Development of Maintenance Management System to Increase the Availability Performance of Public Transport Ferries at Tashico Mwanza

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DOI: 10.56201/ijemt.vol.11.no4.2025.pg81.94

Abstract
Tanzania Shipping Company (TASHICO) is a government company that was established by government for inland water transport. Effective maintenance for the company is regarded as one of the major challenges, especially if its goal is to provide services or products at a higher competency level than its competitors. Therefore, there is a need to develop the Ferry Maintenance System to improve service to it's ships' availability performance at TASHICO Mwanza. The main objective of this study is to develop maintenance management systems to increase the availability performance of public transport ferries at TASHICO Mwanza. To identify maintenance management factors affecting the availability performance of the public transport ferry management system at TASHICO Mwanza and develop a strategic ferry maintenance system for enhancing the availability performance of service ferry at Mwanza. The research used field observations, questionnaires, and documentary reviews to determine the current factors affecting the ferry maintenance management system for service ferries in the TASHICO Mwanza. Furthermore, the relative importance index (RII) was used to rank the significance of identified factors. The modeling of factors was used by the multiple regression model. The model was thereafter validated. The study identified the current factors affecting the ferry maintenance management system: Effectiveness of ferry Maintenance Schedule and Planning, Ferry Spare Parts Availability, Availability of Ferry Maintenance Tools, Availability of Ferry Skilled Maintenance Personnel, Limited Training on ferry maintenance; Effectiveness Communication and Logistics support in station. Finally, the study gave recommendations for improving the identified most significant factor.

1.INTRODUCTION

Transportation plays a crucial role in economic development by facilitating the movement of people and goods. In Mwanza, a major Tanzanian port city located on the shores of Lake Victoria, public transport ferries provide a vital link between islands and mainland communities, supporting trade, tourism, and daily commuting. The demand for efficient and reliable ferry services has grown significantly due to increased population and economic activities in the region. However, the operational performance of these ferries has been negatively affected by frequent breakdowns, inadequate maintenance practices, and long downtimes.

Tashico Mwanza, manages and operates public transport ferries that serve passengers and cargo. Despite efforts to maintain the fleet, the maintenance processes remain predominantly manual and reactive, leading to inefficient resource utilization, unplanned repair costs, and safety risks. The existing maintenance framework lacks a comprehensive, proactive system

that integrates preventive maintenance schedules, real-time monitoring, and data-driven decision-making to enhance fleet availability and reliability.

Inadequate maintenance strategies have significant consequences on ferry availability, affecting service reliability and customer satisfaction. Unplanned downtime due to mechanical failures not only disrupts passenger transportation but also increases the operational costs associated with emergency repairs. Moreover, safety concerns linked to poorly maintained ferries jeopardize passenger well-being and compromise regulatory compliance. Addressing these challenges requires a robust maintenance management system designed to optimize asset performance, reduce downtime, and improve the overall availability of ferry services.

The development of a **Maintenance Management System (MMS)** offers a promising solution to overcome the inefficiencies and limitations of current maintenance practices. An effective MMS integrates preventive, corrective, and condition-based maintenance strategies while leveraging modern technologies such as data analytics, real-time equipment monitoring, and automated scheduling tools. This system will enable Tashico Mwanza to proactively manage maintenance activities, track asset conditions, and make informed decisions that enhance ferry availability and reliability.

By implementing a maintenance management system, Tashico Mwanza aims to achieve key objectives, including:

Minimizing unplanned ferry downtime through predictive and preventive maintenance planning.

Optimizing resource allocation for repair and maintenance tasks.

Enhancing safety and regulatory compliance.

Reducing overall maintenance costs and improving cost efficiency.

This study seeks to design and develop a maintenance management system that addresses these operational challenges, thereby increasing the availability performance of public transport ferries in Mwanza. The proposed solution is expected to foster sustainable ferry operations, ensuring a reliable and safe transportation network for passengers and businesses relying on lake transport services.

Public transport ferries operating under Tashico Mwanza on Lake Victoria play a vital role in connecting communities and supporting economic activities by providing transportation for passengers and goods. However, the operational availability and reliability of these ferries have been compromised due to frequent mechanical failures, inadequate maintenance practices, and prolonged downtimes. The current maintenance approach is largely reactive, with minimal use of preventive and predictive strategies, resulting in high unplanned repair costs, inefficient resource utilization, and safety risks for passengers.

The lack of a structured and efficient maintenance management system has made it challenging to track ferry maintenance schedules, monitor the condition of key components, and make data-driven decisions to optimize fleet performance. These shortcomings not only affect the service reliability and availability of ferries but also undermine public trust in transportation services, posing significant social and economic consequences.

To address these issues, there is a pressing need to develop a comprehensive **Maintenance Management System (MMS)** tailored to the unique requirements of public transport ferries in Mwanza. Such a system should integrate preventive, corrective, and predictive maintenance strategies, enabling proactive planning, real-time monitoring, and efficient maintenance operations. This solution aims to enhance ferry availability, reduce operational costs, and improve safety, thereby ensuring reliable and sustainable ferry transport services.

2.LITERATURE REVIEW

Basic Maintenance Parameters

Table 1 below indicates the definition of various basic maintenance parameters as applied in this study.

No	Term	Description	Author
1	Availability Performance	It measures the amount of time a system such as a ship is available for use. It is usually expressed as a percentage of total time and is usually calculated over a given period	(Nila Chandra Sakti, 2019)
2	Mean Time to Repair (MTTR)	It measures the elapsed time required to perform a given maintenance activity	Scott, 2019
3	Mean Time to Failure (MTTF)	It measures the average amount of time it takes for a ship engine to reach a certain level of performance	(Nila Chandra Sakti, 2019), (Opyrchał, 2021)
4	Mean Time Before Failure (MTBF)	Is the average amount of time a ship engine/equipment can be operated before it fails	(Nila Chandra Sakti, 2019), (Gabriel Pena,2022)
5	Overall Equipment Effectiveness (OEE)	is defined as a lean metric to assess the actual Performance of a production line compared to its maximum potential. It is represented in Percentage terms. OEE = Quality × Performance rate × Availability	(Tsarouhas,2019)

According to the EN 13306:2001 standard, maintenance is defined as a combination of all technical, administrative, and managerial actions during the life cycle of an item intended to retain it in or return it to a state so it can perform the required design function. The standard divides maintenance types into two major categories: Planned/scheduled maintenance and unscheduled/unplanned maintenance. Planned maintenance is divided into preventive maintenance and corrective maintenance. Preventive maintenance is more divided into types which are predetermined maintenance and condition-based maintenance. Also, corrective maintenance is further divided into two parts, deferred corrective maintenance which was very deliberate because it is so essential that we minimize the amount of emergency maintenance we allow into our organizations.

Factors that may lead to the effect of the maintenance management of the ferry boat

The ferry maintenance failure is caused by several issues as discussed below.

i Ferry Maintenance planning and scheduling Ferry Maintenance planning and scheduling are very important in the management system to enhance the reliability, safety, and availability performance of service boats at TASHICO Mwanza ferry. The maintenance concept must be defined during the equipment purchase phase to attain, restore, and maintain operational capability throughout the equipment based on the “Level of Repair Analysis” or other specified criteria. The tasks, approaches, responsibilities, and resources needed to accomplish particular equipment readiness and workplace goals are identified via maintenance planning (Guptal, 2022).

ii. Availability of ship critical spare parts and tools

Machine downtime occurs when spare parts and maintenance tools are not sent promptly. According to Mongomongo and Mjema (2016), the cost of spare parts is around 67% of all

repair costs, and the organizations that manage their spare parts well are likely to be the ones that survive in the long run.

iii. Effectiveness of Ferry maintenance organization strategy and policy

Effective maintenance practices can significantly reduce equipment downtime, although they mostly depend on the availability of replacement parts (Jiang, Chen, & Zhou, 2015). Gao et al. (2018), discuss the importance of proactive strategies in preventive maintenance scheduling, resource allocation, and technology integration to enhance operational efficiency and reduce downtime, while policies governing maintenance activities play a pivotal role in ensuring adherence to safety standards, regulatory requirements and environmental protocols. Park et al. (2018) highlights the correlation between robust policies and reduced risk of accidents, emphasizing the need for a strict compliance framework within ferry maintenance operations.

iv. Ferry Logistics Support It refers to establishing a maintenance planning framework for managing the necessary material, service, information, and capital flows. In the marine sector, supply chain, and logistics management for replacement parts are critical to ensuring high asset availability and dependability while maintaining reasonable operating costs (Mouschoutzi, 2022). It encompasses today's increasingly complex information, communication, and control systems. The logistic support framework includes support and test equipment that must be identified, acquired, used, and supported by management actions, procedures, techniques, and support items from when the equipment is purchased to when it is disposed of (Al-Raqadi, 2019).

According to (Khan, 2021) root cause analysis is defined as a technique for solving problems that finds the main sources of errors or issues. Identification Root causes analysis is a strategy that breaks down issues and failures into their underlying causes. Each piece of equipment can fail for a variety of causes. The methods used to determine the root cause of equipment or system failures are listed below.

Defining, identifying, and removing known and/or possible issues, errors, and so forth from the system, design, process, and/or service before they affect the customer is done using the engineering technique known as FMEA (Ben-Daya & Mohamed,, 2016). FMEA is one of the most popular techniques for early design evaluation from the availability perspective; according to Dillon (2016), the method aids in identifying the needs for the consequences of design changes and the potential causes and effects of system failure. Reports from FMEAs should include indicators of failure techniques that could pinpoint crucial areas for condition monitoring. Each failure mode's control strategy can be derived from the FMEA and could involve an operator task, a preventive task, a predictive task, or both. FMEA is one of the most popular techniques that aims to lower the amount of scrap and failure rate while raising the product's availability and dependability., according to (Pascus et al.,2022). The method aids in identifying the needs for the consequences of design changes and the potential causes and effects of system failure. Reports from FMEAs should include indicators of failure techniques that could pinpoint crucial areas for condition monitoring. Each failure mode's control strategy can be derived from the FMEA and could involve an operator task, a preventive task, a predictive task, or both. These duties are combined to create a maintenance plan's foundation (Soltanali et al., 2023).

One of the most useful approaches for determining the frequency of occurrence of events in probabilistic risk assessment research is the fault tree, which is a logical chart of events. FTA is a top-down methodology that begins with an event at the high system level and repeats it steadily downward until it reaches the occurrences at the detailed level on the equipment (Ben-Daya M. U., 2016).

For investigations into workplace safety and equipment failure occurrences, the five whys method of root because the analysis is frequently employed. The five why the technique is a

straightforward and frequently successful method of problem-solving encourages in-depth thought via inquiry, is easily adjustable, and can be used to tackle the majority of issues (Serrat, 2017).

According to AI Hainay (2016), where the whole-time span including administrative, logistical, active repair, and operating time. As a result, the equipment availability is just the percentage of time that the 30 pieces of equipment can be used for their intended function. The portion of the scheduled hours during which the machine is physically and electrically prepared for operation is represented by availability.

Availability = $\frac{\text{Uptime x 100}}{\text{Uptime +Downtime}}$.....(eqn 2.1)

Equation 2.1 above, describes availability as a driver for:

i Increasing time to failure,

ii. Decreasing downtime due to repairs or scheduled maintenance, and

iii. Accomplishing items 1 and 2 cost-effectively (Davidson 1988).

As availability grows, there is a greater potential for an increase in revenue collection because the equipment is used for a greater percentage of the time. General availability can be defined as the likelihood that a product can perform its needed function throughout a certain period or at a specific moment under the combined effect of its reliability, maintainability, and maintenance support. Reliability, maintenance support, and maintainability performance compact availability performance (Kumar, 2022).

TPM – Total Productive Maintenance developed in Japan as a conception of maintenance management including all departments, i.e. from management to manufacturing, controlling support of the company with maximum productivity based on the increased principle of effectiveness of equipment. The author of the TPM conception is Seichi Nakajima, who gradually studied systems for preventive maintenance in 50tees 60tees years (Preventive Maintenance) in the USA a Europe (Rakyta, 2016).

RCM – Reliability Maintenance presents a systematic approach for identifying effective and preventive equipment and their elements maintenance activities according to specific procedures and proceedings based on intervals defined to perform single maintenance activities. It was developed when maintaining planes Boeing 747, and 777 types in the USA. In 1960 - 1970, it was officially elaborated as a base for maintenance management, mainly in the aircraft industry (Technical standard SAE JA1011).

RBI – Risk Based Inspection is an assessment and risk management process that evaluates the loss risk of pressure equipment's content influenced by materials deterioration. Equipment inspection controls this risk. That means that the priorities of maintenance activities are defined according to analyses and risk assessments. RIMAP - Risk Based Inspection and Maintenance Procedures is a result of a European project (5 Framing project EU 1998-2002), which aimed to develop a unitized optimal approach to inspection and maintenance activities based on risks assessment in industrial companies).

METHODOLOGY

The literature offered many interesting and practical ideas for maintenance concepts; however, the majority of these concepts require a lot of management time and people. Despite substantial advancements in maintenance management systems (MMS) within the maritime industry, a noticeable research gap exists concerning the development of tailored MMS specifically designed to enhance the availability performance of public transport ferries.

However, experts in this field (Rastegari, 2015) concur that by creating a customized maintenance concept, the aforementioned shortcomings were resolved. The new maintenance concept must, therefore, fit the goals and culture of the business as well as the current

maintenance organization. Because many of the notions are only applicable to a certain kind of equipment or sector, there are very few frameworks that are now available; the food and beverage industry has not yet been given a framework;

According to Muchiri et al. (2017), maintenance framework is comparatively superior to other frameworks. However, it has restrictions on the data management and workflow system. The majority of researchers concur that a significant amount of an organization's overall operating costs is related to maintenance expenses. They also agreed that reducing maintenance expenses is essential for improving an organization's profitability. The best maintenance management practices,

According to Emovon et al. (2017), are those that lower maintenance costs, maintain equipment in good working order, and boost production system productivity. Therefore, companies that produce electricity must establish maintenance management procedures that achieve these goals. Therefore, the developing maintenance management system in this paper addresses the above gaps.

This research followed a mixed method of quantitative and qualitative approaches. According to Marvasti (2018), the qualitative approach is a function of a researcher's perceptions and impressions, in which he/she provides his/her subjective evaluation of attitudes, opinions, and behaviors. In contrast, the quantitative approach involves data generation in a numerical form that can be subjected to statistical analyses (Michael, 2016). However, no approach method (qualitative or quantitative) is superior to the other, and both have strengths and weaknesses.

A quantitative approach will deal with collection of the objective information to develop a system for the better performance of the ferry maintenance management system for service boats in the mentioned literature. In addition to these quantitative approaches is largely employed in this study; a closed-ended questionnaire was applied to collect quantitative information based on a Likert-type response scale. Meanwhile, the qualitative approach in this study helped the researcher to collect subjective information concerning the working environment from the ferry staff of the TASHICO Mwanza. In which the researcher will use semi-structured interviews.

The research design refers to the overall strategy that one may choose to integrate the different components of the study coherently and logically. Proper study design selection addressed the research problem effectively (Adebiyi, 2016; Boru, 2018). For this study, the researcher must choose a design that accepts both qualitative and quantitative research approaches. According to McGrew (2020), a design that produces the least margin of error in experimental research is generally considered the desired outcome. Therefore, descriptive research design was used in this study.

A research strategy is a step-by-step plan of action that gives a route, enabling the researcher to conduct a study methodically and on schedule to get excellent results and detailed reporting (Boru, 2018). Simply, it can be referred to as how the researcher attempts to achieve the goals of the investigation. Concerning research/study strategy, the researcher employed a case study because it emphasizes a full contextual analysis of fewer events or conditions and their interrelations. Gustafsson (2017) has described a case study as a thorough investigation into an individual, a group of individuals, or a unit to generalize over several units. This strategy will allow the researcher to gather vast volumes of qualitative and quantitative data from a study area using various sources.

The study was conducted in the TASHICO Mwanza. The researcher chose this area because Mwanza is the main station in Tanzania and handles most of the country's passengers and cargo. Another reason for choosing this area is the interest in proximity since the researcher works and live in Mwanza. This location implies that it was easy for the researcher to administer and monitor information collection from the respondents, enhancing the validity and reliability of the information collected.

According to Ruane (2016), the term population refers to an entire group of individuals, events, or objects with common observable characteristics. The population of this study will collect information from TASHICO officers at the Mwanza of service boats (the ferry staff) and the management level of this ferry (the administrators of the ferry). This population was provided reliable and valid information concerning the subject of the study; while considering that the researcher easily accessed them. The study included only those who were present, in their working areas, at the time of collecting data.

The reason to involve administrators of this ferry is that they have great influence in the planning process and set the operation mode of all units/departments of the ferry, including the Pontoon. On the other hand, the ferry staff was included because they implement and carry out activities onboard daily. They have full details of working conditions (i.e., equipment, financial resources, human research) and working culture (i.e., procedures, policies, social services) on the ferry.

A sample is a portion of the respondents drawn from the population of interest (Singh, 2018; Marvasti, 2018). In many cases, sampling is more feasible than studying the entire population. Although no sample can be guaranteed to be fully representative, it obtains a result from the small number of representatives of the whole population without asking everyone (Mugenda, and Mugenda, 2012). The research selected some officers to represent others from the ferry and management level of TASHICO Mwanza. The selection criteria are an officer of the mentioned two units, being present in the working area while collecting data, and being willing to participate in this research by feeling consent. In the sampling process, the study used a simple random sampling procedure that gives equal representation chance to all members of the study population. There were two groups of respondents; the first involved staff from the ferry, and the second contained TASHICO Mwanza administrators. The study applied a statistical formula for calculating each group's samples in a known population. To achieve this target, the researcher visited the study area and noted the total number of officers in the TASHICO Mwanza and the total number of administrators of this station, as mentioned earlier. It was noted that the total number of individuals (total population) in the TASHICO Mwanza was 130, and the administration was 40. In light of this, the study selected 73 staff from the Ferry and 36 administrators in the main office of TASHICO Mwanza. The total numbers of respondents were 109 individuals. The statistical formula developed by Yamane in 1967 was applied to calculate the sample size from each of the mentioned groups of respondents. It should be noted that only officers who were willing and believed to be able to deliver the required data were selected. The formula and calculation of the sample size are described in the equation below

$$n=\frac{N}{1+Ne^2}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(eqn. 3)}$$

Whereby:

n= Sample size,

N= Sampled population

e= error term (at 95% significance level, the error term is 5% or 0.05)

$$(Staff) = \frac{90}{1+90(0.05)2} = 73$$

$$(Administrators) = \frac{40}{1+40(0.05)2} = 36$$

S/N	Category of respondents	Total Population	Sample size	Percentages
1	The staff of TASHICO ferry	90	73	67%
2	Administrators of TASHICO ferry	40	36	33%
	TOTAL		109	100%

Source: Researcher calculations (2024)

According to (Taherdoost, 2021) data collection refers to the process of collecting data, which entails the methodical gathering of information to reveal important insights relevant to the research topic. The study had two sources of data namely primary and secondary data through interviews, questionnaires, and documentary review. For this matter, the study contained first-hand information collected directly from the study area by the researcher and research assistant. This approach enables individuals to articulate, in their unique expressions, their perspectives on and interpretations of the world. Interviews encapsulate a seemingly common place social exchange where individuals engage in the dynamics of posing and responding to inquiries (Knott et al., 2022). An interview data collection method involves oral questions to respondents individually or in a group. During an interview, verbal communication between the researcher and the respondents and information given was recorded and incorporated into the final research report. The study used semi-structured questions to collect qualitative information regarding interviews. One of the main advantages of the semi-structured interview is that although it provides the kind of data that can be compared, it also provides the researcher with opportunities to collect additional data that might be impossible to collect through questionnaires. All questions that were asked in the interview are in line with the topic under study.

This methodology entails the scrutiny of a variety of document sources, including novels, newspaper articles, academic journal articles, and institutional reports (Morgan, 2022). In this dissertation, various publications such as journals, official documents, books, TASHICO maintenance reports, and web resources were used to gather information related to the subject of the study. According to Docrep, (2019) documentary review has an added value, which includes enabling the researcher to appreciate trends and reconstruct processes.

According to Atlan (2023), validity ensures an accurate representation of intended measurements. With carefully crafted questions that responders used to gather truthful data, content validity was ensured. The questionnaire was pre-tested before performing this study to gauge how long it took respondents to answer all the questions. Identifying discrepancies in the questionnaire's pre-testing also was assisted. However, all the questionnaires will be serialized to avoid repeated data entry in the software.

According to Atlan (2023), reliability ensures consistent measurements, fostering reproducibility. Reliability will be ensured in the study through the test and retest method, where data collection tools were tested in a pilot study before the actual data collection. According to Kakarash (2023), prioritizing data reliability is crucial for integrity, security, quality, and regulatory compliance. After conducting a pilot study, questions found to be irrelevant were structured to fit the study. However, the researcher excluded variables unrelated to the research's purpose to ensure data collected answered the research-specific questions/objectives.

S/N	SPECIFIC OBJECTIVES	INFORMATION REQUIRED	DATA COLLECTION METHOD	DATA ANALYSIS METHODS	TOOLS	OUTPUT
1	To identify maintenance management factors affecting public transport ferry availability performance at TASHICO ferry Mwanza.	Current factors affecting the ferry maintenance management system for service in TASHICO Ferry	-Field observation - Questionnaires -Documentary review -Maintenance technical reports of FERRY maintenance - Personal interview	Relative importance index method	MATLAB	Factors affecting the ferry maintenance management system for service in the TASHICO ferry
2	To develop a maintenance management model for increasing the availability performance of public transport ferries at TASHICO	Output parameters from objective no 1	Data was obtained from analysis of specific objective no 1		MATLAB	Ferry maintenance management model for services in the TASHICO .

4.RESULTS, DISCUSSION AND FINDING

This section presents the results and analysis of data from survey studies, physical observation, documentary reviews, interviews, and questionnaires. The data were analyzed to give outcomes based on the requirement of the development of a Ferry maintenance management system for the improvement of service boat availability performance at TASHICO ferry Mwanza.

4.1Respondent Characteristics

This study covered 109 respondents, of whom 67% were ferry staff and 33% were TASHICO administrators. The results indicated that more than 42.2% of respondents were engineers, whilst very few were operators 5.5%. Most of the respondents involved in the study were male, 82.6%, while female, 17.4%; on the other hand, more than 41.3% of total respondents had diplomas; nearly 64% had work experience of 6 to 10 years in their unit. The result might imply that the majority of the respondents had experience in their unit for more than five years; additionally, this might affect respondents' understanding of the ferry maintenance management system for service boats in the TASHICO .

Table 4.1 shows the respondent characteristics. Regarding the TASHICO environment and drop in availability performance (Table 4.1), a considerable proportion of respondents (47.7%) strongly agreed that service boats have declined. This suggests that the current maintenance management system may struggle to meet the demands and maintain the required availability levels. It indicates the need for interventions to address the drop in availability and improve overall performance.

Table 4. 1: Respond Characteristics

VARIABLE	RESPONSE	FREQUENCY	PERCENTAGE (%)
Department	Staff of ferry	73	67
	Administrators of TASHICO	36	33
		109	**100**
Position	Operator	6	5.5
	Artisan	26	23.8
	Technician	23	21.1
	Engineer	46	42.2
	Other	8	7.3
		109	**100**
Gender	Male	90	82.6
	Female	19	17.4
		109	**100**
Education Level	Certificate	39	35.8
	Diploma	45	41.3
	Degree	24	22
	Masters	1	0.9
		109	**100**
Work experience	1 to 2 years	11	10.1
	3 to 5 years	19	17.4
	6 to 10 years	70	64.2
	11 years and above	9	8.3
TOTAL		**109**	**100**

4.2Performance of Maintenance Personnel

Analysis of the performance of maintenance personnel per required standard Table 4.2: shows that more than half of the total respondents, 54.1% disagree with the existing performance of maintenance personnel, while 8.3% strongly disagree. A very few respondents, 1.8%, reported that the performance of maintenance personnel is moderate, while 14.7% strongly agreed with the performance of the maintenance personnel and 21.1% agreed. Therefore, the low standard of personnel is the cause of the unavailability of ferries at TASHICO.

Table 4. 2: Performance of maintenance personnel response rate

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strong Agree	16	14.7	14.7	14.7
	Agree	23	21.1	21.1	35.8
	Moderate	2	1.8	1.8	37.6
	Strong disagree	9	8.3	8.3	45.9
	Disagree	59	54.1	54.1	100.0
	Total	109	100.0	100.0	

5.CONCLUSION AND RECOMMENDATIONS

5.1Conclusion

i The findings from the analysis of factors affecting the ferry maintenance management system for service boats in TASHICO ferry identified the factors that affect the effectiveness of the maintenance system as Skilled ferry maintenance personnel, availability of ferry maintenance tools, effective communication in ferry, Effective ferry maintenance scheduling and planning, ferry spare parts availability, continuous training, and well-defined ferry maintenance strategies and policies are key factors in ferry maintenance management system for service boats in the TASHICO ferry

ii In analyzing the factors, affecting the effectiveness of the ferry maintenance management system for service boats at TASHICO ferry a multiple regression model was developed having a dependent variable as the effectiveness of the ferry maintenance management system and seven independent variables. The model was validated by using data from the TASHICO ferry.

iii The maintenance management system has been developed for an effective ferry maintenance management system. It is a computerized maintenance management system for enhancing the availability performance of the TASHICO ferry.

5.2 Recommendations

Based on the findings, the following recommendations can be made to improve the ferry maintenance management system for service boats in the ferry:

Prioritize the recruitment and retention of skilled ferry maintenance personnel: Ensure that competent and experienced individuals with the necessary expertise and knowledge are available to perform maintenance tasks effectively and minimize downtime.

Enhance the availability of ferry maintenance tools and equipment: Provide adequate resources and tools necessary for carrying out maintenance activities to enable maintenance personnel to perform their tasks efficiently and effectively.

Improve communication channels within the maintenance system into ferry: Establish clear and efficient communication channels to facilitate timely and accurate sharing of maintenance-related information among maintenance team members.

Enhance ferry maintenance scheduling and planning: Develop effective maintenance schedules and plans to ensure that maintenance tasks are carried out promptly, minimizing disruptions to service boat operations and maximizing their availability.

Ensure reliable availability of ferry spare parts: Establish a robust supply chain management system to ensure the timely procurement and availability of spare parts, avoiding delays in repairs and minimizing downtime.

Invest in continuous training and skill development for ferry crew: Emphasize the importance of regular training programs to enhance the knowledge and capabilities of maintenance staff, enabling them to perform their duties more effectively and efficiently.
Evaluate and improve maintenance management practices: Conduct a critical evaluation of the existing maintenance management practices and identify areas for improvement to ensure effective and efficient maintenance operations.
Allocate sufficient budget for ferry maintenance activities: Ensure that an adequate financial allocation is made for maintenance activities to address necessary repairs, procure spare parts, and ensure timely completion of maintenance tasks.
Implement preventive maintenance measures: Shift from a reactive approach to maintenance by implementing preventive maintenance measures to reduce the reliance on corrective actions and improve the reliability and uptime of the boats.
Emphasize condition monitoring maintenance: Increase the frequency of condition monitoring activities to proactively detect potential issues early on and address them before they lead to breakdowns and disruptions.
Consider implementing a Ferry Maintenance Management System (FMMS): Explore the adoption of an FMMS to streamline maintenance processes, improve data management, and enhance overall maintenance system efficiency.

5.3Future work

Because of the time limit and financial constraint, this study managed to develop the Ferry Maintenance System to improve service boats' availability performance at TASHICO ferry only. Also I would like to advice the company to Develop Asset Management system for control all asset within the company. However, the completion of this study calls for other researchers to conduct research in the mentioned cases. Also, other research could be done on the efficiency of these systems on the ferry performance.

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