenger knowledge, experience, and objectives in waste management. This result was in line with previous study, where environmental conditions influenced relevant individual awareness [8]. The performance of waste disposal and the environment also affected individual concerns [21], leading to the improvement of passenger environmental awareness through ship management. From the perspectives, the awareness improvement was conducted by increasing passenger knowledge, experience, waste management objectives, and environmental conditions.

The results showed that the factors influencing passengers perceptions of ship waste management were comfort, habits, crew information, and management-based placards or posters. Garbage and relevant management information also influenced passengers sustainability perceptions. Furthermore, the availability of information and placards/posters impacted relevant perceptions [7, 23], respectively. In this case, ship crew and shipping companies should facilitate the establishment of passenger comfort in waste management, such as providing adequate bins, as well as portraying posters and clear sustainability information.

The factors influencing passengers attitudes toward ship waste management were the availability of appropriate facilities, time, benefits, and culture. This result was in line with studies where the availability of adequate waste management facilities influenced travelers attitudes toward garbage sustainability [11, 25]. The time and the benefits obtained by passengers also affected attitudes [26] where the availability of adequate facilities greatly influenced waste management. Therefore, shipping companies should improve the provision of adequate management facilities, to overcome the pollution problem.

Based on the results, the factors significantly influencing ship waste management were sorting and collection. This was in line with regulations where management was mainly carried out by sorting and obtaining waste [6, 21]. From the description, ships should enhance sorting and collection processes, facilitating disposal onboard and ensuring appropriate disposal at the port waste facility.

According to the SEM-PLS inner model test, environmental awareness directly, positively, and significantly affected waste management at 0.127 units. This was consistent with previous studies [17, 19, 20], where environmental concerns had implications for waste management and ecosystem sustainability. From the results, the concerns led to the research hypotheses affecting waste management and sustainability, portraying the acceptance of every garbage maintenance element. In addition, environmental awareness positively and significantly impacted solid waste management through the variable between passenger attitudes of 0.789 units.

The results showed that passenger perceptions positively and significantly influenced attitudes of 0.185 units. The perceptions also positively and significantly impacted solid waste management through the variable between passenger attitudes at about 0.191 units. However, the hypothesis prioritizing the direct effect of environmental perceptions on garbage sustainability was rejected due to the negative value of -0.240. This proved that appropriate waste management was performed when passengers had a large perception and good behavior. Passenger attitudes also positively and significantly affected waste management by 1.023 units [25].

The proposed solid waste management model was strong and showed the influence of environmental concern, passenger perceptions and attitudes, as well as solid waste management on passenger ships. This model should be used by ship management as a solution prioritizing waste management practices. The solution efforts was in line with the study where the improvement of garbage sustainability was required to reduce the impact of passengers on the environment [4].

5. CONCLUSIONS

In conclusion, the effect and influential factors of passenger attitudes on ship waste management was analyzed. This analysis led to the implementation and distribution of questionnaires to 160 passengers on 3 ships at the Port of Tanjung Perak Indonesia. The answers obtained from the questionnaire distribution were also analyzed using SEM-PLS approach.

Based on the results, a significant influence was observed between passengers attitudes and ship waste management. The attitudes were also positively and significantly affected by environmental concerns and passenger perceptions. This was accompanied by the indirect and significant effects of environmental concern through the variables between attitudes and waste management. Therefore, ship crews should increase the awareness and attitudes of passengers in waste management. The improvement of environmental awareness also needs to be performed by increasing passenger knowledge about the benefits, impacts, sanctions, and procedures for garbage disposal. This knowledge improvement were carried out through familiarization and placard/poster information. Shipping companies should also support environmental comfort establishment and the availability of adequate management facilities, to improve passengers attitudes.

Several limitations prioritized the sole implementation of concern, perceptions and attitudes of passengers toward ship waste management. In this case, the implementation of various variables were recommended for future reports, such as human, technological, and natural factors affecting ship waste management.

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