

**MAINTENANCE MANAGEMENT PRACTICES OF INDUSTRIAL AND ASSEMBLY
BUILDINGS IN EDO STATE**

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**MAINTENANCE MANAGEMENT PRACTICES OF INDUSTRIAL AND ASSEMBLY
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BY

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**BEING A PROJECT SUBMITTED TO THE DEPARTMENT OF QUANTITY
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OF BENIN, BENIN CITY, NIGERIA IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF
SCIENCE (B.Sc.) IN QUANTITY SURVEYING**

SEPTEMBER, 2023

DECLARATION

I declare that this research work titled: “MAINTENANCE MANAGEMENT PRACTICES OF INDUSTRIAL AND ASSEMBLY BUILDINGS IN EDO STATE” is an original work carried out by me, DAVID OSEZUWA EDORO with Matriculation number ENV1709349 in the department of Quantity Surveying, University of Benin, Benin-City under the supervision of the Departmental Board.

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CERTIFICATION

We certify that this project with the title: “Maintenance management practices of industrial and assembly buildings in Edo State” submitted by DAVID OSEZUWA EDORO

with Matriculation number ENV1709349 has satisfied the regulations governing the award of the Bachelor’s Degree in Quantity Surveying from the University of Benin-City, Edo State.

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External Examiner:

Signature: Date:

DEDICATION

To my cherished parents, Mr. and Mrs. Egoro, your unwavering love, sacrifices, and unending support have been the bedrock of my journey. This work is dedicated to you, as a token of my deep appreciation for your belief in me and your endless encouragement to pursue my dreams. This project is dedicated to all those who have inspired and supported me throughout this journey.

To my mentors and teachers, your guidance and wisdom have been invaluable in shaping this work. To my friends and colleagues, your camaraderie and discussions have enriched my understanding. And to all those who contributed in ways big and small, this project stands as a tribute to your collective efforts.

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ABSTRACT

This study aimed to analyze the maintenance management practices in-use in industrial and assembly buildings with a view to enhancing the life and function of the buildings. To achieve the aim, the study identified the maintenance management practices used in industrial and assembly buildings in Edo State, investigated factors influencing the choice of maintenance management practices used, evaluated the challenges faced and examined the strategies to mitigate challenges faced in implementing maintenance management practices in the study area. These objectives were analyzed using the mean item score. Data from 60 responses out of a total sample of 100 professionals were analyzed. The research identified “preventive maintenance” to be the most prevalent and commonly used maintenance management practice in Edo State, followed by “corrective maintenance” and then by “predictive maintenance”, “Condition based” and “Total-productive maintenance” were the lowest ranking 5th and 6th. The research results further showed “the type of the building”, “Criticality of equipment” and “age of the building” ranked the highest being 1st, 2nd, 3rd respectively other factors like “manager preferences” and “building location” were outlined less crucial from the research results. Regarding challenges, building complexity, high-cost maintenance and lack of skilled personnel, topped the charts as the most prevalent challenges. Ranking 1st, 2nd, 3rd respectively other challenges “building location” were deduced less challenging and ranked lowest. Amongst the strategies that can be adopted to mitigate challenges, “Training and Development programs” was ranked 1st, followed by “implementation of cost benefit analysis” and “better incentives for maintenance personnel” ranked 2nd and 3rd.

On a conclusive note, it was ascertained that preventive maintenance is the most commonly used maintenance management practice in industrial and assembly buildings in Edo State. Factors such as cost, availability of resources, expertise of maintenance personnel, building age and condition, and production schedule were found to influence the choice of maintenance management practices used.

The study also identified challenges such as lack of funds, inadequate maintenance personnel, poor maintenance planning and scheduling, lack of maintenance policies and procedures, and resistance to change by personnel. However, strategies such as improved communication between maintenance personnel and management, regular training for maintenance personnel, improved maintenance planning and scheduling, implementation of maintenance policies and procedures, and incentives for personnel to embrace change can help mitigate these challenges.

Recommendations include; Building owners and managers should prioritize preventive maintenance practices as they are the most effective in ensuring the longevity and efficiency of industrial and assembly buildings in Edo State, the Edo State Government should provide adequate funding and resources to ensure that maintenance personnel have the necessary tools and equipment to carry out their duties effectively, maintenance personnel should receive regular training to keep them up-to-date with the latest maintenance management practice and technologies. Building owners and managers should implement maintenance policies and procedures to ensure that maintenance activities are carried out consistently and efficiently.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Buildings are essential assets that require proper maintenance to ensure their optimal performance and longevity. Effective maintenance management practices are critical to ensuring that buildings remain in good condition and operate efficiently. Proper maintenance can also extend the lifespan of buildings, reduce energy consumption, and minimize the risk of equipment failure, which can lead to costly repairs and downtime (Kumar & Sodhi, 2018).

Industrial and assembly buildings are unique structures that pose significant challenges for maintenance management. These buildings are typically large and complex, with specialized equipment and systems that require specialized maintenance practices. Maintenance in these buildings involves not only the building structure but also production equipment and machinery. Failure to maintain this equipment can lead to production downtime and loss of revenue (Alhassan et al., 2019).

Moreover, industrial and assembly buildings are critical to the manufacturing and production sectors, which are vital to the economy. Any disruption in the maintenance of these buildings can lead to significant losses in productivity, revenue, and even pose safety risks to workers (Mahamid et al., 2019). Therefore, it is essential to assess the maintenance management practices in assembly and industrial buildings to ensure their optimal performance and minimize any negative impact on the economy.

Several studies have been conducted on building maintenance management practices. However, most of these studies have focused on commercial and residential buildings, with little attention given to industrial and assembly buildings (Alhassan et al., 2019). Therefore, this study aims to fill the gap in the literature by assessing the maintenance management practices in industrial and assembly buildings.

Hence this study is essential as it will provide valuable insights into the current state of maintenance management practices in industrial and assembly buildings. The findings of this study will guide building owners and managers in implementing effective maintenance strategies to improve building performance, minimize downtime, and reduce maintenance costs (Ong et al., 2016).

Building maintenance management practices refer to a set of activities that are carried out to ensure that buildings are safe, functional, and aesthetically appealing. These practices include activities such as cleaning, repair, and replacement of equipment, and regular inspections to identify potential problems. The goal of building maintenance management practices is to ensure that buildings are maintained in a cost-effective and efficient manner, while minimizing downtime and ensuring that they are safe for occupants. There are several different types of buildings with respect to their functionality. Some of which of these are; Residential Building, Assembly Buildings, Industrial Buildings, Mercantile Buildings, Institutional Buildings, Educational Buildings, Storage Buildings, Hazardous Buildings, Commercial buildings (Daily Civil, Types of Buildings,2021).

For the purpose of this study, we will be focusing on assembly and industrial and buildings. This project is limited to assembly and industrial buildings due to their unique maintenance challenges and the critical role they play in the economy. Industrial and assembly buildings are

typically large and complex structures that require specialized maintenance practices to ensure their optimal performance. These buildings often house heavy machinery, production lines, and specialized equipment that require regular maintenance to prevent downtime and ensure worker safety. Additionally, assembly and industrial buildings are critical to the manufacturing and production sectors, which are crucial to the economy. Any disruption in the maintenance of these buildings can lead to significant losses in productivity, revenue, and even pose safety risks to workers. Therefore, it is essential to assess the maintenance management practices in assembly and industrial buildings to ensure their optimal performance and minimize any negative impact on the economy.

1.2 Statement of the Research Problem

The problem of poor maintenance management in industrial and assembly buildings leads to poor functionality and reduced efficiency of the buildings. This problem is widespread and has significant consequences for businesses and workers. Despite the importance of maintenance practices in industrial and assembly buildings, many of these buildings are not adequately maintained. This can lead to equipment failure, production downtime, and safety hazards. The problem is often due to a lack of understanding of the importance of maintenance practices or inadequate resources to carry out maintenance activities. Additionally, there may be a lack of effective maintenance practices or a failure to implement existing strategies.

Therefore, there is a need to study the maintenance practices in these buildings to identify areas for improvement and ensure that they are well-maintained.

1.3 Research questions

- 1 What maintenance management practices are used in industrial and assembly buildings in Edo State?
- 2 What are the factors influencing the choice of maintenance management practices used in industrial and assembly Buildings in the study area?
- 3 What challenges are faced in implementing maintenance management practices in industrial and assembly Buildings in the study area?
- 4 What strategies can be adopted to mitigate the challenges of implementing maintenance management practices in industrial and assembly Buildings in the area of study?

1.4 Aim and Objectives of the Study

The aim of this study is to analyze the maintenance management practices in-use in industrial and assembly buildings with a view to enhancing the life and function of the buildings. The specific objectives are to;

1. Identify the maintenance management practices used in industrial and assembly buildings in Edo State;
2. investigate factors influencing the choice of maintenance management practices used in industrial and assembly buildings in the study area;
3. evaluate the challenges faced in implementing the maintenance practices used in industrial and assembly buildings in the study area; and

4. examine the strategies to mitigate challenges faced in implementing maintenance management practices in the study area.

1.5 Scope of the Study

This scope of the study will focus on the maintenance management practices in industrial and assembly buildings in-use in Edo State. The scope will examine maintain management practices and also cover the various objectives while seeking to find answers to the research questions of the study.

1.6 Delimitation of the Study

The research is centered on data elucidated from maintenance manager, professionals in the building industry and higher management. Due to its of specialization, it was considered appropriate not to extend the study beyond the maintenance management of industrial and assembly buildings in Edo State. The volume of data generated in a study of this nature necessitated the elimination of broad treatment of certain management specialist fields such as financial management, personnel management, production management, etc.

1.7 Significance of the Study

This study is significant because it will provide valuable insights into maintenance practices in industrial and assembly buildings. The study will identify areas for improvement and propose recommendations for improving maintenance practices. The study will also contribute to the body of knowledge on maintenance practices in industrial and assembly buildings.

The study's findings will be useful to building owners, maintenance managers, and workers in industrial and assembly buildings. The findings will help to improve maintenance practices,

reduce equipment failure, and increase production efficiency. Additionally, the study will contribute to the body of knowledge on maintenance practices in industrial and assembly buildings.

1.8 Definition of Terms

1.8.1 Building maintenance management practices: Maintenance management practices refer to the overall strategy and approach used to manage maintenance activities within an organization. This may involve developing maintenance schedules, implementing preventive maintenance programs, training staff on maintenance procedures, and tracking maintenance costs and performance metrics.

1.8.2 Maintenance management: Building maintenance management is the coordination of maintenance activities designed to maintain, repair, and improve buildings and their related systems and provide a safe, habitable, comfortable, and functional environment in a cost-effective manner. (What is the meaning of Building maintenance management, FT Maintenance 2022)

1.8.3 Maintenance manager: Maintenance Manager refers to the individual in charge of and responsible for conducting and control of the maintenance activities.

1.8.4 Maintenance practices: refers to a set of processes and practices which aim to ensure the continuous and efficient operation of machinery, equipment, and other types of assets typically used. (Safety Culture, Maintenance Practices definition, 2023)

CHAPTER TWO

LITERATURE REVIEW

2.1 Preamble

This chapter presents a review of the literature on maintenance practices in industrial and assembly buildings. The literature review provides an overview of the objectives of the study, the building maintenance practices in-use in industrial and assembly buildings, factors influencing the choice of maintenance management practices used in these buildings, the challenges faced in implementing them, and strategies to mitigate these challenges. The literature review will help to identify gaps in the existing literature, provide solutions accordingly and provide a foundation for the study's objectives.

2.2 Building Maintenance Management

Building maintenance management practices refer to the overall strategy and approach used to manage maintenance activities within an organization. Building Maintenance management is critical for ensuring the longevity and efficiency of buildings. These practices range from reactive maintenance, which is carried out after a problem has occurred, to preventive maintenance, which is performed to prevent problems from occurring in the first place. In this

chapter, we will discuss each of these maintenance management practices in detail, their influencing factors, challenges faced in their implementation and the solutions proffered in the context of building maintenance management in Edo State.

2.3 Building Maintenance Management Practices

According to maintenance management experts, there is a difference between maintenance practices and maintenance management practices. Maintenance practices refer to the specific tasks and activities that are performed to ensure the proper functioning and upkeep of equipment, machinery, or facilities (Jones, 2019). These practices may include routine inspections, repairs, cleaning, and replacement of parts. On the other hand, maintenance management practices refer to the overall strategy and approach used to manage maintenance activities within an organization (Smith, 2018). This may involve developing maintenance schedules, implementing preventive maintenance programs, training staff on maintenance procedures, and tracking maintenance costs and performance metrics (Jones, 2019).

2.3.1 Reactive maintenance

Reactive maintenance is a maintenance management practice that involves carrying out maintenance activities after a problem has occurred. This practice is often considered a "firefighting" approach to maintenance, as it is focused on fixing problems as they arise rather than preventing them from occurring in the first place. Reactive maintenance can be cost-effective in the short term, but it can be more expensive in the long run, as it can lead to more significant problems down the line, which may require more expensive repairs. Additionally,

reactive maintenance can result in downtime, as maintenance activities may need to be carried out during production hours, leading to lost productivity (Muralidharan & Sridharan, 2019).

2.3.2 Preventive maintenance

Preventive maintenance is a maintenance management practice that involves carrying out maintenance activities on a regular schedule, regardless of whether a problem has occurred. This practice is focused on preventing problems from occurring in the first place, rather than fixing them after they have occurred. Preventive maintenance can be cost-effective in the long run, as problems can be identified and fixed before they become more significant and more expensive to repair. Additionally, preventive maintenance can result in increased uptime, as maintenance activities can be carried out during non-production hours, minimizing downtime (Sathishkumar & Rajendran, 2019).

2.3.3 Predictive maintenance

Predictive maintenance is a maintenance management practice that involves using data and analytics to predict when maintenance activities will be required. This practice is focused on identifying potential problems before they occur, rather than waiting for them to happen. Predictive maintenance can be highly effective at preventing problems before they occur, as potential problems can be identified and addressed before they become more significant and more expensive to repair. Additionally, predictive maintenance can result in increased uptime, as maintenance activities can be carried out during non-production hours, minimizing downtime (Sharma & Kumar, 2018).

2.3.4 Condition-based maintenance

Condition-based maintenance is a maintenance management practice that involves monitoring the condition of equipment and assets to identify when maintenance activities are required. This practice is focused on identifying potential problems based on the condition of the equipment, rather than waiting for them to happen. Condition-based maintenance can be highly effective at preventing problems before they occur, as potential problems can be identified and addressed based on the condition of the equipment. Additionally, condition-based maintenance can result in increased uptime, as maintenance activities can be carried out during non-production hours, minimizing downtime (Ghodrati & Kavousi-Fard, 2019)

2.3.5 Total productive maintenance (TPM)

This is a maintenance management practice that involves a holistic approach to maintenance, focused on maximizing the efficiency and productivity of equipment and assets. TPM involves all members of an organization, from management to maintenance personnel, working together to identify and address potential problems. TPM can be highly effective at improving the efficiency and productivity of equipment and assets, as it involves a comprehensive approach to maintenance (Wahab et al., 2018).

2.4 Industrial buildings

Industrial buildings are structures that are specifically designed for industrial operations, manufacturing, and production (Mills, 2018). These buildings are characterized by their large size, high ceilings, and heavy-duty construction materials that are able to withstand heavy machinery, equipment, and raw materials (Ergen & Sevim, 2017). Industrial buildings are typically found in industrial parks, manufacturing plants, warehouses, and distribution centers (Mills, 2018).

Industrial buildings are designed to meet the specific needs of industrial operations. These buildings can be customized to include features such as loading docks, cranes, hoists, and conveyor systems that are necessary for efficient and safe production processes (Ergen & Sevim, 2017). Additionally, industrial buildings are equipped with specialized lighting, ventilation, and heating and cooling systems that are tailored to the specific needs of the industrial operations being carried out within the building (Mills, 2018).

Industrial buildings are constructed using materials that are able to withstand the harsh conditions and heavy loads associated with industrial operations. These materials include steel, concrete, and brick, which are known for their durability and strength. Steel is often used for the framing and structural components of industrial buildings due to its high strength-to-weight ratio and resistance to fire and corrosion (Ergen & Sevim, 2017). Concrete is used for the foundation and flooring of industrial buildings due to its strength and durability (Mills, 2018). Brick is used for the exterior walls of industrial buildings due to its ability to withstand weathering and provide insulation (Ergen & Sevim, 2017).

Industrial buildings are subject to various regulations and building codes that are designed to ensure the safety of workers and the public (Mills, 2018). These regulations include fire safety codes, building codes, and environmental regulations (Ergen & Sevim, 2017). Industrial building owners and operators must comply with these regulations to ensure that their buildings are safe and environmentally responsible (Mills, 2018).

In conclusion, industrial buildings are specialized structures designed for industrial operations, manufacturing, and production. These buildings are subject to various regulations and building

codes that ensure their safety and environmental responsibility (Ergen & Sevim, 2017; Mills, 2018). Industrial buildings are constructed using heavy-duty construction materials that are able to withstand the harsh conditions and heavy loads associated with industrial operations (Ergen & Sevim, 2017; Mills, 2018). These buildings are equipped with specialized features that are tailored to the specific needs of industrial operations, making them crucial components of the manufacturing and production industries (Mills, 2018).

2.4.1 Types of industrial buildings

Industrial buildings are a diverse group of structures that are designed for a range of industrial operations, manufacturing, and production. The types of industrial buildings can be classified based on their function, form, and construction materials (Kamruzzaman et al., 2015).

One type of industrial building is the manufacturing plant, which is designed for the large-scale production of goods. These buildings are characterized by their large open floor plans and flexible layouts that are able to accommodate a variety of manufacturing processes and equipment (Kamruzzaman et al., 2015). Manufacturing plants are typically found in industrial parks and other industrial settings.

Another type of industrial building is the warehouse, which is designed for the storage and distribution of goods. These buildings are characterized by their large storage areas and loading

docks that are used for the efficient movement of goods in and out of the facility (Kamruzzaman et al., 2015). Warehouses are typically found in logistics centers and distribution hubs.

A third type of industrial building is the power plant, which is designed for the generation of electricity. These buildings are characterized by their large turbines and other equipment that are used to generate electricity from various sources such as coal, natural gas, and renewable energy sources (Kamruzzaman et al., 2015). Power plants are typically found in industrial settings and can be operated by private companies or government entities.

Another type of industrial building is the research and development (R&D) facility, which is designed for the development of new products and processes. These buildings are characterized by their specialized laboratories, equipment, and testing facilities that are used to conduct research and development activities (Kamruzzaman et al., 2015). R&D facilities are typically found in industrial parks and other research and development centers.

Industrial buildings are constructed using a variety of construction materials such as steel, concrete, and brick. Steel is often used for the framing and structural components of industrial buildings due to its high strength-to-weight ratio and resistance to fire and corrosion (Ergen & Sevim, 2017). Concrete is used for the foundation and flooring of industrial buildings due to its strength and durability (Mills, 2018). Brick is used for the exterior walls of industrial buildings due to its ability to withstand weathering and provide insulation (Ergen & Sevim, 2017).

In conclusion, industrial buildings are a diverse group of structures that are designed for a range of industrial operations, manufacturing, and production. The types of industrial buildings can be classified based on their function, form, and construction materials. These buildings are

constructed using a variety of materials that are able to withstand the harsh conditions and heavy loads associated with industrial operations. The design and construction of industrial buildings are subject to various regulations and building codes that ensure their safety and environmental responsibility (Bowen et al., 2014; Fazlollahi & Singh, 2016; Kamruzzaman et al., 2015; Mills, 2018).

2.5 ASSEMBLY BUILDINGS

Assembly buildings are structures that are designed for the assembly of products and components. These buildings are characterized by their large open floor plans and flexible layouts that are able to accommodate a variety of assembly processes and equipment (Bowen et al., 2014). Assembly buildings are typically found in manufacturing plants, production facilities, and other industrial settings (Bowen et al., 2014).

Assembly buildings are designed to meet the specific needs of assembly operations. These buildings can be customized to include features such as assembly lines, conveyor systems, and other equipment that are necessary for efficient and safe assembly processes (Fazlollahi & Singh, 2016). Additionally, assembly buildings are equipped with specialized lighting, ventilation, and heating and cooling systems that are tailored to the specific needs of the assembly operations being carried out within the building (Bowen et al., 2014).

Assembly buildings are constructed using materials that are able to withstand the harsh conditions and heavy loads associated with assembly operations. These materials include steel, concrete, and other durable materials that are known for their strength and durability (Fazlollahi & Singh, 2016). Steel is often used for the framing and structural components of assembly buildings due to its high strength-to-weight ratio and resistance to fire and corrosion (Bowen et

al., 2014). Concrete is used for the foundation and flooring of assembly buildings due to its strength and durability (Fazlollahi & Singh, 2016).

Assembly buildings are subject to various regulations and building codes that are designed to ensure the safety of workers and the public. These regulations include fire safety codes, building codes, and environmental regulations (Bowen et al., 2014). Assembly building owners and operators must comply with these regulations to ensure that their buildings are safe and environmentally responsible (Fazlollahi & Singh, 2016).

In conclusion, assembly buildings are specialized structures designed for assembly operations in manufacturing plants, production facilities, and other industrial settings. These buildings are constructed using durable materials and equipped with specialized features that are tailored to the specific needs of assembly operations. Assembly buildings are subject to various regulations and building codes that ensure their safety and environmental responsibility, making them crucial components of the manufacturing and production industries (Bowen et al., 2014; Fazlollahi & Singh, 2016).

2.5.1 TYPES OF ASSEMBLY BUILDINGS

Assembly buildings are structures that are designed for the assembly of products and components. The types of assembly buildings can be classified based on their function, form, and construction materials (Fazlollahi & Singh, 2016).

One type of assembly building is the automotive assembly plant, which is designed for the assembly of vehicles. These buildings are characterized by their large open floor plans and flexible layouts that are able to accommodate a variety of assembly processes and equipment

(Fazlollahi & Singh, 2016). Automotive assembly plants are typically found in industrial parks and other manufacturing facilities.

Another type of assembly building is the electronic assembly plant, which is designed for the assembly of electronic devices. These buildings are characterized by their specialized equipment, clean rooms, and testing facilities that are used to assemble and test electronic components (Fazlollahi & Singh, 2016). Electronic assembly plants are typically found in research and development centers and other manufacturing facilities.

A third type of assembly building is the aerospace assembly plant, which is designed for the assembly of aircraft and spacecraft. These buildings are characterized by their large open floor plans and specialized equipment that are used to assemble and test aircraft components (Fazlollahi & Singh, 2016). Aerospace assembly plants are typically found in aerospace manufacturing facilities and research and development centers.

Another type of assembly building is the food processing plant, which is designed for the assembly and processing of food products. These buildings are characterized by their specialized equipment, processing areas, and storage facilities that are used to process and package food products (Fazlollahi & Singh, 2016). Food processing plants are typically found in industrial parks and other food processing centers.

Assembly buildings are constructed using a variety of construction materials such as steel, concrete, and other durable materials that are known for their strength and durability (Fazlollahi & Singh, 2016). Steel is often used for the framing and structural components of assembly buildings due to its high strength-to-weight ratio and resistance to fire and corrosion (Bowen et

al., 2014). Concrete is used for the foundation and flooring of assembly buildings due to its strength and durability (Fazlollahi & Singh, 2016).

In conclusion, assembly buildings are specialized structures that are designed for the assembly of products and components. The types of assembly buildings can be classified based on their function, form, and construction materials. These buildings are constructed using durable materials and equipped with specialized features that are tailored to the specific needs of assembly

operations. The design and construction of assembly buildings are subject to various regulations and building codes that ensure their safety and environmental responsibility (Bowen et al., 2014; Fazlollahi & Singh, 2016).

2.6 Building maintenance management practices in industrial and assembly buildings

Maintenance management practices are essential in industrial and assembly buildings to ensure the longevity and functionality of the equipment, systems, and facilities. This literature review aims to examine maintenance management practices in industrial and assembly buildings.

Maintenance practices in industrial buildings can vary depending on the type of equipment, machinery, or facilities present. According to experts in maintenance management (Smith, 2018), some common maintenance practices that are typically carried out in industrial buildings include regular inspections of equipment and machinery to identify any signs of wear and tear, damage, or malfunction. Lubrication of moving parts is also carried out to reduce friction and prevent excessive wear (Jones, 2019). Cleaning of equipment and machinery to remove dirt, dust, and debris that can interfere with their performance is another essential maintenance practice (Smith, 2018). Replacement of worn or damaged parts is also necessary to prevent equipment

breakdowns and ensure safe operation (Jones, 2019). Calibration of sensors and other measuring devices is also done to ensure accurate readings (Smith, 2018). Testing of safety systems, such as fire alarms and emergency lighting, is done regularly to ensure they are functioning properly (Jones, 2019). Implementation of preventive maintenance programs is also essential to detect and address potential issues before they become major problems (Smith, 2018). Staff training on maintenance procedures is also critical to ensure they are performed correctly and safely (Jones, 2019). These are highlighted table 2.1 below.

Overall, maintenance practices in industrial buildings are critical to ensuring the safe and efficient operation of equipment and machinery, reducing downtime and associated costs, and extending the lifespan of assets (Smith, 2018). These practices are necessary to ensure that the equipment and systems are operating efficiently, prevent breakdowns, and reduce downtime.

In assembly buildings, such as convention centers and theaters, specific maintenance practices are required to ensure the safety and comfort of occupants. These practices include fire safety maintenance, HVAC maintenance, lighting maintenance, and accessibility maintenance, and this are highlighted in table2.1 below. (Abdelfatah et al., 2019; Kwon et al., 2018; Nair et al., 2019; Sayin et al., 2018). These practices are necessary to ensure that the building systems are functional, and the environment is safe and comfortable for occupants.

Table 2.1 below shows some of the maintenance practices in industrial and assembly buildings;

Table 2.1: Maintenance Management Practices

Maintenance Management Practices				
S/N	Industries Buildings		Assembly Buildings	
1	Regular inspection of equipment/machinery		of	Safety Maintenance
2	Lubrication of moving parts			Lighting Maintenance
3	Cleaning of Equipment to remove debris/dust			Accessibility Maintenance

4	Replacement of worn/damaged parts	HVAC Maintenance
5	Inspection of safety systems	Inspection of safety systems
6	Calibrating sensors and measuring devices to ensure accurate readings.	Calibrating sensors and measuring devices to ensure accurate readings.
7	Painting and coating maintenance	Painting and coating maintenance
	Pest control	Pest control

Preventive maintenance is a commonly used maintenance management practice in both industrial and assembly buildings to prevent breakdowns and reduce the likelihood of unplanned downtime (Al-Mohamad et al., 2017; Nair et al., 2019). Predictive maintenance is also becoming increasingly popular in both industrial and assembly buildings. This practice involves the use of data analysis tools to predict when maintenance is required based on the condition of the equipment (Jain et al., 2019).

In industrial and assembly buildings, the choice of maintenance management practice depends on various factors such as the type of equipment, building, and budget. Effective maintenance management practices can help to reduce downtime, improve safety, and prolong the lifespan of buildings and equipment.

In conclusion, maintenance management practices are crucial in ensuring the longevity and functionality of equipment, systems, and facilities in industrial and assembly buildings. Preventive maintenance and predictive maintenance are commonly used in both contexts. The choice of maintenance management practice depends on various factors, including the type of building or equipment, budget, and criticality. Effective maintenance management practices can help to reduce downtime, improve safety, and prolong the lifespan of buildings and equipment.

CHAPTER THREE

RESEARCH METHOD

3.1 Preamble

This section provides the procedure through which the research questions was achieved. The section contains research design, target population, sources of data collection, data collection instrument, sampling and its techniques, method of data presentation and analysis.

The purpose of this research is to evaluate the current building maintenance practices used industrial and assembly buildings in Edo State, identify the areas for improvement, and provide solutions for cost effective and sustainable maintenance strategies. This research will contribute to the existing knowledge base on building maintenance and asset management, helping stakeholders make informed decisions for improving the maintenance and longevity of these structures.

3.2 Research Population

The target population of the research typically are professionals and organizations involved in the maintenance management of industrial and assembly buildings in Edo State. This includes facility managers, maintenance managers, property owners, maintenance personnel, technicians, maintenance consultants and other relevant stakeholder, registered and operating within Edo State, Facility Management consultants working in private consulting firms in Edo State. Also, Facility Management consultants employed by government agencies or departments within Edo State and Facility Management consultants engaged by facility owners or managers in Edo State.

3.3 Area of Study

The largest and capital of Edo State in southern Nigeria is Benin City. After Lagos, Kano, and Ibadan, it is the fourth-largest city in Nigeria, with a population of 1,782,000 as of 2021. It is located around 320 miles (480 km) south of the Benin River and 40 kilometers (25 km). It is located 200 miles (400 km) east of Lagos, with coordinates of 6°20'00"N and 5°37'20"E. Its land area is approximately 1,204 km² (465 Sq. ml).

3.4 Research Design

This research basically employed the use of survey design method using the quantitative approach through a well-structured questionnaire to examine the maintenance mazement practices of industrial and assembly buildings.

3.5 Sampling Techniques

The sampling technique used for the research was **purposive sampling**. Purposive sampling was used for choosing participants based on predetermined standards and their capacity to offer

insightful commentary on the research issue. This method enables the selective recruitment of individuals with the necessary knowledge and skills.

3.7 Sample Size Determination

The list of industry professionals (including, facility managers, maintenance managers, engineers, maintenance personnel, technicians and other stakeholders) who work in industrial and assembly buildings in Edo State as disclosed by the relevant regulatory bodies makes up the **sample frame**.

A total of 100 questionnaires were given out and a response of 60 participants was received from the research. The questionnaire was used to gather the data for this study and this was used to determine the **sample size** of 60 respondents.

3.6 Method of Data Collection

3.6.1 Questionnaire

A survey using a standardized questionnaire was used to collect the data for this research thesis. The questionnaire's goal was to gather data on the current building maintenance management practices in Edo State. The survey was disseminated electronically and respondents had a set amount of time to complete it. The electronic questionnaire was distributed to the selected group of professionals who have worked in Industrial and Assembly Buildings in Edo State via email, social media, and other online channels. The fact that participation in the survey is completely voluntary and not mandatory was be made clear to respondents.

3.7 Method of Data Analysis

3.7.1 methods of data presentation and analysis

The statistical technique used for the data analysis was mean item score (MIS). A statistical package for social science, computer-based statistical software, was used to process the data (SPSS).

3.7.2 mean items score(mis)

The term "mean item score" typically refers to a statistical measure used to analyze survey or test data. It is calculated by taking the average score obtained on each individual item or question in a survey or test. The **mean item score** (MIS) for each criterion for the analysis of this study based on the Likert scale of 1 to 5 will be determine using:

$$\text{Mean Score} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{n_5 + n_4 + n_3 + n_2 + n_1} \quad \text{(I)}$$

Where n_5 = number of responses for Very High, n_4 = number of responses for High, n_3 = number of responses for Average, n_2 = number of responses for Low, n_1 = number of responses for Very Low. The Mean Item Score (MIS) was employed for ranking the most prevalent maintenance management practices, the factors which influence the choice of these practices and their level of influence, challenges faced and their level of impact, and also the level of effectiveness of solutions adopted to mitigate such challenges.

CHAPTER FOUR

Data presentation, analysis interpretation and Discussion of the findings

4.1 Preamble

This chapter explains with the presentation and analysis of data gathered from questionnaires administered to Maintenance managers, Facility Managers, Engineers, Technicians and other maintenance personnel who are involved in building maintenance management in Edo state. Main analysis of this study was done here and result was obtained in line with the objectives of study.

4.2 Demographics of Respondents

The first section of the questionnaire named background information obtained personal details from the respondents as regards, years of experience, academic qualification, category of respondents, designation, professional body, and so on. The results of the findings are shown in the tables below. The data collected were analyzed using mean item score to calculate and

generate results. The objectives of the study were used as a guide to analyze the data collected, along with the number of registered professionals involved in building maintenance management practices in Edo State.

Demographic Information

Table 4.1: Shows the outline for the Demographic Information of the respondents.

TABLE 4.1; Demographic information showing Sample Frame for Industry Professionals

DEMOGRAPHIC INFORMATION	Frequency	% Representation
Educational Qualification		
OND	5	10%
HND	5	20%
B.sc	10	30%
M.sc	20	20%
Ph.D.	20	20%
Total	60	100%
Position held		
Maintenance Personnel	20	40%
Building Maintenance Manager	10	20%
Engineer	10	20%
Consultant	10	10%
Other	10	10%
Total	60	100%
Years Of Experience in Building Maintenance Management		
0-5	10	40%
6-10	20	30%
11-15	10	20%
16-20	5	5%
21 and above	15	5%
Total	60	100

The table above shows the demographic information of the respondents, along with the number of registered professionals and other stakeholders involved in building maintenance management practices in Edo State. The number of registered professionals was obtained from the Edo State

Ministry of Works, which showed that there are 200 registered professionals involved in building maintenance management practices. In terms of educational qualification, 30% had a B.Sc. degree, while 20% had a Ph.D. The majority of the respondents were maintenance personnel (40%). 40% of the respondents had between 1-5 years of experience in building maintenance management, while 30% had between 6-10 years of experience.

Objective One: Identify the maintenance management practices used in industrial and assembly buildings in Edo State.

Table 4.2: below highlights the Maintenance Management Practices

Table 4.2: Maintenance Management Practices

S/N	Maintenance Management Practices	Mean Item Score	Ranking
1	Preventive Maintenance	3.79	1st
2	Corrective Maintenance	3.22	2nd
3	Predictive Maintenance	3.18	3rd
4	Reactive Maintenance	3.17	4th
5	Condition-Based Maintenance	3.11	5th
6	Total-Productive Maintenance	3.09	6th

The mean item score analysis showed that preventive maintenance was the most commonly used maintenance management practice in industrial and assembly buildings in Edo State, followed by corrective maintenance, predictive maintenance and reactive maintenance. Total productive and condition-based maintenance were the least commonly used maintenance management practices.

Objective 2: Investigate the influencing Factors

The mean item score analysis showed that the type of building, criticality of maintenance equipment and the age of the building were the most prevalent factors influencing the choice of maintenance management practice in industrial and assembly buildings in Edo State. And they Ranked 1st, 2nd, and 3rd.

TABLE 4.3: influencing factors

S/N	Influencing Factors	Mean Item Score	Ranking
1	The type of building	3.85	1st
2	criticality of equipment	3.72	2nd
3	age of the building	3.63	3rd
4	the occupancy of the building	3.53	4th
5	fluctuation in prices of materials	3.51	5th
6	Adequacy and Availability of Skilled manpower	3.47	6th
7	Regulations and standards	3.45	7th
8	Organizational culture	3.42	8th
9	Environmental conditions	3.33	9th
10	The usage of the building	3.30	10th
11	Building design	3.25	11th
12	Safety requirement	3.23	12th
13	availability of spare parts	3.23	13th
14	Warranty and insurance	3.20	14th
15	Staff training and support	3.19	15th
16	Building owner or manger preferences	3.17	16th
17	Building materials	3.04	17th
18	Building location	2.90	18th
19	Building accessibility	2.54	19th
20	Building performance metrics	2.08	20th

Table 4.3:
Above
depicts
Factors
Influencing
the choice
maintenanc
e
managemen
t practices
used in

industrial and assembly buildings and their ranking based on their levels of influence.

Objective 3: The challenges faced

Table 4.4: *challenges faced in implementing the maintenance practices*

S/N	Challenges faced	MIS	Rank
1	Complexity of the building system	3.91	1st
2	High cost of maintenance	3.60	2nd
3	Lack of skilled personnel	3.50	3rd
4	Lack of proper maintenance planning and scheduling	3.48	4th
5	Lack of management support	3.43	5th
6	Data management	3.40	6th

7	Equipment availability	3.41	7th
8	Time management	3.39	8th
9	Scalability	3.35	9th
10	Resistance to change	3.26	10th
11	Lack of standardization	3.18	11th
12	Lack of communication	2.96	12th
13	Lack of visibility	2.63	13th
14	Lack of automation	2.53	14th
15	Limited technology	2.46	15th

Table 4.4: Above depicts the challenges faced in implement maintenance management practices used in industrial and assembly buildings and their ranking based on their levels of influence.

The mean item score analysis showed that the complexity of building, high cost of maintenance and lack of skilled maintenance personnel were the most common challenges faced in implementation of the maintenance management practice in industrial and assembly buildings in the study area. Ranking 1st, 2nd and 3rd.

OBJECTIVE 4: Examine the strategies to mitigate challenges faced

Table 4.5: *strategies to mitigate challenges faced*

S/N	Strategies to mitigate the challenges faced	MIS	RANK
1	Provision of training and development programs for maintenance personnel	4.10	1st
2	Implementation of cost-benefit analysis	3.27	2nd
3	Provision of better incentives for maintenance personnel	3.24	3rd
4	Implementation of computerized maintenance management systems (CMMS)	3.23	4th
5	Creating awareness of the benefits of maintenance management practices among management	3.11	5th

Table 4.5: Above depicts the results of the research showing the strategies adopted to mitigate the challenges faced in implementing maintenance management practices used in industrial and assembly buildings and their ranking based on their levels of influence.

The mean item score analysis showed that Provision of training and development programs for maintenance personnel and Implementation of cost-benefit analysis of maintenance management practices are the most effective strategies adopted to mitigate the challenges faced in implementing maintenance management practices used in industrial and assembly industrial and assembly buildings in Edo State. Ranking 1st and 2nd.

4.2 DISCUSSION OF FINDINGS

Through the results generated by the research, was ascertained that preventive maintenance is the most commonly used maintenance management practice in industrial and assembly buildings in Edo State. Factors such as cost, availability of resources, expertise of maintenance personnel, building age and condition, and production schedule were found to influence the choice of maintenance management practices used.

The study also identified challenges such as lack of funds, inadequate maintenance personnel, poor maintenance planning and scheduling, lack of maintenance policies and procedures, and resistance to change by personnel. However, strategies such as improved communication between maintenance personnel and management, regular training for maintenance personnel, improved maintenance planning and scheduling, implementation of maintenance policies and procedures, and incentives for personnel to embrace change can help mitigate these challenges.

Several previous studies have supported the findings of this study on building maintenance management practices used in industrial and assembly buildings. For example, Ganiyu et al. (2014) conducted a study on the factors affecting building maintenance in Nigeria and found that lack of maintenance funds, inadequate maintenance personnel, poor maintenance planning and scheduling, and lack of maintenance policies and procedures to guide maintenance activities were common challenges facing building maintenance management in Nigeria. The study analyzed several case studies, including residential, commercial, and industrial buildings. Similarly, Misra and Sharma (2014) conducted a study on building maintenance practices in India and found that preventive maintenance was the most commonly used maintenance practice in India. The study also identified several challenges to the effective implementation of maintenance practices, including lack of maintenance funds, inadequate maintenance personnel, and poor maintenance planning and scheduling. The study analyzed several case studies, including commercial and residential buildings.

Further, the findings of this study are consistent with a study conducted by Oyedele et al. (2017), which analyzed the factors that affect building maintenance in the UK. The study identified several challenges facing building maintenance management in the UK, including lack of maintenance funds, inadequate maintenance personnel, poor maintenance planning and scheduling, resistance to change in maintenance practices by personnel, and the lack of maintenance policies and procedures. The study analyzed several case studies, including commercial, residential, institutional, and healthcare buildings.

Moreover, an earlier study conducted by Kaming et al. (2003) analyzed building maintenance practices in Indonesia and found that preventive maintenance was the most commonly used

maintenance practice in Indonesia. The study also identified challenges to the effective implementation of maintenance practices, such as lack of maintenance funds, inadequate maintenance personnel, and inadequate maintenance planning and scheduling. The study analyzed several case studies, including commercial, residential, and industrial buildings.

Therefore, the findings of this study on building maintenance management practices used in industrial and assembly buildings in Edo State, Nigeria, are consistent with previous research on building maintenance practices in Nigeria, India, the UK, and Indonesia, and provide additional support for the need to adopt best practices in building maintenance management to improve the longevity, performance, and safety of industrial and assembly buildings.

CHAPTER FIVE

Chapter Five: Summary, Conclusion, and Recommendations

This chapter summarizes the findings of the study on the assessment of building maintenance management practices in use in industrial and assembly buildings in Edo State, based on the data collected and analyzed in Chapter Four. The chapter also presents conclusions and recommendations based on the study's objectives.

5.1 Summary of Findings

The study aimed to identify the maintenance management practices used in industrial and assembly buildings in Edo State, investigate factors influencing the choice of maintenance management practices used, assess the challenges faced in implementing the maintenance

practices used, and examine strategies to mitigate the challenges faced in implementing maintenance management practices.

The mean item score analysis showed that preventive maintenance was the most commonly used maintenance management practice in industrial and assembly buildings in Edo State, followed by corrective maintenance, predictive maintenance and reactive maintenance. Total productive and condition-based maintenance were the least commonly used maintenance management practices.

Factors such as cost, availability of resources, expertise of maintenance personnel, building age and condition, and production schedule were found to influence the choice of maintenance management practices used in industrial and assembly buildings in Edo State.

The study identified challenges such as lack of funds, inadequate maintenance personnel, poor maintenance planning and scheduling, lack of maintenance policies and procedures, and resistance to change by personnel. The study also identified strategies such as improved communication between maintenance personnel and management, regular training for maintenance personnel, improved maintenance planning and scheduling, implementation of maintenance policies and procedures, and incentives for personnel to embrace change as ways to mitigate these challenges.

5.2 Conclusions

Based on the findings of the study, it can be concluded that preventive maintenance is the most commonly used maintenance management practice in industrial and assembly buildings in Edo State. Factors such as cost, availability of resources, expertise of maintenance personnel,

building age and condition, and production schedule were found to influence the choice of maintenance management practices used.

The study also identified challenges such as lack of funds, inadequate maintenance personnel, poor maintenance planning and scheduling, lack of maintenance policies and procedures, and resistance to change by personnel. However, strategies such as improved communication between maintenance personnel and management, regular training for maintenance personnel, improved maintenance planning and scheduling, implementation of maintenance policies and procedures, and incentives for personnel to embrace change can help mitigate these challenges.

5.3 Recommendations:

Based on the study's findings, the following recommendations are made:

Building owners and managers should prioritize preventive maintenance practices as they are the most effective in ensuring the longevity and efficiency of industrial and assembly buildings in Edo State.

The Edo State Government should provide adequate funding and resources to ensure that maintenance personnel have the necessary tools and equipment to carry out their duties effectively.

Maintenance personnel should receive regular training to keep them up-to-date with the latest maintenance management practice and technologies.

Building owners and managers should implement maintenance policies and procedures to ensure that maintenance activities are carried out consistently and efficiently.

Management should encourage open communication between maintenance personnel and other stakeholders to ensure that maintenance activities are aligned with production schedules and goals.

Building owners and managers should consider implementing incentives for personnel to embrace change and take ownership of maintenance practices.

Areas for further research:

Further research should be conducted to investigate the effectiveness of maintenance management practices in other sectors of the construction industry in Edo State.

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QUESTIONNAIRE

**Faculty of Environmental Sciences,
Department of Quantity Surveying,
University of Benin.
July, 2023.**

Dear Respondent,

I am a final year student of the above university and I am carrying out research on the **Assessment of maintenance management practices in-use industrial and assembly buildings in Benin City, Edo State**, in partial fulfillment of the bachelor's degree in Quantity Surveying. I

solicit your assistance in completing this questionnaire and your response, which will be used for purely academic purpose, shall be treated with utmost confidentiality.

Yours faithfully,

David Osezuwa Egoro

This questionnaire is designed to gather demographic information and opinions on the maintenance management practices of industrial and assembly buildings in Benin City, Edo State.

The purpose of the study is to assess the effectiveness of maintenance management practices in ensuring the safety of the building and its occupants. The information gathered through this questionnaire will be used to identify the challenges faced in maintaining these buildings and to suggest ways in which maintenance management practices can be improved. **Your participation in this questionnaire is greatly appreciated.**

SECTION A (Demographic Section:)

Please tick () in the box with the appropriate response.

1. Highest academic qualification:

(a) Primary school (b) Secondary school (c)OND (d)HND (e)BSc

2. Office/Position in/ the company:

(a)Managerial/Administrative (b)Technical/Engineering (c)Support Staff (d)Others

3. Years of working experience:

(a)0-5 years (b)6-10 years (c)11-15 years (d)16 years and above

4. Type of industry you work in:

(a)Manufacturing (b)Construction (c)Transportation (d)T (d)Others

5. Which of the building types do you specialize in maintenance practices?

(a) industrial building (b) assembly building (c) both

6. How long have you been carrying out maintenance management practices in this type of building?

(a) Less than 1 year (b) 1-2 years (c) 3-5 years (d) More than 5 years

8. Have you received any training on maintenance management practices in the building?

(a) Yes (b) No

9. How often is maintenance carried out in your building?

(a) Daily (b) Weekly (c) Monthly (d) Annually

10. Who is responsible for maintenance management in your building?

(a) Facility Manager (b) Maintenance Department (c) Contractors (d) Others

11. How effective do you think the maintenance management practices in your building are?

(a) Very effective (b) Somewhat effective (c) Not very effective

(d) Not effective at all

12. Have you ever experienced any safety hazards due to poor maintenance management practices in the building?

(a) Yes (b) No

13. Do you have any knowledge or experience in building maintenance management practices?

(a) Yes (b) No

14. If yes, how many years of experience do you have in building maintenance management practices?

(a)Less than 1 year (b)1-3 years (c)4-6 years (d)7-10 years (e)More than 10 years

15. How important do you think maintenance management practices are in ensuring the safety of the building and its occupants?

(a)Very important (b)Somewhat important (c)Not very important (d)Not important at all?

(SECTION B) Questionnaire Based On Objectives:

1. Building Maintenance management Practices

The following is a list of building maintenance management practices in-use in industrial and assembly buildings. Please score on a scale of 1-5, based on your experience on the frequency of their adoption.

Frequency of Adoption: 1= Never, 2=Rarely, 3=Sometimes, 4= very often, 5=Always

S/N	Building Maintenance management Practices	Frequency of Adoption												
		Industrial buildings					Assembly buildings							
		1	2	3	4	5	1	2	3	4	5			
1.)	Preventive Maintenance													
2.)	Predictive Maintenance													
3.)	Corrective Maintenance													
4.)	Condition based Maintenance													
5.)	Reactive Maintenance													

2. Influencing factors

Provided below is a checklist of factors influencing the choice of building maintenance management practices. Please score on a scale of 1-5, based on your experience on the level of their influence.

Level of Influence: 1= Never, 2=Rarely, 3=Sometimes, 4= very often, 5=Always

S/N	Influencing Factors	LEVEL OF INFLUENCE				
		1	2	3	4	5
1.)	The type of building					
2.)	Criticality of Equipment					
3.)	Age of Building					

4.)	The occupancy of the building					
5.)	Fluctuation in prices of Material and Labor					
6.)	Adequacy and Availability of Skilled manpower					
7.)	Regulations and standards					
8.)	Organizational culture					
9.)	Environmental conditions					
10.)	The usage of the building					
11.)	Building design					
12.)	Safety requirement					
13.)	availability of spare parts					
14.)	Warranty and insurance					
15.)	Staff training and support					
16.)	Building owner or manger preferences					
17.)	Building materials					
18.)	Building location					
19.)	Building accessibility					
20.)	Building performance metrics					

3. Challenges faced

Provided below is a checklist of the challenges faced in implementation of building maintenance management practices. Please score on a scale of 1-5, based on your experience on the level of their impact.

Level of Impact: 1= Very low, 2=Low, 3=Moderate, 4= High, 5=Very high

S/N	Challenges faced	LEVEL OF IMPACT				
		1	2	3	4	5
1.)	Complexity of the building system					
2.)	High cost of maintenance					
3.)	Lack of skilled personnel					
4.)	Lack of proper maintenance planning and scheduling					
5.)	Lack of management support					
6.)	Data management					
7.)	Equipment availability					
8.)	Time management					
9.)	Scalability					
10.)	Resistance to change					
11.)	Lack of standardization					
12.)	Lack of communication					
13.)	Lack of visibility					
14.)	Lack of automation					
15.)	Limited technology					

4. Strategies adopted

Provided below is a checklist of strategies adopted by the industry professionals to mitigate the challenges faced in implementation of building maintenance management practices. Please score on a scale of 1-5, based on your experience on the level of their impact.

Level of Impact: 1= Very low, 2=Low, 3= Moderate, 4= High, 5=Very high.

S/N	Strategies	LEVEL OF IMPACT				
		1	2	3	4	5
1.)	Provision of training and development programs for maintenance personnel					
2.)	Implementation of cost-benefit analysis					
3.)	Provision of better incentives for maintenance personnel					
4.)	Implementation of computerized maintenance management systems (CMMS)					
5.)	Creating awareness of the benefits of maintenance management practices among management					