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Study of Planned Maintenance System Senior Admiral John Lie's Training Ship on Shipping Safety

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Abstract

The implementation of the ship maintenance management system on Rear Admiral Jhon Lie's training ship 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 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 0.307, which means that the planned maintenance system (X1) and ship maintenance (X2) can affect shipping safety (Y) by 30.7%. Ship maintenance (X2) has a significant effect on sailing safety (Y), with P-values = 0.033 0.05 (hypothesis accepted). The planned maintenance system (X1) has a significant effect on sailing safety (Y), with a P-value of 0.037 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: Planned Maintenance System; John Lie; Ship Maintenance; Shipping Safety

INTRODUCTION

The development of the times demands that people achieve their goals quickly. One answer to these demands is the emergence of means of transportation. Since time immemorial, transportation equipment has been used in people's lives to facilitate the wheels of the economy. Sea transportation is one of the most strategic means of moving goods from one area to another and from one port to another. Ships are a very important means of sea transportation in the maritime world to promote the domestic and foreign trade of a country in terms of moving and transporting goods from one place to another that has a higher economic value.

Ships have various kinds of equipment that support the smooth operation of the ship, and these tools have their respective functions. These tools require routine maintenance in order to support the smooth operation of ships and comply with government regulations regarding ship seaworthiness. Events of damage to the equipment on board due to a lack of attention to maintenance disrupt or slows down the operation of the ship, and even the safety of the ship is threatened by the existence of several damages that are not immediately resolved or repaired. Maintaining the condition of the ship is the main goal of every maintenance action. To do all this, it turns out that an appropriate system is needed, one of which is considered possible: management. This management term is now becoming increasingly popular and dominant in ship maintenance systems. Through maintenance, we find ways to control or slow down the rate of deterioration in the ship's condition.

One of the efforts to overcome the matters mentioned above is to create and implement a plan maintenance system for shipping companies in Indonesia. Plan Maintenance System (PMS) is a ship maintenance system that is carried out continuously or on a scheduled basis for equipment and supplies so that the ship is always seaworthy and ready for operation. In Chapter IX. Management for the Safe Operation of Ships, this chapter complies with the International Safety Management (ISM) Code, which requires a safety management system to be established by the shipowner or anyone who has taken responsibility for the ship (the "Company").

Based on the incident 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 there are incidents of the Ship Anchor Winch Operation not functioning optimally when the ship is anchored at Belang Port, Southeast Minahasa in KLM BST activities and the occurrence of unoptimized Ship Lifeboat Operation when it will be lowered for Fire Drill On Board at Amurang Port, South Minahasa.

Based on the description above, the author is encouraged to conduct research on the Training Ship. Laksaman Muda Jhon Lie, and compile a thesis with the title: "Review of the Planned Maintenance System of the Rear Admiral John Lie Training Ship, Towards Shipping 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 dat

a about the company, namely 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 in accordance with 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 through 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

In this study, there are three variables, consisting of two independent variables, and one dependent variable.

1. Planned Maintenance System: X1
2. Ship Maintenance: X2
3. Safety of Voyage: Y

The research questionnaire list that the author conveyed to 76 respondents was then researched, edited, and analyzed in accordance with data processing. The research questionnaire is then scored according to the respondent's answers 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 then use the Smart-PLS 3 tool, version 3.2.9. To describe the frequency of the results of the seafarer certification variable research data (X1), it can be presented in the form of a Histogram Graph, as Figure 1.

To describe the frequency of the results of the seafarer certification variable research data (X1), it can be presented in the form of a Histogram Graph, as fig. 2.

To describe the frequency of the results of the seafarer certification variable

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research data (Y), it can be presented in the form of a Histogram Graph, as fig. 3.

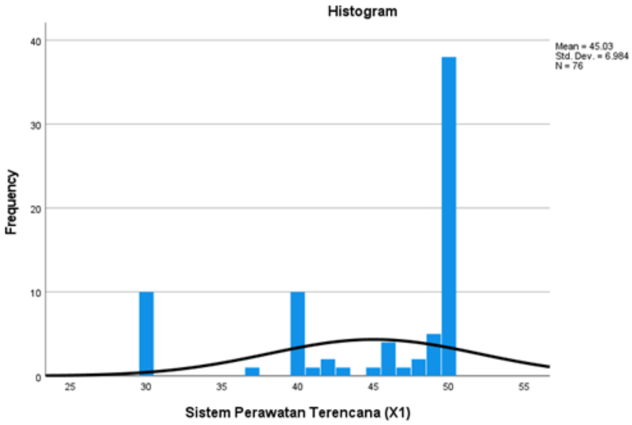

Figure 1. Frequency Histogram of Maintenance System Variables

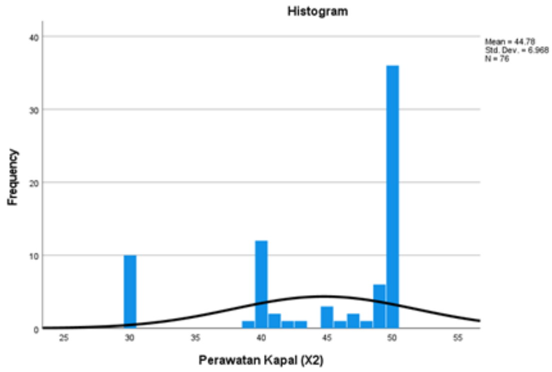

Figure 2. Histogram of Ship Maintenance Variable Frequency

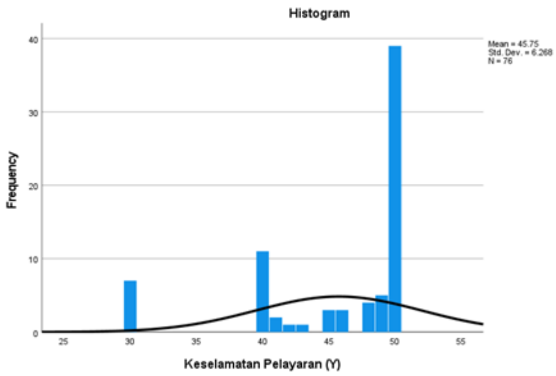

Figure 3. Frequency Histogram of Shipping Safety Variables

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 training ship Rear Admiral John Lie, employees, and teachers of the North Sulawesi Shipping Polytechnic as many as 76 people. The research variables used are independent variables (exogenous variables), namely planned maintenance systems (X1), ship maintenance (X2), and dependent variables (endogenous variables), namely shipping safety (Y).

In Figure 4 below for the independent variable (X1), namely seafarer certification submitted to 76 respondents, the number of criteria (if each statement item gets the

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highest score) X1 = 5 x 76 x 10 = 3800. The total score of the data collection results is 3422, thus, seafarer certification according to the perception of the crew is 3422: 3800 = 90% of the criteria set. These results can be depicted in the following diagram.

In Figure 5 below for the independent variable (X2), namely seafarer certification submitted to 76 respondents, the number of criteria is obtained (if each statement item gets the highest score) X2 = 5 x 76 x 10 = 3800. The total score of the data collection results is 3403, thus, seafarer certification according to the perception of the crew is 3403: 3800 = 89.5% of the criteria set. These results can be depicted in the following diagram.

In Figure 6 below for the independent variable (Y), namely seafarer certification submitted to 76 respondents, the number of criteria is obtained (if each statement item gets the highest score) Y = 5 x 76 x 10 = 3800. The total score of the data collection results is 3477, thus, seafarer certification according to the perception of the crew is 3477: 3800 = 91.5% of the criteria set. These results can be depicted in the following diagram.

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). In this study, seafarer certification (X1) was measured by 12 questions, crew skills (X2) was measured by 12 statements, ship operational performance (Y) was measured by 12 statements, and crew welfare (Z) was measured by 12 statements. The structural model in this study is shown in Figure 7.

Latent models are dimensioned indicating that the research uses reflective dimensions that are relatively appropriate for measuring perceptions. The relationship to be studied (hypothesis) is denoted by arrows between constructs. 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.

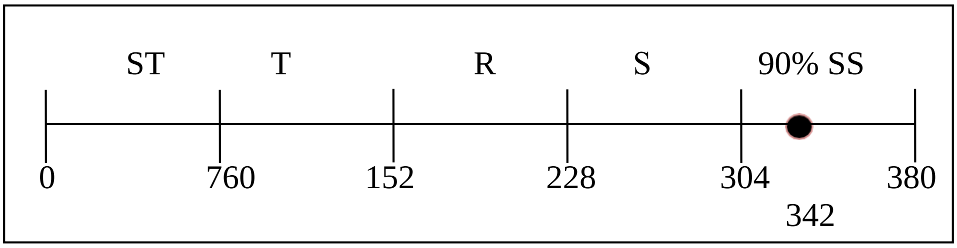

Figure 4. Likert Scale Diagram of Planned Maintenance System

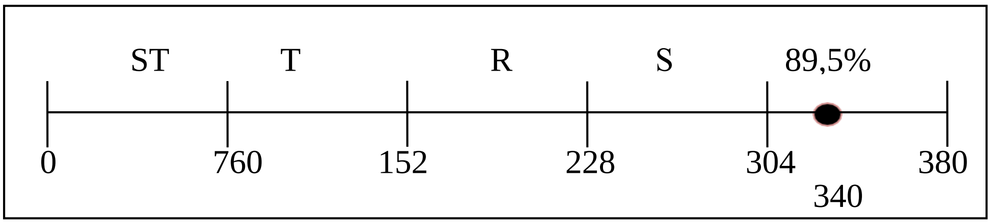

Figure 5. Ship Maintenance Variable Likert Scale Diagram

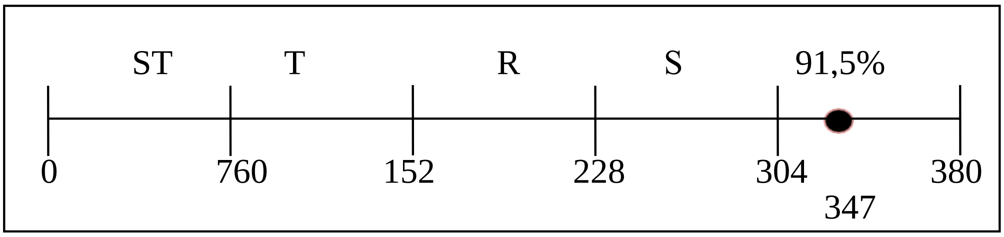

Figure 6. Diagram Skala Likert Variabel Safety of Shipping.

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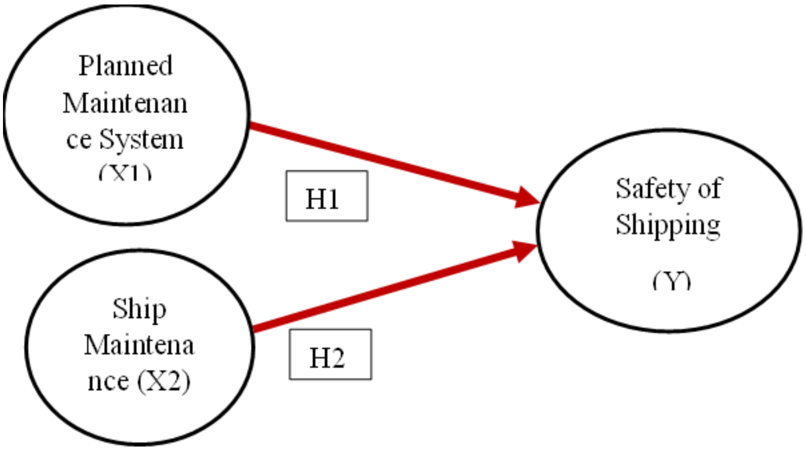

Figure 7. Structural Model

a. *Convergent Validity*

The 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. However, in the research stage of scale development, a loading of 0.50 to 0.60 is still acceptable. Based on the results for outer loading, shows that there are dimensions that have loadings below 0.60 and are not significant. Smart PLS output for loading factors provides results in the following Table 1.

Based on testing the validity of factor loading in Figure 8 and Table 1, it is known that all loading values are > 0.7, which means that it has met the validity requirements based on the loading value.

b. *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.

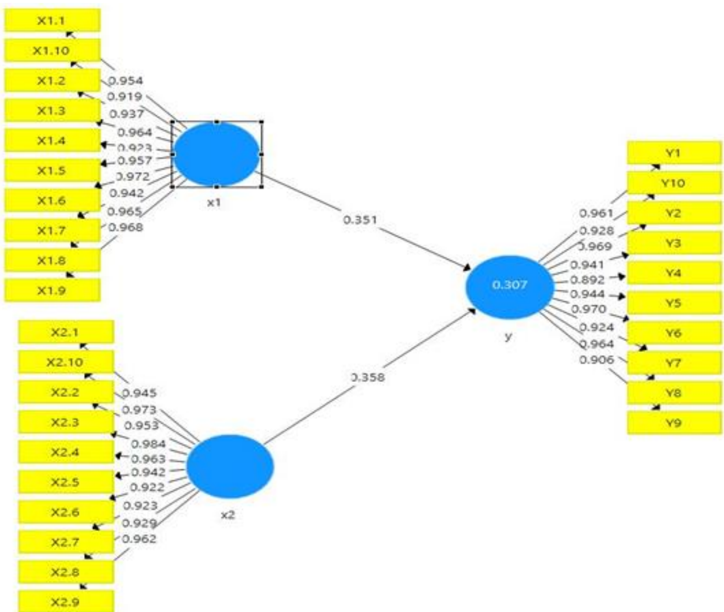

Figure 8. *Convergence Validity*

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Table 1. Validity Testing based on Factor Loading

	Safety Shipping (Y)	Ship Maintenance (X2)	Planned Maintenance System (X1)
X1.1			0.954
X1.10			0.919
X1.2			0.937
X1.3			0.964
X1.4			0.923
X1.5			0.957
X1.6			0.972
X1.7			0.942
X1.8			0.965
X1.9			0.968
X2.1		0.945	
X2.10		0.973	
X2.2		0.953	
X2.3		0.984	
X2.4		0.963	
X2.5		0.942	
X2.6		0.922	
X2.7		0.923	
X2.8		0.929	
X2.9		0.962	
Y1	0.961		
Y10	0.928		
Y2	0.969		
Y3	0.941		
Y4	0.892		
Y5	0.944		
Y6	0.970		
Y7	0.924		
Y8	0.964		
Y9	0.906		

Source: Output Program Smart PLS 2023

Based on Table 2 above, 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 Cronbach's 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. The following is a table of loading values for the research variable constructs resulting from running the Smart PLS program in the next table 3.

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Table 2. *Discriminant Validity*

	Keselamatan Pelayaran (Y)	Perawatan Kapal (X2)	Sistem Perawatan Terencana (X1)
X1.1	0.401	0.167	0.954
X1.10	0.370	0.179	0.919
X1.2	0.382	0.168	0.937
X1.3	0.408	0.205	0.964
X1.4	0.398	0.223	0.923
X1.5	0.424	0.234	0.957
X1.6	0.444	0.244	0.972
X1.7	0.414	0.203	0.942
X1.8	0.430	0.210	0.965
X1.9	0.400	0.229	0.968
X2.1	0.404	0.945	0.195
X2.10	0.451	0.973	0.229
X2.2	0.429	0.953	0.194
X2.3	0.445	0.984	0.225
X2.4	0.421	0.963	0.194
X2.6	0.382	0.922	0.201
X2.7	0.361	0.923	0.192
X2.8	0.407	0.929	0.223
X2.9	0.426	0.962	0.212
Y1	0.961	0.440	0.431
Y10	0.928	0.396	0.407
Y2	0.969	0.423	0.430
Y3	0.941	0.442	0.447
Y4	0.892	0.329	0.325
Y5	0.944	0.374	0.353
Y6	0.970	0.450	0.434
Y7	0.924	0.405	0.383
Y8	0.964	0.438	0.426
Y9	0.906	0.363	0.373

Table 3. Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Sistem Perawatan Terencana (X1)	0.988	0.989	0.989	0.903
Perawatan Kapal (X2)	0.988	0.989	0.989	0.902
Keselamatan Pelayaran (Y)	0.985	0.988	0.987	0.884

Source: Output Program Smart PLS 2023

	Cronbach's Alpha	Composite Reability	Keterangan
Sistem Perawatan Terencana (X1)	0,988	0,989	*Reliable*
Perawatan Kapal (X2)	0,988	0,989	*Reliable*
Keselamatan Pelayaran (Y)	0,985	0,988	*Reliable*

Based on Table 2, shows that the Average Variance Extracted (AVE) of each variable, namely seafarer certification and crew skills, crew welfare, and ship operational performance have constructs> 0.50, meaning that all constructs are reliable. Thus it can be stated that each variable has high discriminant validity.

Meanwhile, it can be seen in Table 4.9 above that the composite reliability value of each variable shows a constructed value> 0.60. These results indicate that each variable has met the composite reliability so it can be concluded that all variables have a high level of reliability.

Furthermore, in the table above, the Cronbach alpha of each variable shows a

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constructed value> 0.70, thus these results indicate that each research variable has met the requirements for the Cronbach alpha value, so it can be concluded that the overall variable has a high level of reliability. So it can be concluded that the dimensions used in this study have high discriminant validity in compiling their respective variables.

Structural Model Analysis or Inner Model.

a. Coefficient of Determination (R2)

Inner model or structural model testing 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 9.

The path coefficient test results in Table 4. obtained results:

Ship Maintenance (X2) has a significant effect on Shipping Safety (Y), with P-Values = 0.033 < 0.05 (Hypothesis Accepted).

Planned Maintenance System (X1) has a significant effect on Shipping Safety (Y), with a value of P-Values = 0.037 < 0.05 (Hypothesis Accepted).

Based on Table 4, shows that the two hypotheses that have a direct effect, there are 2 (two) accepted hypotheses because the T-Statistics value> 1.96 P-Values < 0.05, which means that there is a significant and direct positive effect.

Based on Table 4 shows that:

a. The effect of the planned maintenance system on the safety of the shipping on the training ship Rear Admiral John Lie.

Based on Table 4. shows that the effect of the planned maintenance system on shipping safety is positive with a parameter coefficient of 0.358. Furthermore, based on the T-Statistics H1 of 2.142 is greater than the level or 2.142> 1.96 and the P-values of 0.033 are smaller than the real level or 0.033 <0.05, this indicates that the effect of the planned maintenance system on the safety of shipping is significant. Therefore, it can be concluded that H0 is rejected and Ha is accepted, so there is a significant positive effect of the planned maintenance system on the safety of the shipping on the Laksamana Muda John Lie training ship.

b. The effect of the planned maintenance system on the safety of the shipping on the training ship Rear Admiral John Lie

Based on Table 4. shows that the effect of the planned maintenance system on shipping safety is positive with a parameter coefficient of 0.351. Furthermore, based on the T-Statistics H1 of 2.092 is greater than the level or 2.092> 1.96 and the P-values of 0.037 are smaller than the real level or 0.037 <0.05 this indicates that the effect of ship maintenance on shipping safety is significant. Therefore, it can be concluded that H0 is rejected and Ha is accepted, so there is a significant positive effect of ship maintenance on shipping safety on the training ship Rear Admiral John Lie..

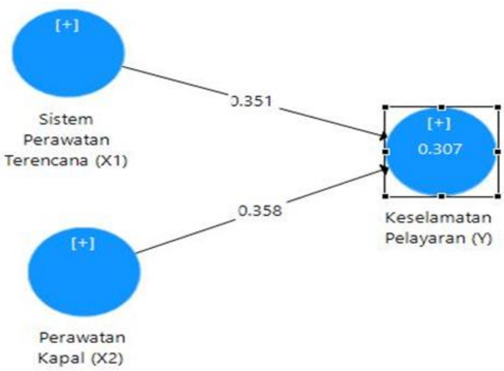

Figure 9 Structural Model *(Inner Model)*

Table 4 Path Coefficient Test & Significance of Influence

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Ship Maintenance (X2) -> Safety Shipping (Y)	0.358	0.355	0.167	2.142	**0.033**
Planned Maintenance System (X1) -> Safety Shipping (Y)	0.351	0.356	0.168	2.092	**0.037**

Source: Output Program Smart PLS 2023

Table 5 shows that the R Square value for the crew welfare variable is 0.307. This achievement explains that the percentage of crew welfare is 30.7%. This means that the planned ship maintenance system variable affects shipping safety by 30.7% and the remaining 60.3% is influenced by other variables. The R-Square value of Shipping Safety (Y) is 0.307, which means that the Planned Maintenance System (X1) and Ship Maintenance (X2) are able to influence Shipping Safety (Y) by 30.7%.ie

The Q-Square value of Safety of Voyage (Y) is 0.253. Since Q-Square = 0.253 > 0, it is concluded that Planned Maintenance System (X1) and Ship Maintenance (X2) have predictive relevance for the Safety of Voyage (Y).

It is known that based on the results of the SRMR goodness of fit test, the SRMR value = 0.036 <0.1, it is concluded that the model has FIT.

Tabel 5. R-Square

	R Square
Shipping Safety (Y)	0.307

Tabel 6. Q-Square

	Q² (=1-SSE/SSO)
Shipping Safety (Y)	0.253

Tabel 7. Goodness of Fit Model Testing

	Estimated Model
SRMR	0.036

CONCLUSION

Based on the results of data analysis, the R-Square value of Safety of Shipping (Y) is 0.307, which means that the Planned Maintenance System (X1) and Ship Maintenance (X2) are able to influence Safety of Shipping (Y) by 30.7%. Ship Maintenance (X2) has a significant effect on Shipping Safety (Y), with P-Values = 0.033 <0.05 (Hypothesis Accepted). Planned Maintenance System (X1) has a significant effect on Shipping Safety (Y),

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with P-Values = 0.037 < 0.05 (Hypothesis Accepted).

There are some suggestions are needed to improve the ship maintenance system, namely improving facilities and infrastructure in every ship maintenance activity in a planned manner in order to improve shipping safety optimally, training / drills to all ship crews in dealing with emergencies on board (drills on board ships play an important role in preparing the crew for emergency situations), implementing the ISM Code where human resources are former seafarers who have Port State Control (PSC) certificates, should inspect ships with honesty and responsibility, PSC is divided into several priorities, namely low priority, Vessels that enter the Port State area and have low priority will be supervised more intensely by the PSC than ships with other priorities, Increase the motivational role of the ship's captain (Captain of the ship) and for all crew members who work on board to be consistent in applying international safety management rules (International Safety Management Code) which have been established by an international maritime organization called IMO (International Maritime Organization).

REFERENCES

Ansori, M. (2020). *Metode Penelitian Kuantitatif Edisi 2*. Airlangga University Press.

PT VALLIANZ OFFSHORE MARITIM. (2018). Head Office Procedure Manual.

Presiden Republik Indonesia. (2020). Penataan Ekosistem Logistik Nasional (p. 3).

Willy, Abdilah dan Hartono, Jogiyanto. 2015. *Partial Least Square* (*PLS*) – *Alternatif Structural Modeling* (*SEM*) *dalam penelitian bisnis*. Penerbit Andi: Yogyakarta.

Chin dalam Jogiyanto dan Willy. (2015). Validitas diskriminan ditentukan dengan melihat cross loading factor dari setiap variabel.

Ghozali. (2014). OuterModel dapat menjelaskan bagaimana setiap blok indikator berhubungan dengan variabel letennya.

Gunawan, I., (2013), Metode Penelitian Kualitatif. Bumi Aksara, Jakarta.

Kurniawan, F., (2013), Manajemen Perawatan Industri, Graha Ilmu, Yogyakarta.

Layuk, A. A., (2021), Penerapan Sistem Manajemen Perawatan Kapal dalam Menunjang Kelancaran Pengoperasian Kapal MT. CATUR SAMUDRA. Venus Journal, 9(1), 9–15.

Mekarisce, A. A., (2020), Teknik Pemeriksaan Keabsahan Data pada Penelitian Kualitatif di Bidang Kesehatan Masyarakat. Jurnal Ilmiah Kesehatan Masyarakat: Media Komunikasi Komunitas Kesehatan Masyarakat, 12(3), 145–151.

NSOS, T. T., (2018), Manajemen Perawatan dan Perbaikan Kapal, Direktorat Jendral Departemen Perhubungan, Jakarta.

IMO. (n.d.). International Maritime Organization. https://www.imo.org/

IMO. (2004a). SOLAS; Chapter V, Regulation 19 Carriage requirements for shipborne navigational systems and equipment.

SOLAS *Consolidate Edition* (2018). Diakses dari SOLAS-Consolidated-Edition-2018.docx.pdf (seamanmemories.com)

ISM Code. (2019). Sekilas Tentang ISM Code & PM 45 Tahun 2012 Tentang Manajemen Keselamatan Kapal. http://blog.docking.id/sekilas-tentang-ism -code-pm-45-tahun-2012-tentang-manajemen-keselamatan-kapal

Jogiyanto. (2013). Pengujian reliabilitas dapat dilihatberdasarkan nilai Chonbach’s alpha harus lebih dari 0,6 dan nilai composite reliability harus lebih dari 0,7.

Koji Sekimizu. (2010). STCW A GUIDE FOR SEAFARERS.

Managing Director WALLEM SHIPMANAGEMENT. (2010). Shipboard Management Manual -

Part 1. In Organization (p. 42).
Panduan Penulisan Proposal Hasil Penelitian Tesis. (2019). Univesitas Sam Ratulangi, Manado: Sulawesi Utara.
Anantharaman, M., & Lawrence, N., (2013), Develop a Condition Based Maintenance Model for a Vessel's Main Propulsion System and Related Subsystems, Marine Navigation and Safety of Sea Transportation: Maritime Transport & Shipping, 235-238.