

The Effect of Ship Docking Variable Configuration on Ferry Docking Time

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Abstract. One of the strategy models in maintaining the financial performance company that operates Ferry Ro-Ro is through increasing revenue and optimizing company expenses by creating cost efficiency. Maintenance cost especially ship docking cost is the second-largest company expense because to meet with regulatory requirements for all passenger ships such as Ferry Ro- Ro must be conducting docking work every year. Efficiency docking costs can be conducted by decreasing ship docking time thus decreasing ship docking cost and also could increase ship availability days to deliver operational excellence and maintain customer service levels. Optimizing ship docking time could be conducted by analyzing variable influence to ship docking time. The goal of this study is to discover factor characteristics that influence work time of docking work for ships by considering management perspective through questionnaires from Indonesia's largest Ferry Ro-Ro company. Management assessment also aims to conduct weighting of variables then analyzed with Analytic Network Process (ANP) methods using Superdecision software. The result shows five priority variables that influence on docking time of Ferry Ro-Ro such as the age of the ship variable, the ship length variable, the steelwork variable, the work of engine variable, the propulsion work variable based on management perspective. Furthermore, the priority variables used to build variable configurations variation models by combining one variable with another variable until formed 25 configuration variable variation models. The variable configuration variation model was tested using sample data from 72 Ferry Ro-Ro ships owned by PT. ASDP Indonesia Ferry (Persero) with linear regression and multiple linear methods using Minitab software that aims to get the combination of variables that most affect on docking time of Ferry Ro-Ro ships. The analysis result shows that Ship Docking Variable Configuration (SDVC) models with configurations consisting such as the age of the ship variable, the ship length variable, the steelwork variable, the work of engine variable, the propulsion work variable have become the most influential configuration variables on ship docking time with a level of significance of 71,30%. The outcomes of the configuration variable identification could become management consideration for implementing planned maintenance management which aims to reduce the amount of work that must be done at the time of ship docking by optimizing docking work before ship conducting docking without affecting the ship's operating day especially on steelwork, overhaul work & propeller work for a ship that has old age and has long dimension. Planned maintenance implementation, especially on steelwork, engine overhaul work, propeller work on older ships with large dimensions can make the company create plan material and labor needs at an optimal cost and also make long term relationships with suppliers thus could increase management opportunities to achieve economies of scale in the ship maintenance supply chain process. This result is also expected can enrich the literature on ship docking management and contribute to Ferry Ro-Ro company to minimize potential delays in docking time then could increase ship operating days thus increasing the company revenue and corporate performance.

Keywords: Ship Docking Time · Ship Docking Variable Configuration · Analytic Network Process · Linear Regression · Multiple Linear Regression

1 Introduction

Ship docking is an annual maintenance and inspection activity carried out to prove that the ship meets the standard technical conditions according to the requirements of the Ship Classification Agency [15]. Biro Klasifikasi Indonesia (BKI) as the Ship Classification Agency in Indonesia has regulated that ships carrying more than 12 (twelve) passengers must carry out an annual inspection (annual survey) and inspection of the bottom (bottom survey) or docking by not exceeding the limit that has been set with a time interval limit of every year (BKI, 2014) (Fig. 1).

Another regulation in Indonesia has also regulated for docking schedule of passenger ships must be carried out every year and cannot be extended (Ministry of Transportation, 2017). Ship docking time is the duration of the ship when it is in the shipyard, where the ship repairs, besides conducting repair work also to meet regulation compliance by regulator [6]. Research data conducted by [6] shows that types of ship such as General Cargo Vessel, Bulk Vessel, Chemical Vessel, Liquid Petroleum Gas Vessel, Car Carrier, Crude Oil Vessel, Container Vessel, Liquefied Natural Gas (LNG) Carrier, and Dredger require an average docking time of 6–9 days as shown in Fig. 2. Optimum maintenance scheduling is needed to increase ship availability [2].

Based on the realization data on the implementation of docking by the biggest Ferry Company in Indonesia, PT. ASDP Indonesia Ferry (Persero), as shown in Fig. 3 that Ferry Ro-Ro ship still needs an average of 25,27 days in carrying out ship docking.

Comparison of the total docking time requirement between Ferry Ro-Ro and another ship type which are only required to carry out docking every 3–4 years [6, 19, 20] and to



Fig. 1. Ship docking process [15]



Fig. 2. Average docking time based on the ship type [6]



Docking Time of Ferry Ro-Ro

Fig. 3. Average docking time of Ferry Ro-Ro (ASDP, 2021)

carry out the renewal of certification every 5 years by the Ship Classification Agency [2, 4] with an average docking time was 9 days as the comparison data is shown in Fig. 4. The comparison data show that Ferry Passenger ships require 7 times longer docking time (a total of 126 days) than another ship type (a total of 18 days) in 5 years period.



Fig. 4. Comparison docking time between Ferry Ro-Ro ship and another ship type

The regulatory requirement that requires companies to carry out docking of ships every year and the duration of docking of ships which still require a relatively long time compared to another ship type make increasing docking cost of Ferry Ro-Ro ships.

In addition, Ferry Ro-Ro ships also have possible damage during operation that causes decreasing ship operation days. This shows that passenger ships have a lower operation day than other ship types, thus decreasing company revenue and corporate performance.

Previous research has figured out that the duration of docking time for various types of vessels such as Tanker, General Cargo, Bulk Vessel, Container Vessel, LNG Carrier, Dredger and Fishing Vessel, is influenced by several variables such as ship age, type of ship, deadweight [6], Gross Tonnage [5], steelwork [5, 8, 22], painting work [11, 22], blasting work [5, 22], pipeline work [6] and propeller work [22]. These variables affect docking time and docking cost [6] as part of ship operational cost [4].

Taking into account the description above and related research, the authors conducted research to identify and analyze variables that affect docking time, especially on Ferry Ro-Ro ships apart from variables that have been carried out in previous research on Tankers, General Cargo, Bulk Vessel, Container Vessel, LNG Carrier, Dredger and Fishing Vessel, as shown in Fig. 5.

The identification of variables that affect the docking time of Ferry Ro-Ro ships become an important thing to do to mitigate the influence of potential variables that could become management consideration for implementing planned maintenance management which aims to reduce the amount of work that must be done at the time of ship docking by optimizing docking work before ship conducting docking without affecting the ship's operating day which will indirectly increase the company revenue and corporate performance. Good docking management can significantly increase revenue and efficiency [3].

Furthermore, this study is likely to contribute to the growing the body of knowledge on ship docking which has been carried out in previous studies on another ship type such as Tankers, Car Carriers, Crude Oil Tankers, Container Tankers, LNG Carrier, Dredger, and Fishing Vessel, but there has been no research related to the docking time of Ferry Ro-Ro.



Fig. 5. Comparison docking research based on ship type

2 Literature Review

Several studies have been carried out related to the docking of several types of ships such as Tanker, General Cargo, Bulk Vessel, Container Vessel, LNG Carrier and Dredger using various variables and methods.

Research related to dry docking conducted by Alhaouli on 24 vessels of Tanker, proposes a model for scheduling ship docking implementation. The analysis process uses the Integer Programming approach with LINGO software. The results showed that the model used can increase the operational availability of ships up to 92% [2].

Another study was carried out by Apostolidis on 414 Tanker ships uses generalized method of moments (GMM). This research aims to develop a docking cost model using the variables of ship type, ship size, and ship age [4].

Research related to the method of reducing ship docking cost was carried out by [19] through optimizing cooperation between companies involved in the curing process. The analysis process in this study applies Game Theory and The Shapley Value methods.

Research related to the implementation of ship docking was also carried out on several different types of ships on 8 ships with the type of ship consisting of 6 (six) Car Carrier, one LPG Carriers, and one Bulk Carriers. The research was conducted focusing on the analysis of docking costs [10]. This study aims to obtain cost efficiency or reduce the cost of docking ships.

Other research discusses the docking process at shipyards by proposing a project management tool that can be used for ship repair and maintenance processes. Improvement in the unpredictable work order process by providing better communication between the companies involved thus providing cost efficiency and process effectiveness [13].

Research on the estimated time of docking the ship is also carried out using other methods such as regression (CART) used to analyse data mining [23]. In this study, the limitation of the docking work volume is used to estimate the docking work time. This research produces a linear model to calculate work time of docking work according to work classification.

Research on the cost of docking ships was also carried out on 71 Container Carrier ships using the variables of ship size, ship age, ship type, docking time using the Generalized Method of Moments (GMM) method [1]. The goal of this research is to see how these variables affect the cost of repair Container Carrier ships.

Other research related to ship docking was carried out using a larger number of test vessels, namely 600 vessels of various types. Analyze the influence of predetermined factors on the time of docking the ship [6]. The variables that have been determined are the age of the ship, the size, and the type of the ship and analyzed uses MLS which is used in estimating the coefficient in the process of regression analysis.

Research related to the cost of docking work for one ship is also carried out uses GST method [20]. The variables used in this research are the type of work from the beginning of the process to the final stage of the docking process.

Research on the process of docking the ship is also carried out using data obtained by the largest shipyard in Indonesia in seven years. This study aims to propose an algorithm that can be used to estimate the time required for docking ships using the Numerical Ant-Colony Decision Tree (nACDT) method which combines the Classification and Regression Tree (CART) method with the Ant-Colony Optimization (ACO) method [22]. This study uses the "Method of Least Square" followed by regression analysis. The results of this study also propose a mathematical model that can be used by decision-makers in making decisions related to determining the estimation of labor requirements in ship docking work.

Research on the cost of docking ships is carried out by analyzing the need for labor in units of the number of people per day from 50 cargo ships [7]. Variables used in this study such as ship size (deadweight), ship age, and ship type are taken from one shipyard. This study uses the "Method of Least Square" followed by regression analysis.

Furthermore, research related to ship docking was also carried out on 600 cargo ships by analysing the impact of various factors on work time of ship repair and developing research by analyzing variables that affect the need for labor per day [8]. Research on the time and need for labor per day for docking work use three variables such as ship age, ship size, and type uses regression. This study also proposes a mathematical model combining the time factor and the need for labor per day of docking work.

Another study was conducted by [3] by proposing a model that can support decision- makers in preparing the schedule of preventive maintenance on the ship that is needed during docking. The proposed model consists of several limitations such as the maintenance window, maintenance completion, ship limit constraint, and budget constraint.

Research on the docking process carried out by [11] used 43 vessels with the Fishing Vessel type, 30 vessels with Oil Tanker, 51 vessels with the Multipurpose Cargo Ship, 40 vessels with Warship, 11 ships with the Dredger/Barge, and 15 tug boat. The goal of this research is to investigate the cost of labor requirements in the process of carrying out ship docking with the variables used, namely ship age, deadweight, ship type, displacement, and variations in the type of work. This study uses the Multiple Regression Linear statistical method to determine the effect of the variables that have been determined on the cost of labor requirements in the ship docking process.



Fig. 6. Comparison docking research based on ship type

Research on the ship docking process was also carried out by [9] using several types of ships consisting of 315 ships with Bulk Carrier ships, 339 ships with the Tanker ship. The analysis process is carried out in stages, namely, the first analysis is carried out on 315 Bulk Carrier ships, then a second analysis is carried out on 339 Tanker ships, and finally, an analysis is carried out with a combined number of 654 ships consisting of Tanker and Bulk Carrier which uses regression with two alternative analysis tools, namely Microsoft Excel an Matlab software.

Research on ship docking using several types of ships was also carried out by [5] using 586 ships with several type of ships. The goal of this research is to see how variables affect the working time of docking work of the ship and proposes model that can be used to estimate the time required for ship docking. The method used in the the analysis process of this research is Multiple Linear Regression.

Research on the docking time of Bulk Carrier ships was carried out by [12] using 108 ships. This study aims to propose an analytical function to analyze the time variable on the work carried out during ship docking. The method used in this research is regression.

Research conducted by [14] in conducting research related to the process of docking is carried out in two stages. In the first stage, researchers conducted research related to decision making in the selection of docking locations through qualitative variable analysis using the Analytic Hierarchy Process (AHP) method and with several predetermined criteria such as meteorological conditions, logistics, damage, work conditions, and price. In the second stage, the researcher also conducted a quantitative analysis of variables using data on 13 vessels with the Chemical Tanker ship and 16 vessels with the Roll-on/Roll-off (Ro-Ro) ship. The goal of this research is to propose model used in managerial assessment dry-docking performance.

Based on the results of the literature study as described above and the summary as shown in Fig. 6, the goal of this research is to determine the cause of various factors on work time of docking work for ships, especially Ferry Ro-Ro ships that have not been carried out by previous research on another ship type.

3 Methods

3.1 Literature Review

The first step in the research process is to conduct a literature review which aims to obtain references related to the categories of variables and methodologies that have been used in previous studies.

3.2 Research Variable

Table 1 shows the factors that were employed in this study.

This study uses variables that have been used in previous studies such as ship age, ship length, ship width, deadweight gross tonnage, plate work, blasting work, painting work, propeller work, and valve work. Additional variables that have not been used in previous research and will be used in this study such as lightship variables, dry-dock time accuracy variables since the ship arrived at the shipyard, and engine overhaul work variables.

Variable	Unit	Variable Code	
Docking Time Variable	Day	Yt	
Ship Age Variable	Year	X1 (UK)	
Length Overall Variable	m	X2 (LOA)	
Breadth	m	X3 (B)	
Gross Tonnage Variable	GRT	X4 (GT)	
Engine Overhaul Work Variable	Horse Power (HP)	X5 (HP)	
Dry-docking Time Accuracy Variable	Day	X6 (KWND)	
Deadweight Variable	Ton	X7 (DWT)	
Lightweight Variable	Ton	X8 (LWT)	
Steelwork work Variable	Kg	X9 (SW)	
Blasting Variable	m2	X10 (BW)	
Painting Variable	m2	X11 (PW)	
Propeller Work Variable	Unit	X12 (PplW)	
Valve Work Variable	Unit	X13 (VW)	
Piping Work Variable	m	X14 (PpiW)	

Table 1. Research Variable

3.3 Building Variable Network Model

The second stage is to develop a network model of the relationship between variables and the relationship of variables to the docking time of Ferry Ro-Ro as shown in Fig. 7. Furthermore, conduct an assessment from the management of PT. ASDP Indonesia Ferry (Persero) aims to do the weighting and determine the variables that affect the docking time of Ferry Ro-Ro based on management assessment.

3.4 ANP Analysis

ANP analysis used to analyze the results of filling out questionnaires or management assessments that aim to determine the effect of variables on Ferry Ro-Ro docking time.

3.5 Determine Priorities Variable

The next stage is to determine 5 (five) priority variables that affect the time of Ferry Ro-Ro docking based on management's assessment.

3.6 Building Variable Configuration Variation Models

The priority variables that have been obtained in the previous step are then used to model variations in variable configurations with various models ranging from 1 (one) variable

Configurati	on	Variable	Variable Configuration Variation Model		Qty
variable	2	Yt	vs	X1 (UK) + X2 (LOA)	
				X1 (UK) + X9 (SW)	
				X1 (UK) + X5 (HP)	
				X1 (UK) + X12 (PplW)	
				X2 (LOA) + X9 (SW)	
				X2 (LOA) + X5 (HP)	10
				X2 (LOA) + X12 (PplW)	
				X9 (SW) + X5 (HP)	
				X9 (SW) + X12 (PplW)	
				X5 (HP) + X12 (PplW)	
	3	Yt	vs	X1 (UK) + X2 (LOA) + X9 (SW)	
				X1 (UK) + X2 (LOA) + X5 (HP)	
				X1 (UK) + X2 (LOA) + X12 (PplW) X2 (LOA) + X9 (SW) + X5 (HP)	6
				X2 (LOA) + X5 (HP) + X12 (PplW)	
				X9 (SW) + X5 (HP) + X12 (PplW)	
	4	Yt	vs	X1 (UK) + X2 (LOA) + X9 (SW) + X5 (HP)	
				X1 (UK) + X2 (LOA) + X9 (SW) + X12 (PplW) X2(LOA) + X9 (SW) + X5 (HP) + X12 (PplW)	3
	5	Yt	vs	X1 (UK) + X2 (LOA) + X9 (SW) + X5 (HP) + X12 (PplW)	1

 Table 2.
 Variable Configuration Variation Models

to 5 (five) variables so that 25 models of variable configuration variations are formed as shown in Table 2.

Variations in the configuration of variables that have been modeled then tested using docking data of from Indonesia's largest Ferry Ro-Ro company uses 72 ships sample amount.



Fig. 7. Variable Network Model

3.7 Regression Analysis

The variable configuration model that has been formed is then analyzed using the Linear Regression and Multiple Linear Regression methods to analyze the relationship between the dependent variable and single and multiple variables [21]. The results of the analysis of sharing models of single variable configuration variations and multiple variable configurations that meet the parameters of classical assumption testing and partial or simultaneous regression hypothesis testing are then grouped into Ship Docking Variable Configuration (SCDV) which is a variable configuration variation model that affects the docking time of Ferry Ro-Ro.

4 Result

4.1 Weighting Result (ANP)

The results of the variable weighting analysis according to management perspective uses ANP show that impact level of a single variable on the docking time of the Ferry ship in order of the greatest level of influence starting from the age of the ship with a level of influence of 46.10%, the variable length of the ship with a level of influence of 18,50%, job variable steelwork with an influence level of 9%, ME&AE overhaul work variable with an influence level of 4.90%, propeller work with an influence level of 4%, ship width variable with an influence level of 2%, deadweight variable with an influence level of 2% and accuracy variable docking time, lightweight, blasting work, painting work, valve work, and piping work with each effect level of 1.9%.

The finding of ANP study demonstrate that work time of docking work is influenced by five key factors of Ferry Ro-Ro, namely the age of the ship variable, the ship length variable, the steelwork variable, the work of engine variable, the propulsion work variable have each variable's degree of impact as shown in Fig. 8.



Fig. 8. Priority variable and the level of influence of the variable on the docking time of Ferry Ro-Ro



Fig. 9. Normality Test Result

4.2 Regression Analysis

4.2.1 Normality Test

The results of the normality test with a significant level of 0.05 as the first stage of testing classical assumption showed that 24 variable configuration models met the criteria with a p-value > 0.05 as shown in Fig. 9. Normality testing aims to ensure that the distribution of data between variables is normal.

4.2.2 Multicolinerity Test

The second test on the classical assumption test is the multicollinearity test which aims to ensure that there is no multicollinearity between variables. Test results show that all configuration models have met the acceptance criteria for the multicollinearity test with a VIF value < 10 as shown in Fig. 10.

4.2.3 Heteroscedasticity Check

The third step is heteroscedasticity check. The outcome of the test were carried out by observing the scatterplot the graph shows that there are 23 variable configuration models

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Fig. 11. Heteroscedasticity Check Result

that meet the criteria for acceptance of the heteroscedasticity test (irregular distribution of data) and there are 2 variable configuration models that do not meet the configuration x^2 and configuration x^{12} with the data distribution of the 2 configuration models being regular as shown in Fig. 11.

4.2.4 Autocorrelation Check

Autocorrelation check aims to ensure that there is no autocorrelation between variables. The test results show that in 25 models the variable configuration has met the acceptance criteria for the autocorrelation test ($dU \le d \le 4$ -dU) as shown in Fig. 12.



Fig. 12. Autocorrelation Check Result

4.2.5 Hypothesis Test

The fifth test on the classical assumption test is hypothesis testing with a significant level of 0.05. The results of hypothesis testing show that 23 variable configuration models meet the criteria for accepting the hypothesis test (p-value 0.05) and 2 variable configuration models do not meet the test, such as configuration (x_2,x_{12}) and configuration (x_2) as shown in Fig. 13.

The test results according to the statistical criteria show that 21 configuration models meet the criteria. The next step is to test the level of influence of the variable configuration model on the docking time of Ferry Ro-Ro using the coefficient of determination test. Test results of coefficient of determination show that the variable configuration variation model has a different level of influence with the lowest level of influence being influenced by the configuration model (x5) and the model with the highest level of influence is owned by the configuration model (x1,x2,x9,x5,x12) with the level of influence is 71.30% as shown in Fig. 14.



Fig. 14. Determination Coefficient



Fig. 15. Variables configuration that affect to docking time of Ferry Ro-Ro

5 Discussion

5.1 Ship Docking Variable Configuration

Variable configuration variable models that have met statistical rules and have been tested for the level of influence on the docking time of the Ferry Ro-Ro ships are then grouped as Ship Docking Variable Configuration (SDVC) from the lowest configuration effect level to the high trough influence level as shown in Fig. 15.

The variable configuration model that has the highest level of influence can be a consideration for the company's management in managing the docking of the Ferry Ro-Ro ships more efficiently. The configuration model with the highest level of influence is the configuration model which consists of a combination of variables consisting of combination of ship age variables (x1), ship length variables (x2), steelwork work variables (x9), engine overhaul work variables (x5) and work variables. Propeller (x12) with the following regression model:

$$Yt = 3.64 + 0.2643 x1 + 0.3297 x2 + 0.000488 x9 - 0.002247 x5 + 0.772 x12$$
(1)

The configuration model $(x_1, x_2, x_9, x_5, x_{12})$ has an influence level of 71.30% which means that 71.30% of the docking time of Ferry Ro-Ro ship is influenced by a combination of ship age variables (x_1) , ship length variables (x_2) , steelwork work variable (x_9) , engine overhaul work variable (x_5) and propeller work variable (x_{12}) , with 28.70% influenced by other variables not discussed in this study as shown in Fig. 16.

The configuration model that has the greatest influence and is grouped as Ship Docking Variable Configuration (SDVC) is the configuration model (x1,x2,x9,x5,x12) formed from a combination of ship age variable components (x1), ship length variable (x2), steelwork variable (x9), engine overhaul work variable (x5), the propulsion work variable (x12) have determination coefficient (r-square) of 71.30% indicating that the formed SDVC has a very significant level of influence strong against docking time and regression equation model as Eq. (1).

The formed SDVC model has a determination coefficient (r-square) of 71.30%. The determination coefficient of 71.30% of the formed SDVC indicates that the docking time



Fig. 16. Significance percentage of the SDVC influence on docking time of Ferry Ro-Ro

of the ship is influenced by the formed SDVC. This shows that the formed SDVC has a very strong influence on the docking time of the ship as shown in Figs. 4 and 5.

6 Conclusion

According to the analysis process uses ANP, it can be concluded that from the assessment that has been carried out, it is obtained 5 (five) priority variables that affect the docking time of Ferry Ro-Ro, namely ship age variables (x1), ship length variable (x2), steelwork variable (x9), engine overhaul variable (x5), the propulsion work variable (x12) have impact level as shown in Fig. 17.

The results of the regression analysis show that the configuration model that has the greatest influence and is grouped as Ship Docking Variable Configuration (SDVC) is



Fig. 17. Significance percentage of the SDVC influence on docking time of Ferry Ro-Ro



Fig. 18. Ship Docking Variable Configuration (SDVC) of Ferry Ro-Ro

the configuration model $(x_1, x_2, x_9, x_5, x_{12})$ formed from a combination from ship age variables (x_1) , ship length variable (x_2) , steelwork variable (x_9) , engine overhaul variable (x_5) , the propulsion work variable (x_{12}) have determination coefficient (r-square) of 71.30% indicating that the formed SDVC has a very significant level of influence strong against docking time and regression equation model as follows:

Yt = 3.64 + 0.2643 x1 + 0.3297 x2 + 0.000488 x9 - 0.002247 x5 + 0.772 x12(2)

The Ship Docking Variable Configuration (SDVC) as shown in Fig. 18 that was formed considered the management that in planning the estimated docking time of Ferry Ro-Ro, the dominant variables had to be considered namely ship age variables, variable ship length, the steelwork variable, engine overhaul variable, the propulsion work variable.

7 Managerial Implications

The results of the identification of the influence of variables also become the basis for determining steps for implementing strategic maintenance management such as the basis for implementing planned ship maintenance management which aims to reduce the amount of work that must be done at the moment of the ship's docking through the management of the implementation of work on the operating trajectory without affecting the ship's operating day in particular for factors that have a considerable impact to the time of docking work for ships thus increases the effectiveness of docking management because the work carried out during docking is only focused on meeting the certification requirements by the Ship Classification Agency to minimize the need for work time of docking work for Ferry Ro-Ro. The analysis finding are likely to be taken into account by business management to mitigate in the planning process which aims to improve the management of ship docking work through the planning process the need for goods and services for docking work which is carried out in a planned manner to find suppliers who meet the criteria for both quality and quantity of costs determined by the company to increase opportunities for the company to achieve economies of scale in the supply chain process for ship maintenance.

The implementation of management strategy in the docking planning process according to analysis process can make consideration to decrease maintenance cost and unpredictable level for ship damage as well as reduce the time required for the implementation of ship docking to increase the company's competitiveness by increasing ship operations readiness, which will indirectly increase revenue company and corporate performance.

The combination of variables in the SDVC such as the combination of ship age variables with ship length variables and steelwork variables makes management need to consider the risk of ship docking time delays through more accurate work planning, especially for steelwork planning for ships that have relatively old age and with the dimensions of the ship getting bigger. The ship age variable also provides other considerations for management that in procuring a fleet of ships, in addition to considering the advantage factor in the business aspect so that the operational performance of the ship can meet business demands and with relatively low maintenance costs.

Management also needs to consider ME&AE overhaul work by taking strategic steps such as collaborating with various ship engine spare parts suppliers to ensure the availability of spare parts in collaboration with ME&AE overhaul service contractors in ensuring that maintenance up to the implementation of ship engine overhaul can be carried out optimally and pay attention to time limits. Ship maintenance and operating schedules.

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