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Designing a Maintenance System Plan to Increase Effectiveness and Efficiency on The MT Success Altair XLII Ship

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ABSTRACT

The MT Success Altair XLII, an oil tanker with a tonnage of 45,000 DWT, requires regular routine maintenance to maintain its performance and crew safety. An integrated and structured maintenance planning system can increase maintenance effectiveness and efficiency and reduce the risk of accidents. However, implementing the Plan Maintenance System (PMS) on board the ship was not optimal, resulting in a fatal accident in 2019. Therefore, the research "Designing a Plan Maintenance System to Increase Effectiveness and Efficiency on the MT Success Altair XLII Ship" is proposed to improve ship maintenance performance. The conclusions of this research emphasize the need for routine maintenance of ship safety equipment, structured maintenance planning, and crew discipline in implementing PMS. The suggestion is that disciplined human resources should implement PMS and familiarize the company with the help of shipping consultants. Hopefully, this research can help ship management companies improve ship maintenance performance and operational safety in the future.

1. Introduction.

The oil tanker vessel MT Success Altair XLII, with a tonnage of approximately 45,000 DWT, has been operating in harsh and dynamic maritime environments for several years (Muhammad, 2019). As a vital asset in naval operations, this vessel requires systematic and planned routine maintenance to ensure its operational smoothness and reliability (Efendi, 2016). Not only can the vessel's performance decline without proper maintenance, but there is also the risk of equipment failure, leading to serious operational disruptions (Prasetyo, 2017). Moreover, failure to maintain equipment in optimal condition could result in accidents that endanger the crew and cargo's safety and negatively impact the marine environment (Muhammad, 2019).

The importance of designing an effective and efficient maintenance planning system for the MT Success Altair XLII vessel becomes increasingly evident when facing these operational challenges. A well-integrated and structured maintenance planning system not only ensures that all maintenance activities are carried out on schedule but also helps improve overall operational effectiveness and efficiency (Prasetyo, 2017). A well-designed system can minimize the risk of unexpected breakdowns, reduce downtime due to repairs, and significantly improve the availability and reliability of the vessel (Williams, 2016). With the proper and timely maintenance system in place, the Plan Maintenance System (PMS) can help reduce the risk of equipment failure, minimize downtime due to repairs, and ultimately increase the vessel's availability and reliability (Rawung, 2023; Lee, 2017). The use of PMS can also enhance operational safety (Sidabutar, 2016), as it ensures that all vital components of the vessel, such as the engine, navigation systems, and safety equipment, are always in good condition and ready for use.

In maritime safety, the ISM Code, regulated under SOLAS Chapter IX, emphasizes the importance of implementing a safety management system (Yudhistira, 2024). Element 1.4 of the ISM Code underscores that shipping companies are expected to develop a safety management system (Asmarinanda, 2020) as a standard for vessel maintenance, pollution prevention, and

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human safety at sea. Section 10 of ISM Code Chapter 5 specifically highlights the importance of vessel and equipment maintenance as an integral part of maritime safety (Gjerde, 1998). However, the implementation of PMS on the MT Success Altair XLII has not been optimal, particularly in the deck department, leading to severe consequences, including an accident that occurred on April 24, 2019, when a sailor fell into the sea during cargo loading operations at the Port of Tobelo, Ambon. This incident can be linked to deficiencies in the ship's crew's implementation of PMS.

This study focuses on developing and implementing a better maintenance planning system for the MT Success Altair XLII to improve vessel maintenance performance. This research aims to build an effective and efficient maintenance planning system, identify and analyze factors that influence maintenance needs and spare part inventory, and consider these factors in developing an optimal maintenance schedule. Additionally, the research aims to continuously evaluate the maintenance planning system to improve the effectiveness and efficiency of vessel maintenance, optimize the maintenance methods applied to the vessel, and make the implementation of maintenance more effective and efficient. This study is expected to significantly improve the reliability and operational efficiency of the MT Success Altair XLII vessel in the future.

2. Methodology.

This research employs a methodology consisting of several key steps, namely literature review, data collection, and data processing, all aimed at developing and designing an effective and efficient Planned Maintenance System (PMS) for the MT Success Altair XLII vessel.

2.1. Literature Study.

The literature review was conducted to gather relevant information and concepts related to designing a maintenance planning system for vessels. The reviewed literature includes various references on developing structured maintenance systems, the importance of systematic maintenance planning, and relevant maritime safety regulations, such as the ISM Code in SOLAS Chapter IX. This study provides a strong theoretical foundation for designing the PMS system to maintain the vessel's operational condition, enhance safety, prevent damage, and minimize operational downtime.

2.2. Data Collection.

The data collection stage involves gathering and managing various data related to vessel maintenance and the due dates of maintenance items. This data is crucial for managing vessel maintenance efficiently and ensuring safety at sea. The collected data includes technical specifications of the vessel, such as the type of vessel, dimensions, tank capacity, and safety equipment data, such as lifeboats. Tables 1, 2, 3, and 4 show the vessel data and an example of some data containing information on the lifeboat.

Table 1: Ship Data.

Ship Name	**Success Altair XLII**
Type of Ship	Oil Product Tanker
Loa	149,30 m
Lbp	141,74 m
Breadth	23,75 m
Depth	12,65 m
Height	36,73 m
Bridge Front - BOW	123,3 m
Bridge Front - STERN	26,0 m
Bridge Front – M'FOLD	51,5 m
DWT	17499 ton
Route	Beginning – End (6-10 Hours)
Speed	10 knot

Source: Authors.

Table 2: Lifeboat Data.

Type		**Enclosed Lifeboat**
Length		7.32 m
Breadth		2.35 m
Depth		0.95 m
Number of Persons		22
Boat Speed		4 knots
Weight	Boat	1,450 kg
	Person	1,650 kg
	Equipment	350 kg
	Total	3,450 kg

Source: Authors.

2.3. Data Processing.

Data processing in designing the Planned Maintenance System (PMS) design scheme, which produces tables in Microsoft Excel, is crucial in building an effective maintenance system. Below is a brief explanation of each table:

a. Maintenance Table
   This table lists all equipment, components, or parts that require maintenance. Each entry will include information such as the equipment's name, serial number, technical specifications, location on the vessel, and maintenance

Table 3: Tank Capacity Data.

TANK CAPACITIES (cbm)			
CARGO TANKS (100 %)			
1P. 1315.99	1S. 1315.99		
2P. 1715.39	2S. 1715.39		
3P. 1498.64	3S. 1481.56		
4P. 1903.53	4S. 1903.53		
5P. 1481.72	5S. 1481.72	**F.W Tanks 100%**	
6P. 1903.53	6S. 1903.53	FW Tank (P)	86.41
7P. 1685.39	7S. 1676.71	FW Tank (S)	86.41
SP. 179.95	SS. 170.79	FEED WT	29.49
TOTAL	**23350.4**	**TOTAL**	**202.31**
H. Level Alarm	95%	Level gauge	AUTRONICA TANK RADAR
Overfill Alarm	98%		

Source: Authors.

requirements. This table will serve as the foundation for scheduling and tracking routine maintenance.

b. Periodical Maintenance Schedule Table
This table organizes maintenance schedules based on predefined frequencies. Each entry includes information about which equipment or components need to be inspected, when the maintenance is to be performed (e.g., monthly), and the type of work required. This table will serve as the main guide for carrying out routine maintenance.

c. Job History Table
This table records the maintenance history performed on each equipment or component. Each entry will include the maintenance date, type of work performed, results of the maintenance, and the name of the technician who carried out the work. This table helps track the maintenance history and assess the reliability of the equipment.

d. Form Table
This table is used to store various forms or documents related to maintenance. Each entry in the table will include information about the type of form, reference number, creation date, and other relevant information. This table facilitates quick access to documents related to maintenance.

3. Results and Discussion.

3.1. Results of Maintenance System Plan Design.

The data processing results, including the design of a Plan Maintenance System (PMS) consisting of several tables, represent a crucial step in developing a ship maintenance system.

Table 4: Tank Capacity Data.

TANK CAPACITIES (cbm)	
BLST TKS (100 %)	
F.P.Tk.	335.54
1P 638.22	1S. 599.16
2P 522.54	2S. 549.2
3P 818.38	3S. 782.02
4P 647.14	4S. 677.23
5P 636.14	5S. 512.32
6P 577.40	6S. 603.25
COOLING SW	15.71
APT	424.98
TOTAL	**8239.23**
AUTRONICA TANK RADAR	

Source: Authors.

This PMS design will be the primary guideline for keeping ships in good operational condition and ensuring crew safety. In this study, the components referred to are lifeboats, inflatable liferafts, primary and emergency fire pumps, fire hydrants, portable fire extinguishers, fire detection and alarm systems, CO2 fixed fire extinguishers, deck foam extinguishing systems, fireman outfits, pyrotechnics and line-throwing appliances, and life-saving appliances.

3.1.1. Maintenance Table.

The maintenance table is an important part of the Plan Maintenance System (PMS), which details and organizes maintenance schedules for various ship components. This table includes the type of maintenance, frequency, methods used, and implementation schedule, as in Table 5.

In developing a ship's Plan Maintenance System (PMS), various vital components are identified and organized through a detailed maintenance table. Each element is assigned a unique code to facilitate identification and tracking, along with information on the maintenance methods and procedures to be followed, including the required maintenance frequency. The ship's PMS is divided into several main sections: Hull, Machinery and Electrical Equipment, and Deck Machinery & Ship Equipment (Yanto, 2022). More specific subsections within Deck Machinery & Ship Equipment include Safety Equipment, Anchor and Mooring Systems, Cargo Handling Equipment, and Hatch Covers (Ship Safety Handbook).

3.2. Maintenance Procedures.

The designed Plan Maintenance System will function efficiently and effectively if the procedures for using and implementing the PMS are properly followed.

Table 5: Maintenance Table.

Code Number	Items	Method	Procedure	Periodicity: 1 week	2 weeks	1 month	3 months	6 months	1 year	2 years	2.5 years	5 years
3.1.1.1 Lifeboat Port Side												
3.1.1.1.1 Lifeboat Port Side												
3.1.1.1.1.1	Hull	Clean	Bersihkan bagian luar hull lifeboat		√							
		Check	Pastikan bagian luar hull tidak mengalami korosi, kerusakan atau cacat lain		√							
		Check	Pastikan marking pada lifeboat dapat terbaca. Perbaiki bila diperlukan		√							
		Clean	Bersihkan bagian dalam hull lifeboat		√							
		Check	Pastikan bagian dalam hull tidak mengalami korosi, kerusakan atau cacat lain		√							
		Clean / Check	Bersihkan tempat duduk dari debu dan kotoran lain yang menempel, periksa dari kerusakan		√							
3.1.1.1.1.2	Release gear	Check	Perhatikan kondisi pemasangan, pastikan terpasang dengan baik	√								
		Clean	Bersihkan dari kotoran yang menempel	√								
3.1.1.1.1.3	Watertight door	Clean	Bersihkan dari kotoran yang menempel		√							
		Check	Pastikan pintu dapat dibuka dan ditutup dengan baik		√							
		Check	Pastikan gasket pada pintu tidak ada kerusakan, perbaiki atau ganti apabila terdapat kerusakan		√							

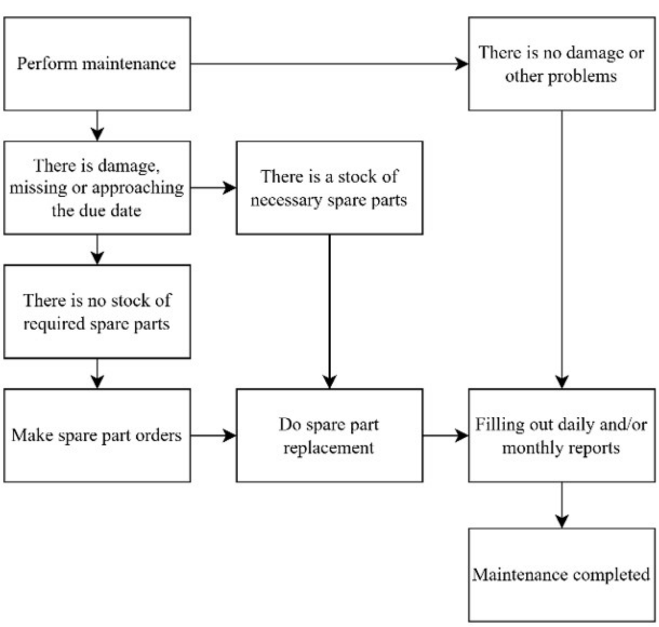
Source: Authors.

3.2.1. PMS Implementation and Use Procedures.

The implementation and utilization procedures of the Plan Maintenance System (PMS) involve several stages to achieve an effective and efficient maintenance system. These stages include

a. PMS Training: This stage involves training the ship's crew on properly using and implementing the PMS.
b. PMS Systematization: This stage involves preparing and documenting the PMS system and procedures.

Figure 1: PMS systematic scheme.



Source: Authors.

c. Periodic Evaluation: This stage involves regular evaluations of the PMS performance and the maintenance activities.

3.2.2. Spare Part Replacement Procedure.

The procedure for replacing spare parts on ship safety equipment is highly relevant and crucial to ensuring that safety equipment remains functional. Below are the details of each procedure:

1. Scheduled Replacement: Components of safety equipment that have exceeded their due date or reached their usage limit must be replaced during periodic maintenance.
2. Replacement During Docking: If safety equipment components reach their due date or require replacement while the ship is in operation, replacement must be carried out while the ship is docked before resuming operations.
3. Replacement Due to Damage: In addition to scheduled replacements, spare parts must be replaced when safety equipment components experience damage or failure.
4. Fill in the Spare Part Order Form: You must first fill in the spare part order form to order spare parts.

3.2.3. Spare Part Ordering Procedure.

The spare part ordering procedure is essential to ensure the availability of necessary spare parts and maintain the proper functioning of the ship. Below is a detailed explanation of each step in the spare part ordering procedure:

a. Based on Requests from the Officer (Ship's Chief): Spare part orders must be based on the requests or needs submitted by the Officer or Ship's Chief.
b. Approval from the Ship Captain: The spare part ordering requests submitted by the Officer must be approved by the Ship Captain.
c. Mentioning Remaining Spare Part Stock: In the spare part order form, it is important to mention or record the remaining stock (inventory) of spare parts available on the ship.

3.2.4. Stockist Procedure.

The Stockist procedure is vital to managing the safety spare part stock on board to ensure the availability of required components in good condition (Andi, 2023). Below is a detailed explanation of each step in the Stockist procedure:

a. Recording Spare Part Stock by the Officer: The Officer (Ship's Chief) is responsible for recording and supervising the safety spare part stock on board. This includes recording the available spare parts' quantity, type, and condition.
b. Routine and Periodic Inspections: Safety equipment spare parts on board must be inspected regularly and periodically according to a predetermined schedule. This inspection ensures all components are in good condition, undamaged, and ready for use.

c. Stock Updates and Reporting When the Ship Docks: The safety equipment spare part stock on board must constantly be updated and well-managed. When the ship docks, information regarding the stock must be reported to the relevant authority onshore.

3.3. Analysis.

3.3.1. Document Analysis.

Key elements in developing a Plan Maintenance System (PMS) for ship safety equipment include analyzing three types of documents:

a. Manuals: Provide comprehensive guidance for the use, maintenance, and troubleshooting of safety equipment, helping the crew maintain equipment properly.
b. Procedures: Outline general steps in routine maintenance, including inspections, component replacements, and functional testing, ensuring systematic maintenance.
c. Work Instructions: Offer detailed step-by-step guidelines, necessary tools, and safety measures to ensure consistency and accuracy in maintenance execution.

3.3.2. Technical Analysis.

a. Technical analysis in developing a Plan Maintenance System (PMS) for ships focuses on maintenance in the context of surveys and ship inspections. Key points derived from this analysis include:
b. Pre-Survey Maintenance: Maintenance should be conducted before ship surveys and inspections to ensure readiness.
c. Maintenance Frequency: The PMS schedule is designed to occur more frequently than survey schedules to maintain optimal ship conditions.
d. Ship Condition: The primary goal of maintenance is to ensure the ship remains seaworthy.
e. Inspection Readiness: Routine maintenance ensures the ship is always prepared for surveys and inspections.
f. Safety and Compliance: An effective PMS enhances safety and ensures compliance with maritime regulations.

3.3.3. Commercial Analysis.

a. Commercial analysis highlights that routine ship maintenance is a long-term investment with significant benefits. The key points include:
b. Reduced Downtime: Proper maintenance minimizes operational disruptions.
c. Regulatory Compliance: Ensures adherence to maritime regulations, avoiding penalties or delays.
d. Customer Satisfaction: Reliable operations foster customer trust and loyalty.
e. Cost Efficiency: Preventive maintenance reduces costly emergency repairs.
f. Long-Term Profitability: A well-maintained ship delivers consistent returns over time (Tsang, 2002).

Conclusions.

Based on the research results on the design of the plan maintenance system to increase effectiveness and efficiency on MT Success Altair XLII Ship, several conclusions can be drawn. First, safety equipment on the ship must undergo routine maintenance under the provisions stated in the International Safety Management Code (ISM Code). This step is taken to reduce potential problems, extend the service life of the equipment, and increase ship productivity. Second, implementing a planned maintenance system is crucial, especially on pioneer ships, emphasizing the need for clear manuals, procedures, and work instructions to facilitate its implementation. Third, when the ship is docked, maintenance is a must to ensure that all safety equipment is always in good condition and ready to use so that it can provide confidence in the safety of the ship when operating. These conclusions are an essential basis for developing and implementing a better maintenance planning system on the ship to improve maintenance performance and operational reliability in the future.

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