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# Study Of The Maintenance, Certification, And Operation System Of The Tug Boat Anugerah Lautan 5 On Sailing Safety

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**Abstract**

The implementation of the ship maintenance management system, certification, and ship operation on the ship Tug Boat Anugerah Lautan 5 did not run optimally, which impacted the less-than-optimal condition of various training ship equipment because the crew did not carry out the ship maintenance system according to the procedure, resulting in the incident that the ship's anchor left winch operation did not function optimally when the ship was anchored in Belang Port, Southeast Minahasa. This study aims to identify and analyze the positive and significant effect of the planned maintenance system on shipping safety. The primary data collection methods used in this study were questionnaires and interviews. In this study, data processing and presentation were in the form of diagrams and path analysis with structural equation modeling (SEM-PLS) using SmartPLS. From the results of the data analysis, the R-square value of shipping safety (Y) is 0.433, which means that the maintenance system (X1) and ship maintenance (X2) can affect shipping safety (Y) by 43.30%. Ship maintenance (X1) has a significant effect on safe sailing (Y), with P-values = 0.033 > 0.05 (hypothesis accepted). Certification (X2) has a considerable impact on safe sailing (Y), with P-values = 0.036 > 0.05 (hypothesis accepted). The operation of ship (X3) has a significant effect on safe sailing (Y), with a P-value of 0.000 > 0.05 (hypothesis accepted). As a result of the analysis, it was found that the planned maintenance system has a significant effect on shipping safety.

**Keywords: Maintenance System; Sertification; Safe Sailing, ship.**

## INTRODUCTION

The development of the times requires people to reach a place quickly. One of the answers to these demands is the emergence of Transportation Equipment. Since time immemorial, transportation has been used in people's lives to support government, economy, and education. Sea transportation is one of the most strategic means, namely by moving goods from one area to another, from one port to another. Until now, an efficient means of mass transportation is a ship that can be likened to a very large floating warehouse and can carry merchandise through thousands of miles of ocean.

The ship has a variety of equipment that supports the smooth operation of the ship, and these tools have their respective functions. These tools require routine maintenance so that they can support the smooth operation of the ship and meet government regulations regarding the seaworthiness of the ship. Government Regulation No.31 of 2021 concerning the Implementation of the Shipping Sector, and based on Law No. 17 of 2008 concerning Shipping, in this Law what Shipping means is a unified system consisting of transportation in waters, ports, safety and security, and protection of the maritime environment. Indonesian waters are the territorial sea of Indonesia along with its archipelagic waters and inland waters. The incidence of damage to equipment on ships due to lack of attention to ship maintenance thus disrupting or slowing down ship operations, and even ship safety is threatened by the existence of some damage that is not immediately addressed or repaired.

Maintaining or preserving the condition of the ship, is the main objective of any maintenance action. To do this, it turns out that an appropriate system is needed, one of which is considered possible is management. Management is becoming increasingly popular and dominant in ship maintenance systems. Based on events on the ship, the application of the ship maintenance management system is not running optimally, this has an impact on the less-than-optimal condition of various training ship equipment because the crew does not carry out the ship maintenance system according to procedures so that the Ship Anchor Winch Operation does not function optimally when the ship is anchored at Belang Harbor, Southeast Minahasa and the occurrence of the un optimality of the Ship Lifeboat Operation when it will be lowered for Emergency Drill on Ship (emergency drill) at Amurang Harbor, South Minahasa.

Based on the description above, the author is encouraged to conduct research on the training ship young Admiral John Lie, and compile a thesis with the title: “Review of the Maintenance System, Certification, and Operation of the Tug Boat Anugerah Lautan 5 Against Sailing Safety”.

## RESEARCH METHODOLOGY

This study used primary data and secondary data. The primary data collection methods used in this study are questionnaires and interviews. Secondary data in this study are data about the company in the form of respondent profiles. The secondary data collection method used is the documentation method. In this study, data processing and presentation in the form of diagrams and using path analysis with Structural Equation Modeling (SEM-PLS) using SmartPLS. The data obtained, after being processed and sorted, will be used for statistical analysis of the data under the research objectives. The data analysis used is the analysis of the coefficient of determination and hypothesis testing. The statistical analysis used in this research is path analysis. The main analysis carried out is to test the path construct whether it is empirically tested or not. Further analysis is carried out to find direct and indirect effects using correlation and regression so that it can be known to arrive at the last dependent variable, which must go through the direct path or intervening variables. Data analysis techniques using the Structural Equation Model (SEM), were carried out to explain thoroughly the relationship between variables in this study.

## RESULT

### a. Description of Research Data

This study has three variables, consisting of two independent variables, and one dependent variable.

a. Maintenance System: X1
b. Certification: X2
c. Ship Operation: X3
d. Shipping Safety: Y

The research questionnaire list that the author conveyed to 86 respondents was then researched, edited, and analyzed by the data processing as discussed in Chapter III. The research questionnaire is then scored according to the respondent's answer and summed up. The research process must be carried out carefully so as not to experience errors in recapitulating. The results of the score recapitulation for each variable were then used in the Smart-PLS 3 tool, version 3.2.9. A recapitulation of the total score for each variable can be seen in the appendix.

### 1). Variabel Sistem Perawatan (X1)

The results of data processing (2024) for ship maintenance variables have:

- Mean: 45,23
- Standard Deviation: 6,680
- Variance: 44,628
- Range: 20
- Lowest score: 30
- Highest score: 50
- Total number: 3890

The frequency score of the ship maintenance variable spreads from the lowest score of 30 to the highest score of 50 with a value range of 20. Furthermore, the frequency distribution results of ship maintenance are:

To describe the frequency of the results of the research data on the maintenance system variable (X1), it can be presented in the form of a Histogram Graph, as follows Figure 1:


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**Table 1. Variable Statistics X I**

| Maintenance System X1 | | |
|---|---|---|
| N | Valid | 86 |
| | Missing | 0 |
| Mean | | 45.23 |
| Median | | 49.04 |
| Std. Deviation | | 6.680 |
| Variance | | 44.628 |
| Range | | 20 |
| Minimum | | 30 |
| Maximum | | 50 |
| Sum | | 3890 |

**Maintenance System (X1)**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 30 | 10 | 11.6 | 11.6 | 11.6 |
| | 39 | 1 | 1.2 | 1.2 | 12.8 |
| | 40 | 12 | 14.0 | 14.0 | 26.7 |
| | 41 | 2 | 2.3 | 2.3 | 29.1 |
| | 42 | 1 | 1.2 | 1.2 | 30.2 |
| | 43 | 1 | 1.2 | 1.2 | 31.4 |
| | 45 | 3 | 3.5 | 3.5 | 34.9 |
| | 46 | 2 | 2.3 | 2.3 | 37.2 |
| | 47 | 3 | 3.5 | 3.5 | 40.7 |
| | 48 | 2 | 2.3 | 2.3 | 43.0 |
| | 49 | 10 | 11.6 | 11.6 | 54.7 |
| | 50 | 39 | 45.3 | 45.3 | 100.0 |
| | Total | 86 | 100.0 | 100.0 | |

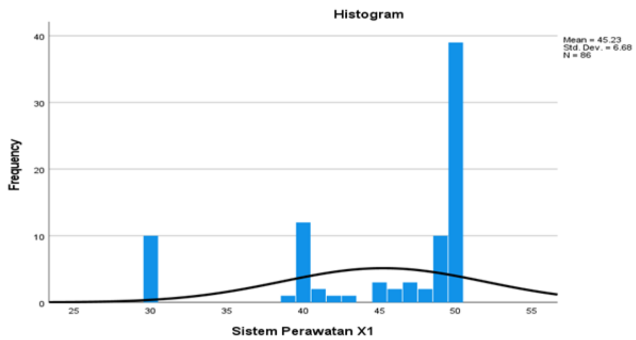


Figure 1 Maintenance system (X1)
Frequency Histogram of Maintenance System Variables

**2). Certification Variable (X2)**

The results of data processing (2024) for the certification variable, have:

- Mean: 45,48
- Standard Deviation: 6,707
- Variance: 44,982
- Range: 20
- Lowest score: 30
- Highest score: 50
- Total number: 3911

The frequency score of the ship maintenance variable spreads from the lowest score of 30 to the highest score of 50 with a value range of 20. Furthermore, the frequency distribution results of ship maintenance are Tabel 3.

To describe the frequency of the results of the certification variable research data (X2), it can be presented in the form of a Histogram Graph, as follows in Figure 2.

Table 3. Variable Statistics X2 (Certification X2)

| | | |
|---|---|---|
| **N** | **Valid** | **86** |
| | Missing | 0 |
| **Mean** | | 45.48 |
| **Median** | | 49.18 |
| **Std. Deviation** | | 6.707 |
| **Variance** | | 44.982 |
| **Range** | | 20 |
| **Minimum** | | 30 |
| **Maximum** | | 50 |
| **Sum** | | 3911 |

Table 4. Certification X2

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 30 | 10 | 11.6 | 11.6 | 11.6 |
| | 37 | 1 | 1.2 | 1.2 | 12.8 |
| | 40 | 10 | 11.6 | 11.6 | 24.4 |
| | 41 | 1 | 1.2 | 1.2 | 25.6 |
| | 42 | 2 | 2.3 | 2.3 | 27.9 |
| | 43 | 1 | 1.2 | 1.2 | 29.1 |
| | 45 | 2 | 2.3 | 2.3 | 31.4 |
| | 46 | 5 | 5.8 | 5.8 | 37.2 |
| | 47 | 1 | 1.2 | 1.2 | 38.4 |
| | 48 | 3 | 3.5 | 3.5 | 41.9 |
| | 49 | 5 | 5.8 | 5.8 | 47.7 |
| | 50 | 45 | 52.3 | 52.3 | 100.0 |
| | Total | 86 | 100.0 | 100.0 | |

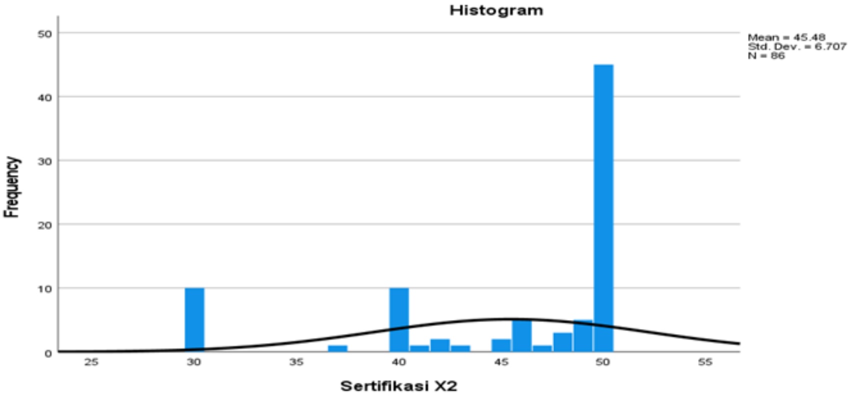


Figure 2 Histogram Frekuensi Variabel Sertifikasi

**3). Ship Operation Variables (X3)**

Data on ship operation variables (X3) can be seen in Table 5 in the attachment.

The results of data processing (2024) for the certification variable, have:

- Mean : 40.50
- Standard Deviation: 7,342
- Variance : 53,900
- Range : 20
- Lowest score : 30
- Highest score : 50
- Total number : 3483

The frequency score of the ship maintenance variable spreads from the lowest score of 30 to the highest score of 50 with a value range of 20. Furthermore, the frequency distribution results of ship maintenance are Tabel 6.

To describe the frequency of the results of the ship operation variable research data (X3), it can be presented in the form of a Histogram Graph, as follows in Figure 3.

Table 5. Variable Statistics X3

Ship Operation X3

| | | |
|---|---|---|
| N | Valid | 86 |
| | Missing | 0 |
| Mean | | 40.50 |
| Median | | 40.50 |
| Std. Deviation | | 7.342 |
| Variance | | 53.900 |
| Range | | 20 |
| Minimum | | 30 |
| Maximum | | 50 |
| Sum | | 3483 |

Tabel 6. Ship Operation (X3)

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 30 | 21 | 24.4 | 24.4 | 24.4 |
| | 37 | 2 | 2.3 | 2.3 | 26.7 |
| | 38 | 6 | 7.0 | 7.0 | 33.7 |
| | 39 | 3 | 3.5 | 3.5 | 37.2 |
| | 40 | 12 | 14.0 | 14.0 | 51.2 |
| | 41 | 8 | 9.3 | 9.3 | 60.5 |
| | 42 | 4 | 4.7 | 4.7 | 65.1 |
| | 43 | 5 | 5.8 | 5.8 | 70.9 |
| | 45 | 1 | 1.2 | 1.2 | 72.1 |
| | 48 | 1 | 1.2 | 1.2 | 73.3 |
| | 50 | 23 | 26.7 | 26.7 | 100.0 |
| | Total | 86 | 100.0 | 100.0 | |

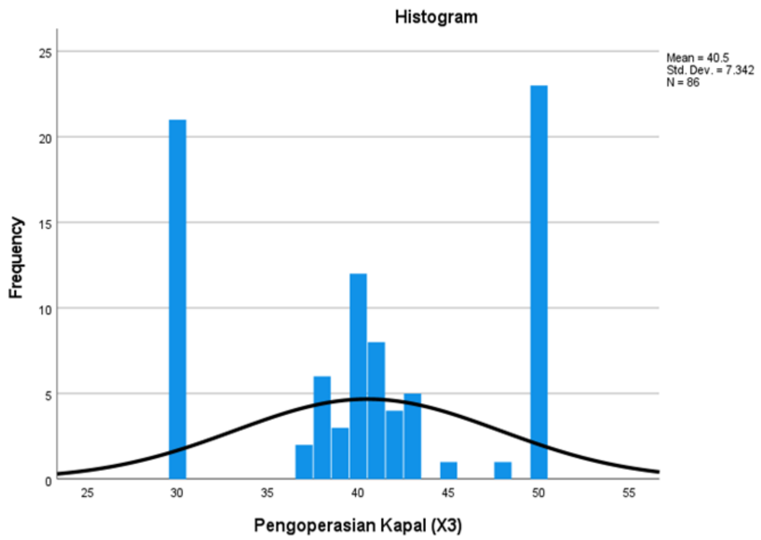


Figure 3 Frequency Histogram of Ship Operation Variable



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**4). Sailing Safety (Y)**

Sailing Safety variable data (Y) can be seen in the table in the attachment.

The results of data processing (2024) for sailing safety variables have:

- Mean: 46,02
- Standard Deviation: 5,968
- Variance: 35,623
- Range: 20
- Lowest score: 30
- Highest score: 50
- Total number: 3958

The frequency score of the sailing safety variable spreads from the lowest score of 30 to the highest score of 50 with a value range of 20. Furthermore, the frequency distribution results of sailing safety are in Table 8.

To describe the frequency of sailing safety variable research data results (Y), it can be presented in the form of a Histogram Graph, as follows Figure 4

Table 7. Variable Statistics Y

Sailing Safety (Y)

| | | |
|---|---|---|
| N | Valid | 86 |
| | Missing | 0 |
| Mean | | 46.02 |
| Median | | 49.12 |
| Std. Deviation | | 5.968 |
| Variance | | 35.623 |
| Range | | 20 |
| Minimum | | 30 |
| Maximum | | 50 |
| Sum | | 3958 |

Table 8. Sailing Safety (Y)

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 30 | 7 | 8.1 | 8.1 | 8.1 |
| | 40 | 11 | 12.8 | 12.8 | 20.9 |
| | 41 | 2 | 2.3 | 2.3 | 23.3 |
| | 42 | 1 | 1.2 | 1.2 | 24.4 |
| | 43 | 1 | 1.2 | 1.2 | 25.6 |
| | 45 | 3 | 3.5 | 3.5 | 29.1 |
| | 46 | 7 | 8.1 | 8.1 | 37.2 |
| | 48 | 5 | 5.8 | 5.8 | 43.0 |
| | 49 | 6 | 7.0 | 7.0 | 50.0 |
| | 50 | 43 | 50.0 | 50.0 | 100.0 |
| | Total | 86 | 100.0 | 100.0 | |

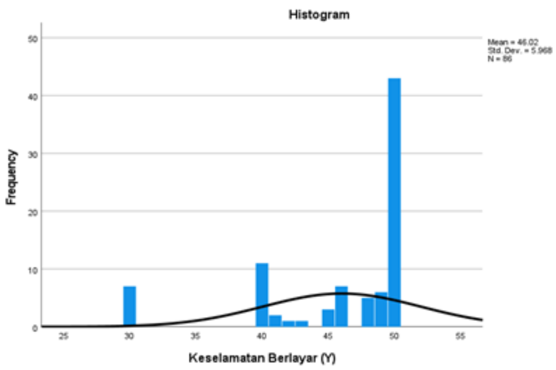


Figure 4. Frequency Histogram of Shipping Safety Variables

### 5). Recapitulation of Questionnaire Data

The data used in this study were obtained from the results of filling out a questionnaire with a Likert scale by the crew of the Tug Boat Anugerah Lautan 5, employees, and teachers of the North Sulawesi Sailing Polytechnic as many as 86 people. The research variables used are independent (exogenous variables), namely maintenance system (X1), certification (X2), ship operation (X3), and dependent variables (endogenous variables), namely sailing safety (Y).

**a. Maintenance System Variables (X1)**

In Figure 5 below for the independent variable (X1), namely the Maintenance System submitted to 86 respondents, the number of criteria is obtained (if each statement item gets the highest score) X1 = 5 x 86 x 10 = 4300. The total score of the data collection results is 3890, thus, the Maintenance System according to the perception of the crew is 3890: 4300 = 90.4% of the criteria set. These results can be depicted in the diagram as follows:

**b. Certification Variable (X2)**

In Figure 6 below for the independent variable (X2), namely Certification submitted to 86 respondents, the number of criteria is obtained (if each statement item gets the highest score) X2 = 5 x 86 x 10 = 4300. The total score of the data collection results is 3403, thus, Certification according to the perception of the crew is 3911: 4300 = 91% of the criteria set. These results can be depicted in the diagram as follows:

**c. Ship Operation Variables (X3)**

In Figure 7 below for the independent variable (X2), namely the operation of the ship submitted to 86 respondents, the number of criteria is obtained (if each statement item gets the highest score) X2 = 5 x 86 x 10 = 4300. The total score of the data collection results is 3403, thus, the operation of the ship according to the perception of the crew is 3483: 4300 = 81% of the criteria set. These results can be depicted in the diagram.

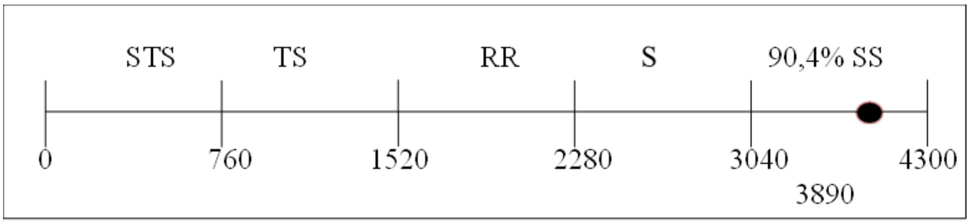

Figure 5. Likert Scale Diagram of Planned Maintenance System Variables

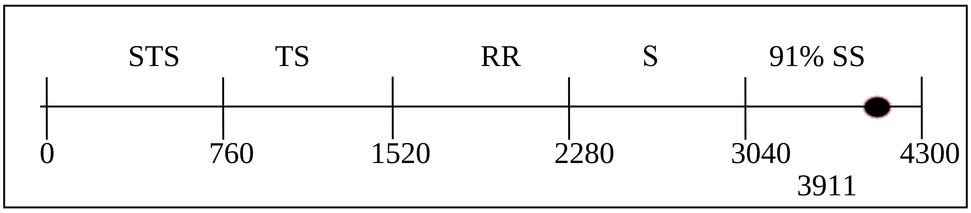

Figure 6. *Certification Variable Likert Scale Diagram*

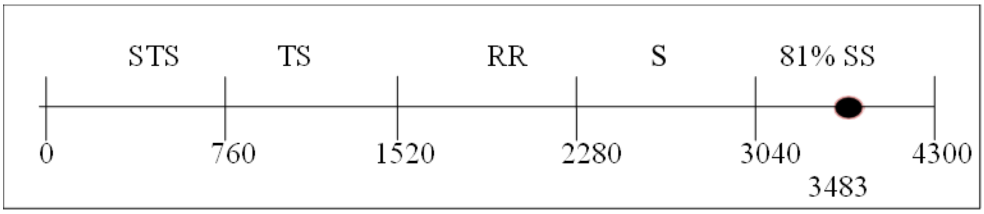

Figure 7. Certification Variable Likert Scale Diagram


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**d. Sailing Safety Variables (Y)**

In Figure 8 below for the independent variable (Y), namely sailing safety submitted to 86 respondents, the number of criteria is obtained (if each statement item gets the highest score) Y = 5 x 86 x 10 = 4300. The total score of the data collection results is 3958, thus, sailing safety according to the perception of the crew is 3958: 4300 = 92% of the criteria set. These results can be depicted in the diagram as follows

**Statistical Analysis**

The statistical method used to test the hypothesis in this study is Partial Least Square (PLS). PLS is an alternative method of analysis with variance-based Structural Equation Modeling (SEM). The advantage of this method is that it does not require assumptions and can be estimated with a relatively small sample size. In Structural Equation Modeling, there are two types of models formed, namely the measurement model (outer model) and the structural model (inner model). The measurement model explains the proportion of variance in each manifest variable (dimension) that can be explained in latent variables. Through the measurement model, it will be known which dimensions are dominant in forming latent variables. After the measurement model of each latent variable is described, the structural model is then described which will examine the effect of each exogenous latent variable on the endogenous latent variable. In this study, the planned maintenance system (X1) was measured by 10 questions, ship maintenance (X2) was measured by 10 statements, and shipping safety (Y) was measured by 10 statements.

The tool used is the Smart PLS Version 3 program which is specifically designed to estimate structural equations on a variance basis. The structural model in this study is shown in Figure 9.

With latent constructs being toward dimensions, it indicates that the research uses reflective dimensions that are relatively appropriate for measuring perceptions. The relationship to be investigated (hypothesis) is denoted by arrows between the constructs.

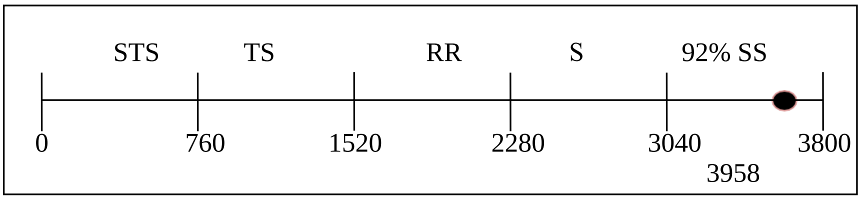


Figure 8. Likert Scale Diagram of Sailing Safety Variables

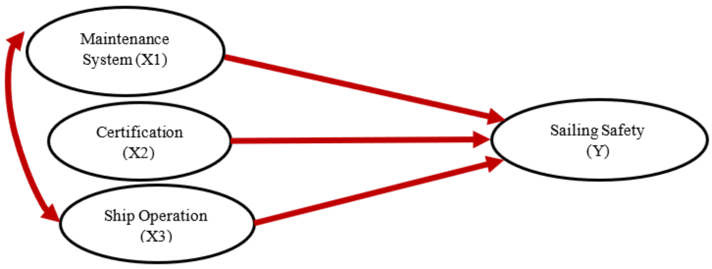


Figure 9. Model Struktural

**Measurement Analysis (Outer Model)**

Measurement model testing (outer model) is used to determine the specification of the relationship between latent variables and their manifest variables, this test includes convergent validity, discriminant validity, and reliability.

Convergent validity of the measurement model with reflexive dimensions can be seen from the correlation between the item/dimension score and the construct score. Individual dimensions are considered reliable if they have a correlation value above 0.70.


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However, in the research stage of scale development, a loading of 0.50 to 0.60 is still acceptable.

Based on the outer loading validity test in Table 1 and Figure 1, it is known that all outer loading values are> 0.7, which means that they have met the validity requirements based on the outer loading value.

Smart PLS output for loading factors provides the results in Table 9.

Table 9. Validity Testing based on Factor Loading

| | | | | |
|---|---|---|---|---|
| **X1.1** | | | | **0.936** |
| **X1.10** | | | | 0.972 |
| **X1.2** | | | | 0.923 |
| **X1.3** | | | | 0.982 |
| **X1.4** | | | | 0.962 |
| **X1.5** | | | | 0.927 |
| **X1.6** | | | | 0.917 |
| **X1.7** | | | | 0.919 |
| **X1.8** | | | | 0.916 |
| **X1.9** | | | | 0.958 |
| **X2.1** | | | 0.947 | |
| **X2.1** | | | 0.912 | |
| **X2.2** | | | 0.933 | |
| **X2.3** | | | 0.959 | |
| **X2.4** | | | 0.921 | |
| **X2.5** | | | 0.952 | |
| **X2.6** | | | 0.968 | |
| **X2.7** | | | 0.932 | |
| **X2.8** | | | 0.961 | |
| **X2.9** | | | 0.964 | |
| **X3.1** | | 0.831 | | |
| **X3.1** | | 0.880 | | |
| **X3.2** | | 0.806 | | |
| **X3.3** | | 0.877 | | |
| **X3.4** | | 0.879 | | |
| **X3.5** | | 0.843 | | |
| **X3.6** | | 0.890 | | |
| **X3.7** | | 0.886 | | |
| **X3.8** | | 0.805 | | |
| **X3.9** | | 0.869 | | |
| **Y1** | 0.957 | | | |
| **Y10** | 0.917 | | | |
| **Y2** | 0.960 | | | |
| **Y3** | 0.932 | | | |
| **Y4** | 0.880 | | | |
| **Y5** | 0.926 | | | |
| **Y6** | 0.964 | | | |
| **Y7** | 0.902 | | | |
| **Y8** | 0.955 | | | |
| **Y9** | 0.878 | | | |

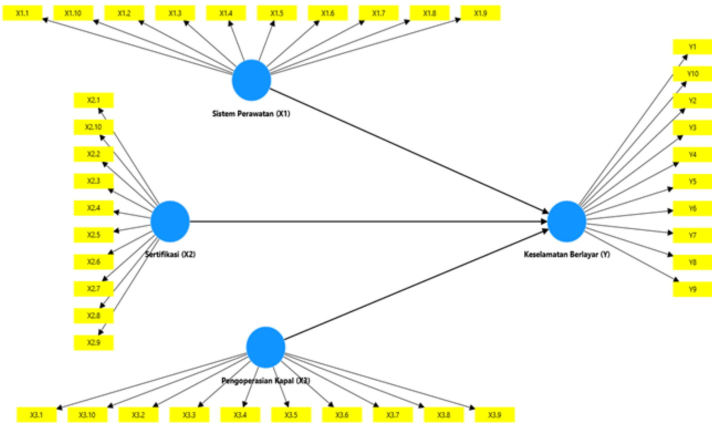


Figure 10. Convergent Validity

**All valid because > 0.7**

Based on testing the validity of factor loading in Figure 8 and Table 9, it is known that all loading values are > 0.7, which means that they have met the validity requirements based on the loading value.

### Discriminant Validity

This section will describe the results of the discriminant validity test. The discriminant validity test uses the cross-loading value. A dimension is declared to meet discriminant validity if the cross-loading value of the dimension on its variable is the largest compared to other variables. The following is the cross-loading value of each indicator in Table 10.

Tabel 10 *Discriminant Validity*

| | Sailing Safety (Y) | Ship Operation (X3) | Certification (X2) | Maintenance System (X1) |
|---|---|---|---|---|
| X1.1 | 0.409 | 0.140 | 0.214 | 0.936 |
| X1.10 | 0.463 | 0.144 | 0.259 | 0.972 |
| X1.2 | 0.425 | 0.093 | 0.196 | 0.923 |
| X1.3 | 0.458 | 0.176 | 0.258 | 0.982 |
| X1.4 | 0.436 | 0.184 | 0.228 | 0.962 |
| X1.5 | 0.397 | 0.137 | 0.220 | 0.927 |
| X1.6 | 0.393 | 0.093 | 0.233 | 0.917 |
| X1.7 | 0.378 | 0.091 | 0.223 | 0.919 |
| X1.8 | 0.404 | 0.113 | 0.244 | 0.916 |
| X1.9 | 0.435 | 0.220 | 0.249 | 0.958 |
| X2.1 | 0.414 | 0.079 | 0.947 | 0.185 |
| X2.10 | 0.382 | 0.134 | 0.912 | 0.200 |
| X2.2 | 0.389 | 0.085 | 0.933 | 0.195 |
| X2.3 | 0.417 | 0.171 | 0.959 | 0.227 |
| X2.4 | 0.414 | 0.161 | 0.921 | 0.260 |
| X2.5 | 0.439 | 0.121 | 0.952 | 0.256 |
| X2.6 | 0.457 | 0.121 | 0.968 | 0.277 |
| X2.7 | 0.426 | 0.089 | 0.932 | 0.229 |
| X2.8 | 0.436 | 0.118 | 0.961 | 0.238 |
| X2.9 | 0.408 | 0.149 | 0.964 | 0.259 |
| X3.1 | 0.391 | 0.831 | 0.110 | 0.138 |
| X3.10 | 0.346 | 0.880 | 0.137 | 0.134 |
| X3.2 | 0.362 | 0.806 | 0.172 | 0.190 |
| X3.3 | 0.354 | 0.877 | 0.125 | 0.149 |
| X3.4 | 0.388 | 0.879 | 0.098 | 0.111 |
| X3.5 | 0.346 | 0.843 | 0.079 | 0.095 |
| X3.6 | 0.365 | 0.890 | 0.076 | 0.101 |
| X3.7 | 0.375 | 0.886 | 0.117 | 0.133 |
| X3.8 | 0.337 | 0.805 | 0.042 | 0.044 |
| X3.9 | 0.429 | 0.869 | 0.147 | 0.172 |
| Y1 | 0.957 | 0.434 | 0.449 | 0.459 |
| Y10 | 0.917 | 0.386 | 0.419 | 0.400 |
| Y2 | 0.960 | 0.431 | 0.446 | 0.428 |
| Y3 | 0.932 | 0.378 | 0.456 | 0.455 |
| Y4 | 0.880 | 0.331 | 0.326 | 0.334 |
| Y5 | 0.926 | 0.335 | 0.343 | 0.370 |
| Y6 | 0.964 | 0.456 | 0.454 | 0.470 |
| Y7 | 0.902 | 0.406 | 0.377 | 0.402 |
| Y8 | 0.955 | 0.464 | 0.442 | 0.444 |
| Y9 | 0.878 | 0.360 | 0.362 | 0.349 |

Based on Table 10. above, it states that there are several dimensions in the research variables that have smaller cross-loading values compared to the cross-loading values on other variables so they must be known and observed further. Another way to measure discriminant validity is to look at the square root value of the average variance extracted (AVE). The recommended value is above 0.5 for a good model. The next test is the composite reliability of the dimension blocks that measure the construct. A construct is said to be reliable if the composite reliability value is above 0.60.

Then it can also be seen by looking at the reliability of the construct or latent variable as measured by looking at the Cronbach alpha value of the dimension block that measures the construct. A construct is declared reliable if the Cronbach alpha value is above 0.7. The following describes the construct results for each variable, namely the planned maintenance system, ship maintenance, and shipping safety with each variable and dimension. Furthermore, validity testing is carried out based on the average variance extracted (AVE) value.

The recommended AVE value is above 0.5. It is known that all AVE values are> 0.5, which means that they have met the validity requirements based on AVE. Furthermore, reliability testing is carried out based on the value of composite reliability (CR).

The recommended CR value is above 0.7. It is known that all CR values are> 0.7, which means that they have met the reliability requirements based on CR. Furthermore, reliability testing was carried out based on the Cronbach's alpha (CA) value.

The recommended CA value is above 0.7. It is known that all CA values are > 0.7, which means that they have met the reliability requirements based on Cronbach's alpha.

Table 10 Validity Testing based on Average Variance Extracted (AVE)

| | Average variance extracted (AVE) |
|---|---|
| Sailing Safety (Y) | 0.860 |
| Ship Operation (X3) | 0.735 |
| Certification (X2) | 0.893 |
| Maintenance System (X1) | 0.886 |

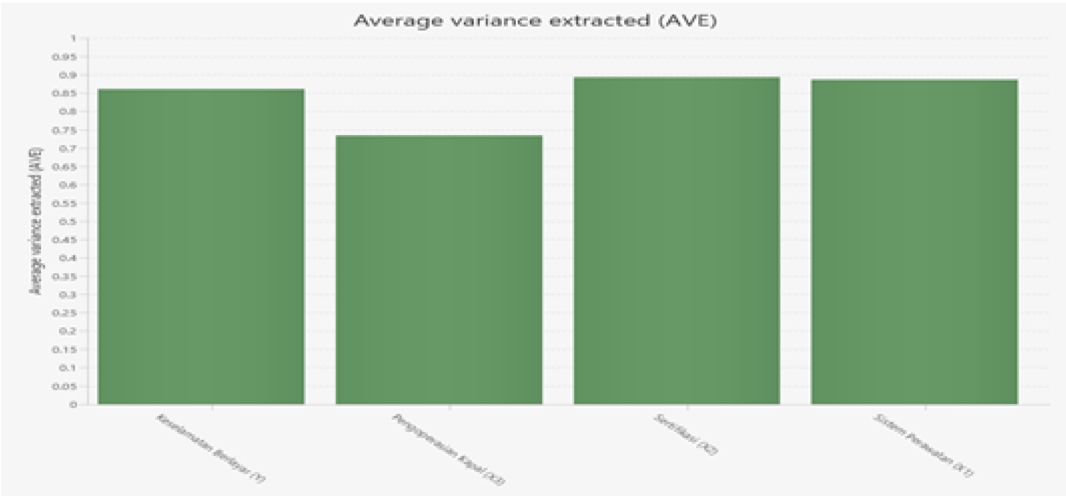


Figure 11. Validity Testing based on Average Variance Extracted (AVE)
*Source: Smart PLS 2024 Program Output*

Table 11 Reliability Testing based on Composite Reliability (CR)

| | Composite reliability (rho_c) |
|---|---|
| Sailing Safety (Y) | 0.984 |
| Ship Operation (X3) | 0.965 |
| Certification (X2) | 0.988 |
| Maintenance System (X1) | 0.987 |

*Source: Smart PLS 2024 Program Output*

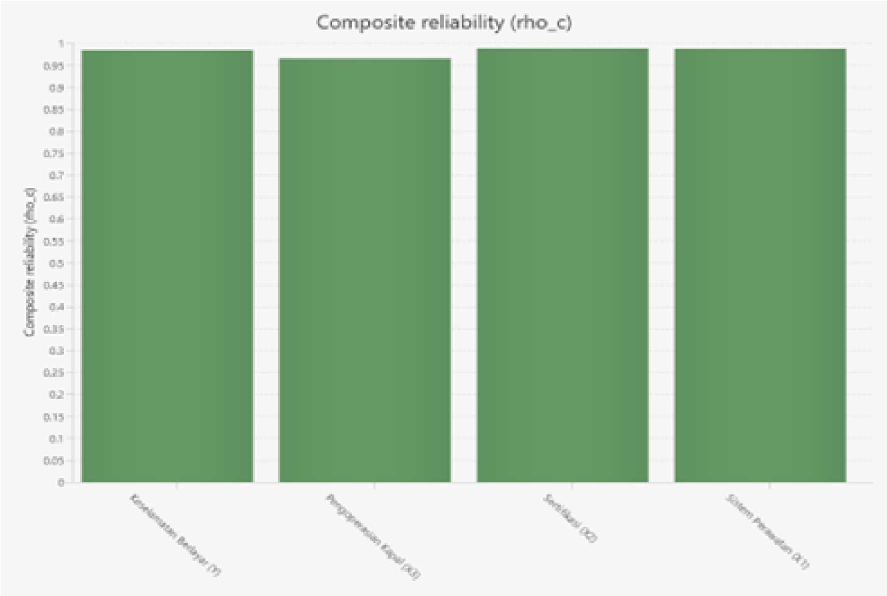


Figure 12 Reliability Testing based on Composite Reliability (CR)
*Source: Smart PLS 2024 Program Output*

Table 12 Reliability Testing based on Cronbach's Alpha (CA)

| | Cronbach's alpha |
|---|---|
| Sailing Safety (Y) | 0.982 |
| Ship Operation (X3) | 0.960 |
| Certification (X2) | 0.987 |
| Maintenance System (X1) | 0.986 |

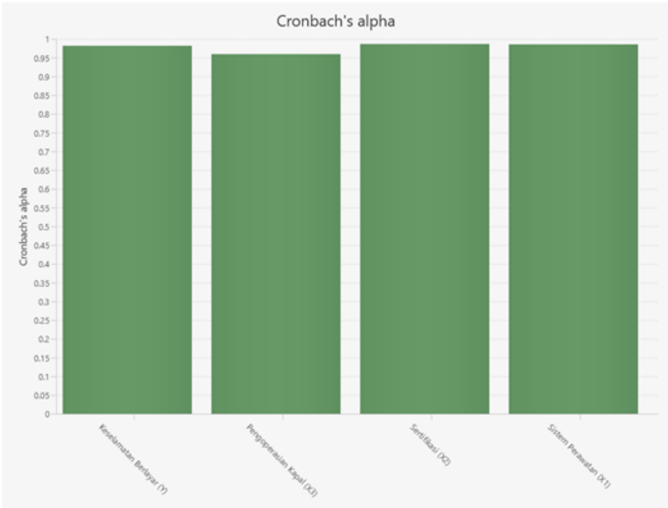


Figure 13 Reliability Testing based on Cronbach's Alpha (CA)
*Source: Smart PLS 2024 Program Output*

The recommended CA value is above 0.7. It is known that all CA values are > 0.7, which means that they have met the reliability requirements based on Cronbach's alpha.

***Structural Model Analysis or Inner Model***

**1. Coefficient of Determination (R2 )**

Testing the inner model or structural model is carried out to see the relationship between constructs, significance values, and R-square of the research model. The structural model is evaluated using the R-square for the test-dependent construct and the significance of the structural path parameter coefficient. Based on data processing that has been carried out using the SmartPLS 3.0 program, the R-Square value is obtained as follows in Figure 14.

The results of the path coefficient test in Table 4.10 obtained results:

- Ship Operation (X3) thus has a significant effect on Sailing Safety (Y), with P-Values = 0.000 < 0.05 (Hypothesis Accepted).
- Certification (X2) thus has a significant effect on Safety Sailing (Y), with P-Values = 0.036 < 0.05 (Hypothesis Accepted).
- Maintenance System (X1) thus has a significant effect on Sailing Safety (Y), with P-Values = 0.033 < 0.05 (Hypothesis Accepted).Hasil uji *path coefficient* in Table 14.

Based on Table 14. above shows that the R-Square value for the sailing safety variable is 0.433. This achievement explains that the percentage of the amount of Safety Sailing is 43.30%. This means that the variables of ship maintenance system, certification, and ship operation affect sailing safety by 43.30% and the rest is influenced by other variables. The R-Square value of Safety Sailing (Y) is 0.433, which means that the Maintenance System (X1), Certification (X2), and Ship Operation (X3) can influence Safety Sailing (Y) by 43.30%.

The Q-Square value of Safety Sailing (Y) is 0.349. Since Q-Square = 0.349 > 0, it is concluded that Maintenance System (X1), Certification (X2), and Ship Operation (X3) have predictive relevance for Safety Sailing (Y).

## 2. Goodness of Fit (GoF) Assessment

Based on data processing that has been carried out using the Smart PLS program, the following Model Fit values are obtained Table 16.

It is known that based on the results of the SRMR goodness of fit test, the SRMR value = 0.044 <0.1, it is concluded that the model has FIT.

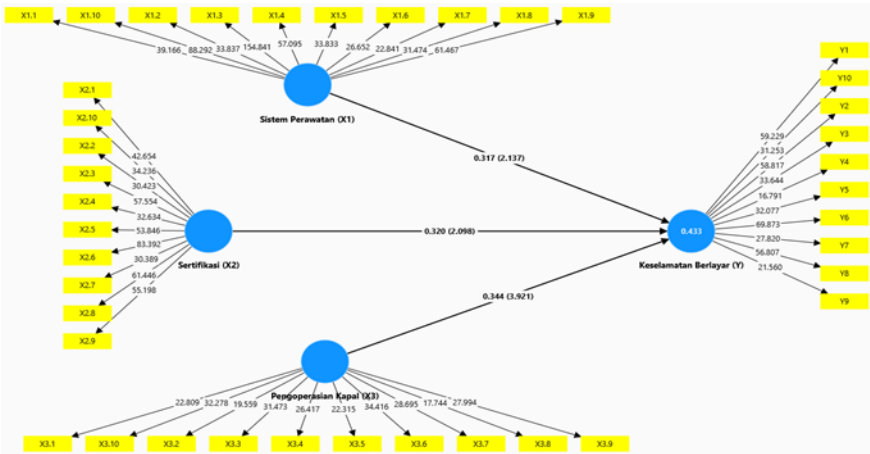


Figure 14 Structural Model (Inner Model)
*Source: Smart PLS 2024 Program Output*

Table 13 Test Path Coefficient & Significance of Influence

| | Original sample (O) | Sample mean (M) | Standard deviation (STDEV) | T statistics (\|O/STDEV\|) | P values |
|---|---|---|---|---|---|
| Ship Operation (X3) -> Sailing Safety (Y) | 0.344 | 0.330 | 0.088 | 3.921 | 0.000 |
| Certification (X2) -> Sailing Safety (Y) | 0.320 | 0.330 | 0.153 | 2.098 | 0.036 |
| Maintenance System (X1) -> Sailing Safety (Y) | 0.317 | 0.319 | 0.148 | 2.137 | 0.033 |


http://ejournal.unsrat.ac.id/index.php/platax 10.35800/jip.v10i2.58619

Table 14 *R-Square*

| | R-square | R-square adjusted |
|---|---|---|
| Sailing Safety (Y) | 0.433 | 0.412 |

*Source: Smart PLS 2024 Program Output*

Table 15 *Q-Square*

| | Q² (=1-SSE/SSO) |
|---|---|
| Sailing Safety (Y) | 0.349 |

*Sumber : Output Program Smart PLS 2024*

Table 16 Testing Goodness of Fit Model

| | Saturated model | Estimated model |
|---|---|---|
| SRMR | 0.044 | 0.044 |

## CONCLUSION

Based on the results of the research that has been conducted and data analysis as described in the previous chapter, the following conclusions are presented from the research results as follows:

The maintenance system has a significant effect on sailing safety, where H0 is rejected and Ha1 is accepted;

Certification has a significant effect on sailing safety, where H0 is rejected and Ha2 is accepted.

Ship operation has a significant effect on sailing safety, where H0 is rejected and Ha2 is accepted.

Ship maintenance, certification, and operation systems can affect sailing safety.

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