



Analysis of the Suboptimal Performance of the Steering Gear on MT. Narpatisuta

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Abstract

The steering gear is one of the auxiliary machineries on board a ship that is used to move the ship's rudder, allowing the ship to turn to the right or left. This machinery utilizes an electro-hydraulic system, which combines electric and hydraulic technologies to control the ship's steering direction. The research focuses on analyzing the suboptimal performance of the steering gear on the MT. Narpatisuta. The objectives of the research are to identify the factors causing the suboptimal performance of the steering gear, the impacts resulting from this suboptimal performance, and the efforts made to address the suboptimal performance of the steering gear on the MT. Narpatisuta. The research method used is a qualitative descriptive method, with data collection techniques in the form of observation, interviews, documentation and literature study. The data analysis technique uses the SHEL method. Test the validity of the data using triangulation. The research results show that suboptimal performance of the steering gear is caused by hydraulic pipe leaks, deteriorating quality of hydraulic oil, and damage to seal and o-ring components, which lead to reduced steering gear performance, slower rudder movement, and can disrupt ship operations, endangering crew safety and the ship's cargo. Efforts that can be made to remedy this include routine inspection and maintenance of the steering gear and its components. Thus, this research emphasizes the need for routine inspection and maintenance to prevent these problems which must ensure maximum steering gear function, maintain safety and ship operational efficiency.

Keywords: Analysis, Steering Gear, Propulsion, Ship

1. Introduction

The diversity of marine resources in Indonesia is the main focus in exploring economic potential and sustainability. An in-depth analysis of the fisheries, marine and marine energy potential sectors will provide a holistic picture of the contribution of marine resources to the national economy. With very wide waters, it is one of the developing means of transportation in the sea dimension. Sea transportation plays an important role in Indonesia's connectivity because this country consists of thousands of islands. Sea transportation is a form of transportation that operates on the sea to facilitate activities in delivering goods or making national and international crossings [1]. Sea transportation

includes various types of ships including passenger ships, cargo ships, fishing ships, tankers and others.

A tanker (Motor Tanker) is a ship designed to transport oil or its derivative products. Tankers usually have designs specifically designed to handle liquid cargo efficiently and safely, including tanks designed according to the type of cargo being transported, powerful pumping systems, and sophisticated safety equipment. The MT Narpatisuta ship is a ship owned by the company PT Segara Laju Perkasa which was inaugurated in 2019 (IMO 9890458, MMSI 525500606). The ship has a total length of 90 meters with a GT of 2938. MT Narpatisuta carries cargo of oil products such as B30, Peralite, and Pertamina on the Tual Oil Fuel Terminal (TBBM) or TBBM Wayame loading

port route and the TBBM Saumlaki, Dobo, Kaimana, Fak-Fak, and Bula.

In operating a ship, the support of a competent and responsible crew is required because on board the ship there are many important components in its operation which, if hampered, will hinder the operation of the ship, so crew members (ABK) are needed who can carry out shipping operations under any conditions. One of the ship machinery equipment that plays an important role in ship operation is the steering gear or also known as the steering engine. The steering engine itself functions to help move the ship's rudder to turn to the left (port side) and to the right (starboard side) [2]. The steering engine must be capable of turning the rudder from an angle of 35° on one side to an angle of 35° on the other side when the ship is at its deepest draft and traveling at maximum forward service speed and, under the same conditions, from an angle of 35° on both sides to an angle of 30° on the other side in no more than 28 seconds [3].

Ship machinery is all the machinery on board the ship to support the operation of the ship [4]. The MT Narpatisuta ship itself has a rams type steering gear with hydraulics as the operating system. A hydraulic system is a system that transmits power using liquid fluid [5]. The basic principle of a hydraulic system is to take advantage of the properties of liquids, namely that their shape is not fixed, but can adjust to where they are placed. Liquids are incompressible because the pressure they receive is transmitted evenly in all directions.

Hydraulic systems are often applied to obtain a force that is greater than the initial force released by the conducting fluid. The pressure is increased by a pump which is then transmitted to the working cylinder through pipes and valves [6].

The translational movement of the piston rod of the working cylinder caused by fluid pressure in the cylinder chamber is used for forward and backward movement as well as up and down according to the installation of the cylinder, namely in the horizontal and vertical directions. As time progressed, hydraulic systems began to be applied in several machines or vehicles, one of which was sea transportation, namely ships. The hydraulic system on a ship functions as a means of transmitting power through fluid (usually hydraulic oil) to control various equipment and systems on the ship. The rotor and blades are connected in the housing, and when the oil flows forward, the oil pushes the propeller disc and by pressing the fins on the rotor so that the propeller blades can rotate at a certain angle, if the direction of flow is reversed then the propeller blades will rotate in that direction. opposite or vice versa [7]. The basic working principle of a hydraulic system involves the application of Pascal's law which states that the pressure applied by a fluid at a point in a closed fluid will propagate throughout the fluid and to the walls of the container without decreasing, as long as there is no change in the cross-sectional area of the container.



Fig.1. Electro-hydraulic Steering Gear

Based on this description, the activities carried out were identifying dangerous risks and operating the steering gear while the

researcher was carrying out marine practices, therefore the researcher carried out this research by taking the title "Analysis of the

Suboptimal Performance of the Steering Gear on MT Narpatisuta". The aim is to find out the factors that cause the steering gear to not work optimally in MT. Narpatisuta, the impact that occurred, and efforts to overcome it.

2. Materials and Methods

This research aims to analyze the non-optimal working of the steering gear at MT Narpatisuta, starting to find out the causal factors, impacts, and efforts to overcome them. The researcher will explain several methods in this research starting from the approach, research setting, data collection techniques, data analysis techniques, and data validity testing.

2.1 Methods

Research methods are science that discusses procedures or paths in connection with the research carried out, which has systematic steps including research procedures and research techniques [8]. Methods refer to techniques used in research based on data collection to find solutions to a problem and scientific activities carried out systematically to solve research problems [9]. In this research, researchers used qualitative research methods with a descriptive type. Descriptive qualitative method is a type of qualitative research that collects and analyzes information in the form of words, images, and not numbers. This strategy is where the researcher investigates phenomena in the lives of individuals and asks someone to tell their life story which is then retold by the researcher in a descriptive chronology.

2.2 Research Setting

This research was carried out on the MT Narpatisuta ship from August 2022 to August 2023. This ship operates in eastern Indonesia with a cargo of oil products owned by PT Segara Laju Perkasa. This ship has a crew of 20 consisting of 4 deck officers, 4 engine officers, 1 bostwain, 3 helmsmen, 3 oilers, 1 chef, 1 engine cadet, and 3 deck cadets.

2.3 Data Collection Techniques

Data collection techniques or methods are part of the process of carrying out research, because the purpose of research is to find or

obtain the data to be studied. Data collection techniques are an important component in conducting research because the main goal is to obtain data to support research [10]. This research uses data collection techniques in the form of observation, interviews, documentation and literature study. Observation is collecting data directly in the field accompanied by recording so that the data obtained is specific. Researchers directly observed problems with the steering gear which did not work optimally due to several factors. An interview is a question and answer activity regarding several individuals who are related to the problem to be discussed in order to ask for information related to the problem and provide solutions. Researchers in this study conducted interviews with the Chief Engineer. Furthermore, documentation becomes a data collection technique by collecting a number of copies of documents needed for research according to the steering gear object at MT Narpatisuta. Researchers obtained documents regarding the steering gear through the manual book on the ship. Finally, literature study, which involves collecting data by looking for theoretical bases and references to conduct a general review of published literature on various topics. In this research, researchers used library sources in the form of books, journals, encyclopedias, magazines and documentation regarding steering gear.

2.4 Data Analysis Techniques

Data analysis techniques are a process of searching for data, analyzing the data and then compiling it systematically from documentation, field notes and then making it into one data, breaking it down into several categories, then synthesizing it and making conclusions that can be shared with others [11]. Qualitative data analysis is a process of filtering data originating from the data collection process, namely recording and note-taking, literature review, interviews, and participation [12]. In this research, researchers used the SHEL method. The SHEL method is a method for collecting data on marine transportation incidents. The SHEL method studies several interactions including Software, Hardware, Environment, and Liveware.

2.5 Data Validity Testing

Data collection techniques must be checked for the validity of the data. Data obtained from a party must be checked for validity by obtaining information from several other sources. Researchers in this study obtained supporting data using the triangulation method. Triangulation can be interpreted as a data collection technique by combining data from various existing data collection techniques and data sources [13]. The triangulation technique in this research can be used to check the validity of data through other sources by checking data contained in literature studies and several existing book or journal references. Next, the researchers studied the results of observations obtained during the research period to evaluate the performance of the steering gear. The data obtained is then checked using observation or documentation. By using this technique researchers can compare the results of observations with the results of interviews, as well as what people say in public with what they say in private.

3. Results

Based on the results of observations, interviews, documentation and literature study, the following are some of the findings that researchers obtained:

3.1 Factors that cause the steering gear to not work optimally

a. Software

1. Human negligence regarding the Plan Maintenance System (PMS)

Plan Maintenance System (PMS) is a planned maintenance or maintenance system aimed at preventing undesirable things from happening. When researchers carried out sea practices (prala), one of the factors that caused the steering gear to not work optimally was the lack of maintenance on the system. What is meant is that checking of the steering gear is only carried out when there is a pool of oil around the steering gear, which is only known when the oiler is on duty or the cadet is carrying out periodic controls or checks.

Apart from making observations, the researcher also conducted interviews with the Chief Engineer who is responsible for all machinery in the engine room and explained

matters related to the existing manual book. The Chief Engineer also explained that maintenance procedures for the steering gear must be carried out in accordance with the manual book.

The impact of the mismatch between the Plan Maintenance System and the manual book is that the maintenance schedule becomes irregular and can only be carried out when the steering gear is not operating, causing trigger factors that cause the steering gear to not work optimally. Efforts that can be made to anticipate discrepancies in maintenance are by carrying out routine maintenance based on the Plan Maintenance System so that the steering gear can work optimally.

b. Hardware

1. There is a hydraulic oil leak in the steering gear

Hydraulic oil leaks in the steering gear can be caused by several factors, including leaks in the high pressure steering gear pipe, where this condition can cause a decrease in hydraulic pressure that is not in accordance with the parameters so that the movement of the rudder (steering leaf) becomes abnormal. Another factor that can cause the steering gear to not work optimally is a valve system that is not operating properly. What is meant by valve here is a distribution valve which functions as a regulator of the flow of hydraulic fluid which moves the rudder. In the distribution valve there is a solenoid valve and a relief valve, where the valve functions to control the flow and pressure of fluid either entering or leaving through the pipe. If the process of opening and closing the valve is not perfect, it can reduce the amount of hydraulic oil in the hydraulic cylinder that moves the vane, so that the pressure drops and the rudder movement is not optimal.

2. Decreased hydraulic pump performance

The decrease in performance of the hydraulic pump in question is the lack of suction and exhaust power from the pump and the presence of noise from the pump. This can be seen from the pressure gauge which shows the pressure is dropping. The decrease in pump performance is partly influenced by shaft seal leaks, ball bearing damage, and wear on the idle spindle, damage to the packing cover ring and slip ring surface seal as well as dirt in the

inlet area of the pump. This was based on the chief engineer's statement when researchers asked about the effect of decreasing hydraulic pump performance. The impact this causes is a decrease in steering gear pressure, so efforts are made to overcome this by repairing and checking components such as seals and o-rings.

c. Environment

1. Corrosion occurs on the steering gear components

Poor quality hydraulic oil can cause corrosion to the steering gear components. Poor quality hydraulic oil can cause rapid corrosion and even fatal component damage. Apart from carrying out observations, the researcher also conducted an interview with the Chief Engineer to further confirm the results of the observations made by the researcher that the quality of the hydraulic oil was not good enough, resulting in corrosion of the steering gear components, which resulted

in rudder movement not being optimal, thus disrupting ship operations.

d. Liveware

1. Lack of cooperation between the engine crew regarding the steering gear and other components.

While on guard duty there was no checking of the condition of the steering gear and lubrication system which resulted in no action for maintenance and replacement. This is what can result in the steering gear not working optimally. The impact of the lack of cooperation and awareness between the crew regarding the steering gear and its lubrication system is that there are many problems that occur with the steering gear because the machine is considered trivial, which means maintenance is rarely needed. So the way to overcome this is to regularly check the steering gear.

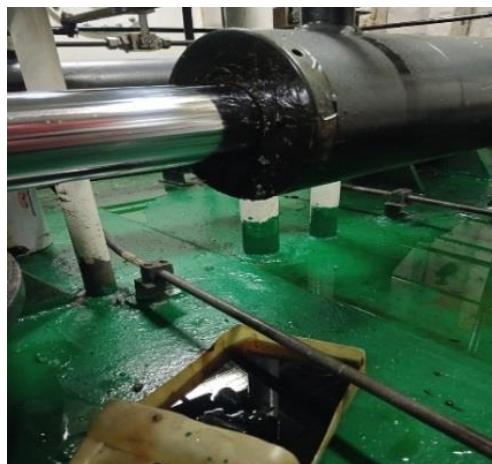


Fig.2. Leak in hydraulic cylinder

3.2 The impact that will occur if the steering gear does not work optimally

a. Software

Based on observation activities carried out by researchers while carrying out sea practices on the MT Narpatisuta ship, the impact that occurs from human negligence on the implementation of the Plan Maintenance System from a software perspective is that the steering gear lacks supervision which results in if there is a damaged component it is not repaired immediately resulting in component damage which results in disruption of ship operations such as navigation errors.

Therefore, if the Maintenance System Plan is not implemented properly, it is possible that

damage to the components will occur which will result in the steering gear not working optimally which could disrupt the smooth operation of the ship. Researchers conducted a literature study to strengthen the results of observations related to the impact of human negligence on the implementation of the existing Plan Maintenance System.

b. Hardware

Based on observations made by researchers while carrying out sea practices on the MT Narpatisuta ship, the impact of hydraulic oil leaks and wear on components such as seals and o-rings in terms of hardware is that it has quite a negative impact on the

performance of the steering gear, namely that it can lose direction in controlling the ship. The impact that occurs if there is a leak in the hydraulic oil and wear of the seals and o-rings is that the performance of the steering gear cannot be optimal, which causes this problem to become an obstacle to ship operations.

This is due to the crew's lack of attention to the steering gear, where if damage occurs it is not treated immediately and the damage can continue. Therefore, more attention is needed to anticipate hydraulic oil leaks in the steering gear and check the seals and o-rings.

Apart from making observations, the researcher also conducted an interview with the Chief Engineer to strengthen evidence and confirm the results of the observations that the researcher had made and found that the impact that occurred from hydraulic oil leaks and damage to seals and o-rings from a hardware perspective was that the steering gear was working. not optimally, this is due to leaks in hydraulic oil and damage to components so that replacement of spare parts is required and the ship is not operational.

c. Environment

Based on observations made by researchers while carrying out sea practices on the MT Narpatisuta ship, the impact that occurs from poor lubrication factors on the steering gear from an environmental perspective is because the lubrication of the steering gear does not work properly which causes the rudder movement to not be optimal and can increase the chance of damage to the steering gear components so that it can disrupt ship operations such as increased exhaust emissions resulting from inefficient maneuvering.

Apart from carrying out observations, the researcher also conducted an interview with the Chief Engineer to strengthen the results of the observations made by the researcher on board the ship, and it was found that the impact of poor lubrication on the steering gear components caused damage to the steering gear components and resulted in the work of the steering gear is not optimal so that the rudder movement is not optimal and hampers the ship's operations.

d. Liveware

Based on observations that researchers made while carrying out sea practices on the MT Narpatisuta ship, the impact that will occur from the lack of cooperation between engine crews regarding the steering gear and its components from a liveware perspective is that the Plan Maintenance System (PMS) is not achieved optimally, so that when an irregularity occurs in the operation of the steering gear it is not detected, it can the occurrence of a collision that could endanger the safety of the ship's crew and the surrounding area.

Apart from making observations, the researcher also conducted interviews with the Chief Engineer to strengthen the results of the observations made by the researcher, and it was found that the impact that occurred from the lack of cooperation between the crew from a liveware perspective was a lack of attention between the engine crew regarding the performance of the steering gear if damage occurred components so that they are not known to the engine crew. Efforts that can be made to overcome this problem are by improving communication between engine crews and frequently holding discussions about maintenance of the steering gear and each of its components.

3.3 Efforts are made so that the steering gear can work optimally

a. Software

Based on observations made by researchers while carrying out sea practices on board ships, efforts that can be made so that the steering gear can work optimally are carrying out the Plan Maintenance System which is guided by the manual book, as well as carrying out checks and replacing components on the steering gear in accordance with the planned maintenance system already made. Because the steering gear is one of the important pieces of machinery on board a ship which aims to change the direction of the ship's rudder, if the steering gear has a problem it can disrupt the ship's operations.

Therefore, it is necessary to pay more attention to the system maintenance plan to prevent undesirable things from happening.



Fig.3. Changed Oil Filter Steering Gear

Apart from conducting observations, the researcher also conducted interviews with the Chief Engineer and found the results that to overcome human negligence regarding the maintenance system plan that the crew carried out using the instruction manual book was to carry out the system maintenance plan that had been created and could be implemented in accordance with the instruction manual book, for example oil Filters that have completed 500 working hours must be maintained by replacing the oil filter with a new one and checking the components and lubrication system. To strengthen the results of observations and interviews conducted by researchers, researchers also carried out a literature study regarding the efforts made so that the steering gear can work optimal

b. Hardware

Based on observations made by researchers while carrying out sea practices on board ships, efforts can be made to overcome the decline in hydraulic pump performance, namely by replacing damaged pump components such as shaft seals, ball bearings and slip rings. Apart from that, regular maintenance and repairs are also required, such as checking the differential temperature between the inlet area of the pump and the ball bearing cover. In the inlet area, for example the suction side housing must be checked for mud, if there is mud dirt it must be cleaned immediately.

Apart from making observations, the researcher also conducted an interview with the Chief Engineer to strengthen the results of

the observations that the researcher made and the efforts that can be made so that the steering gear can work optimally, namely by carrying out maintenance and checking components such as loose fittings which can cause oil leaks and checking the pump pressure whether normal or not.

c. Environment

Based on the results of observations made by researchers during sea practices on the MT Narpatisuta ship, efforts that can be made to ensure that the steering gear continues to work optimally is to always check the quality of the hydraulic oil and replace the oil filter after working hours so that the quality of the hydraulic oil is maintained and the performance of the steering gear can work optimally.

When conducting research, apart from making observations, the researcher also conducted interviews with the Chief Engineer and found that the oil filter could actually be cleaned with diesel fuel, but the results obtained were not optimal. This activity cannot actually be repaired, it would be better if you replace the spare part with a new one.

d. Liveware

Based on research conducted by researchers when carrying out sea practices on the MT Narpatisuta ship, an effort that can be taken to overcome the factor of the steering gear not working optimally is by planning for each duty officer to check the steering gear. This aims to monitor if there are leaking components so that they can be addressed

immediately. When the researcher made observations, the researcher also conducted an interview with the Chief Engineer with the results obtained to overcome this factor by regularly checking the steering gear.

4. Discussion

In the research process that the researchers have carried out, they discuss the impact of the steering gear not working optimally, which makes this problem the focus of research on this problem, MT. Narpatisuta, then the researchers conducted a study using the SHEL method. At this stage, researchers understand the factors that cause problems in terms of Software, Hardware, Environment and Liveware. With this method, researchers hope that the research can be right on target. The aim of this research is to find out and explain the causes of the steering gear not working optimally in MT. Narpatisuta. Efforts that can be made to overcome this problem, the results of the discussion carried out by researchers are as follows:

a. Software

After the researcher conducted research, interviews and literature studies conducted by the researcher, the previous point showed that there was a mismatch in the Plan Maintenance System which had an effect on delays in maintenance on the steering gear. Therefore, a review of the Maintenance System Plan is carried out in accordance with the manual book so that maintenance can be carried out well in the future to maintain optimal steering gear performance and find out more quickly if damage occurs so that it can be resolved quickly.

b. Hardware

After conducting research, interviews, documentation and literature studies carried out by researchers, the previous point in terms of hardware is the decline in the performance of the hydraulic pump so that this factor influences the steering gear to not work optimally. Efforts that can be made to overcome this problem are by paying attention to the pressure of the hydraulic pump and repairing damaged components in the pump.

c. Environment

After the researchers conducted research, interviews, documentation and literature studies, what was carried out by the researchers in the previous point from an environmental perspective was that the oil filter in the hydraulic oil was dirty so that there were deposits of dirt and the effort that could be taken was to replace the oil filter according to the manual book and Pay attention to the quality of hydraulic oil.

d. Liveware

After conducting research, interviews, documentation and literature studies carried out by researchers, what is found in the previous point in terms of liveware is the lack of cooperation and attention between the crew towards the steering gear when on guard duty which results in unknown leaks occurring. An effort to overcome this problem is to remind each other when the machinist or oiler is on duty to always pay attention to the condition of the steering gear with the aim that if a leak occurs, it can be resolved immediately.

Based on the problems that occurred as explained above, it can be concluded that the steering gear's non-optimal operation is related to one another, which is explained by the SHEL method in the research. To understand the relationship between these factors, researchers discussed above by connecting related SHEL components.

1) Liveware-Software

There is a lack of cooperation and awareness between the crew regarding the steering gear and its components, and when the guard duty does not check the steering gear and there is no coordination to carry out and carry out its duties, this results in the existing Maintenance System Plan and instruction manual book not being implemented. Therefore, leaks occur in the steering gear which results in the steering gear working not optimally. This is due to loose fittings and decreased pressure on the hydraulic pump which results in decreased steering gear performance. Efforts to overcome this are by increasing cooperation and awareness between crews to carry out checks when carrying out guard duty.

2) Liveware-Hardware

Lack of cooperation and awareness between the crew when carrying out guard duty regarding checking the steering gear and hydraulic pump can reduce the performance of the steering gear. Efforts that can be made to overcome this problem are by replacing the hydraulic pump component on the steering gear that is leaking with a new one so that it does not hamper the ship's operations.

3) Liveware-Environment

Lack of cooperation and awareness between the crew when carrying out guard duty regarding checking the steering gear and its lubrication system is not only carried out if there is a leak in the steering gear, but this can be carried out every time on guard duty to check the steering gear. In terms of the environment, it has been discussed that the quality of hydraulic oil that is not very good can cause a loss of system efficiency which can cause slow or unresponsive steering movements. Apart from that, if the hydraulic oil does not comply with the provisions of the manual it can cause overheating which can cause further damage to components and reduce the service life of the system.

4) Liveware-Liveware

Lack of communication and cooperation between the crew can cause unknown leaks in the steering gear. This condition makes the lack of synergy in carrying out work on the ship less than optimal. As is the case with the poor quality of hydraulic oil due to lack of attention, which then causes problems in the future and can disrupt ship operations. Efforts that can be made are to increase communication and cooperation between the crew so that a good and coordinated work environment can be created.

5. Conclusions

Based on the results and discussion above, researchers can conclude that the factors that cause the steering gear to not work optimally are due to leaks in the hydraulic oil and decreased performance of the hydraulic pump due to human negligence regarding the system maintenance plan. The impact that occurs if the steering gear does not work optimally is that

the ship's maneuvering becomes hampered, the movement of the ship's rudder becomes slow and can cause the risk of accidents that can threaten the safety of the ship's crew. So the effort that can be made to keep the steering gear working optimally is to carry out routine checks and maintenance on the steering gear and its components and the need for maintenance in accordance with the system maintenance plan.

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