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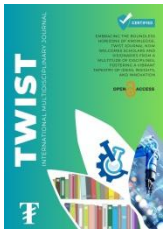

Building Resilient Infrastructure to Support Sustainable Industrial Growth in Nigeria by Resolving Issues with Maintenance Procedures

Samson Adedayo Adeleye*
Department of Mechanical Engineering, Ekiti State University, Ado-Ekiti, Nigeria
[**Corresponding author*]

Benjamin Segun Oluwadare
Department of Mechanical Engineering, Ekiti State University, Ado-Ekiti, Nigeria

Oluwafemi Festus Olaiyapo
Department of Mathematics, Emory University, Atlanta, United States

Abstract
Among the most significant factors while determining the level of industrial development of a nation is the sufficiency and effectiveness of its core infrastructure. The provision and maintenance of infrastructural facilities stimulate economic growth and enhance the development prospects of a nation. This paper briefly discusses the availability and problems associated with Nigeria's current engineering infrastructure facilities. It also addresses the efficient upkeep of Nigeria's public infrastructure. Nigerian public facility maintenance performance metrics are covered in this paper. It emphasizes the importance of spare parts and the various departments that are involved in maintenance either directly or indirectly and how they can function together to improve the upkeep of Nigeria's public infrastructure. The difficulties that engineering professionals face in maintaining their practices are listed in the article, along with issues that prevent public facilities in Nigeria from being maintained effectively. Suggested approaches and actions are provided for efficient upkeep of infrastructure and resolving issues that Nigerian engineering practitioners face when performing maintenance procedures.

Keywords
Maintenance, Maintenance culture, Maintenance practice, Infrastructural facilities, Public organization, Nigeria

INTRODUCTION

For most organizations, maintenance represents the single largest variable operating cost. Nonetheless, management does not give maintenance the attention it deserves. Maintenance is the term for acts performed to return equipment to a suitable state [1]. The main purpose of maintenance is to guarantee that the facilities (structures, equipment, etc.) are in good, safe condition and can be produced or serviced for the least amount of money [2]. Maintenance is categorized as planned or unplanned. Planned maintenance is the necessary work that is scheduled, coordinated, controlled, and documented; unplanned maintenance, on the other hand, is the type that is done without prior planning and is also known as emergency maintenance. Preventive and corrective maintenance are two additional categories into which planned maintenance can be divided. The vast majority of maintenance tasks are carried out on engineering infrastructure, such as factories and other machinery, electrical and electronic systems, buildings, road networks, manufacturing industries, and highway structures, which heavily rely on planned preventive and corrective maintenance schemes [1].

In the beginning, the Nigerian government primarily established public organizations like the Nigerian Railway Corporation and River Basin Authorities as means of providing social services and jobs, not as profit-making businesses. However, because of these organizations' operational inefficiencies, the same government has recently placed a strong emphasis on privatizing some of them. This Nigerian government strategy is consistent with Ani's conclusion that the dysfunction of public sector governance is the main source of corruption, inefficiency, and waste in developing countries [3]. The usage of plants, machinery, and vehicles is an essential part of these companies' daily activities. As per reference [4], a plant comprises all the tangible means of production that are utilized in a factory or business, such as buildings,

furniture, machinery, workshop equipment, and service equipment. Inadequate equipment use can lead to failure. It cannot be claimed that failure has been totally eradicated, even in cases where plants or equipment may have been designed with dependability in mind. Therefore, if equipment reliability needs to be guaranteed, plant and equipment maintenance should always be done.

Historical statistics showed that companies running public road transport operations in Nigeria have always had problems recovering their investment expenditures, even when more customers are preferring this method of transportation. The functioning of several public organizations, such as Nigerian Railway Corporation, Nigerian Telecommunications Limited (NITEL), and River Basin Authorities, are impacted by the previously described impediment. In the case of MTN, a multinational foreign communication company that dominated the market for mobile phones and quickly recovered its investment costs in addition to making a sizable profit, NITEL paid a heavy price for its operational inefficiencies. Public sector organizations were still expected to deliver services in a timely manner, at the appropriate location, and with efficiency, even though their primary goal was not to turn a profit. An obvious sign that public organizations that have not yet undergone privatization need to increase operational efficiency is the growing reduction in government support for public corporations. Privatization of public organizations has gained popularity recently in Nigeria due to these important factors. Currently, most public companies are expected to generate enough surpluses to not only break even but also stand alone [5].

Sadly, high salaries do not translate into higher productivity in government-run commercialized sectors such as aviation, Nigeria Telecommunication Limited (NITEL), Nigerian Port Authority (NPA), Nigeria National Petroleum Corporation (NNPC), and National Electric Power Authority (NEPA) [6].

The effective use of an organization's infrastructure is a prerequisite for public sector evaluations. It is a well-known fact that certain public sector organizations outperform others in terms of facility utilization, despite the fact that low capacity utilization has been one of the major global problems affecting many public sectors. Organizations with superior technical and managerial capabilities were able to outperform those with subpar personnel. Furthermore, a significant barrier to obtaining subpar performance is the corrupt behavior of the upper echelons of the management teams in numerous Nigerian public sectors [7].

Governments, whether federal, state, or local, provide, own, or oversee facilities that are designated as public. In general, they fall into one of two categories: movable facilities, which include things like cars, computers, typewriters, and earth moving machinery that are subject to periodic relocation, as well as immovable infrastructure like buildings, water and electricity pipes, etc., that cannot change their location. For the acquired assets to function properly, all of these facilities—regardless of their group—need efficient, routine maintenance. Effective maintenance levels have a direct impact on public facility performance. However, maintenance is one of the biggest issues that public organizations face, which has the unfortunate consequence of leaving their grounds littered with broken plants and equipment that are left to rust in sunny and rainy weather before being sold as scrap [8]; We can take steps to avoid this.

It is now obvious that effective infrastructure maintenance is required to build robust infrastructure, encourage sustainable industrial growth, and get past Nigerian maintenance's obstacles. According to [9], there is a common belief that Nigeria lacks a maintenance culture, which results in a scarcity of infrastructure facilities. It is still not given enough attention to manage maintenance. Only when a facility has a problem is maintenance given serious consideration. The infrastructure was rickety, dispersed unevenly, and, in general, in poor condition, with key facilities being particularly neglected. The majority of Nigerians lacked access to basic services, and they were very costly to deliver.

Due to a dearth of basic necessities, Nigeria remains among the world's poorest countries, even after gaining political independence fifty-six years ago. With the exception of the Petroleum Trust Fund's recent intervention, the majority of the country's infrastructure was on the verge of complete collapse. The effectiveness and sufficiency of a country's infrastructure facilities have a major impact on its industrial and economic development. Therefore, in order to guarantee their sufficiency and efficient operation, it becomes essential that our infrastructure facilities receive proper attention. The level of efficient maintenance techniques affects how well infrastructure functions. Regrettably, Nigerian cities lack the necessary procedures to maintain the individual components of infrastructure. Underserved, badly maintained, and incomplete infrastructures are insufficient because they cannot function properly.

Lack of effective maintenance strategy is causing total breakdown of infrastructure facilities and high cost of infrastructure provision. In order to enhance industrial growth, core infrastructural facilities must be operated efficiently and at a reasonable cost to consumers. This paper aims to assess Nigerian maintenance practices' challenges as well as the issues preventing public infrastructure facilities from operating at an adequate and effective level in public organizations.
This paper is structured into eight sections. The second section, which follows the introduction, provides a brief overview of the issues surrounding the various engineering infrastructure facilities in Nigeria, as well as their current status and availability. The third section addressed Nigeria's public facilities' efficient upkeep. This paper's Section 4 discusses performance metrics for Nigeria's public facility maintenance. The value of spare parts and the functions of various departments that are either directly or indirectly involved in maintenance are covered in Section 5, along with the ways in which these departments can support the creation of effective maintenance procedures for the public infrastructure of Nigeria. The difficulties that engineering practitioners face in maintaining their practices are listed in Section Six, along with issues that prevent public facilities in Nigeria from being maintained effectively. The challenges that Nigerian engineering practitioners face in maintaining their infrastructure are addressed, and suggested strategies and actions for doing so are provided in Section 7. Section eight presents the conclusion.

A SYNOPSIS OF THE ENGINEERING INFRASTRUCTURAL FACILITIES' STATUS AT THE MOMENT IN NIGERIA

The state of infrastructure at the moment can reveal issues and difficulties encountered during the application of maintenance procedures, or it can indicate how simple maintenance practices are to achieve.

An overview of the current state of power supply and energy resources

To effectively use power and energy resources for the diversification of the Nigerian economy, an overview of the current state of these resources is necessary in order to assess their level of development, existing constraints, and ways to overcome those constraints. With the help of readily available maintenance services, a country's technological development can be measured by looking at its energy and supply resources. According to [1], Nigeria's energy profile is characterized by irregular power supply, which leads to power outages, load shedding, power rationing, and shortages of petroleum products with related costs. This is due to the inadequate maintenance services provided for our energy infrastructure. Distribution, transmission, and generation of power comprise the three categories of power infrastructure.

Power Generation Infrastructure

According to [10]. the formal and informal segments make up Nigeria's power generation sub-sector. Embedded licenses and captive license generators are the two main player categories in the formal segment. Embedded generators produce electricity primarily for use by other consumers, thanks to the Electric Power Sector Reform Act of 2005. The majority of embedded license generators are linked to the grid. The power plants of Afam, Kainji Hydro, and Sapele are a few examples. However, captive license generators only produce electricity for their personal use. Large manufacturing companies, as well as upstream oil and gas companies (for the purpose of supplying electricity to their oil flow stations, gas plants, and platforms for processing and loading crude oil), are the owners of the majority of captive license generators. Presently, most captive license generators are off-grid.

The informal segment is comprised mostly of off-grid small to medium-sized petrol and diesel generators (625 VA to 920 VA) and pockets of solar panels used to generate power for residential houses and small to medium-sized commercial and industrial enterprises such as hotels, supermarkets, and block-molding industries. Since these generators have a capacity under 1 MW, they are exempt from the need for a power generation license, which is only required for generators with a capacity up to 1 MW, according to the Nigerian Electricity Regulatory Commission, or NERC. The informal power generation market in Nigeria is huge. [11]. estimate that Africa imports $450 million worth of small-to medium-sized generators (in the informal sector) each year, with Nigeria holding a roughly 55% share of the market.

Nigeria is estimated to have a 15-GW total power demand [12]. However, with average daily power generation of 3.6 GW from a total installed generation capacity of 12.5 GW (power generation infrastructure capacity utilization of only 31%), the nation can only supply 24 percent of its own energy needs (PricewaterhouseCoopers 2016a). Gas is Nigeria's principal energy source; gas and thermal stations provide around 80% of the nation's electricity, with hydroelectric power facilities, mainly Kainji and Shiroro, providing the remaining 20% [12]. In Nigeria's power generation business (formal segment), which was previously a state monopoly, the largest change brought about by the Electric Power Sector Reform Act of 2005 was the liberalization of the subsector, permitting private ownership and operation of power facilities.

Power Transmission Infrastructure

The 330/132kV and 132/11kV substations in Nigeria have a combined capacity of 10,166MVA and 11,660MVA, respectively. The country's power transmission infrastructure consists of roughly 6,680 km of 330 kV and 7,780 km of 132 kV lines [13]. Nigeria uses 42% of its total installed capacity—12,522 MW—for power transmission, with 5,300 MW of that capacity used (Advisory Power Team Office of the Vice President of the Federal Republic of Nigeria and Power Africa 2015a).

High transmission losses of roughly 7.4% serve as a stark reminder of Nigeria's transmission inefficiencies.

(Data from January to July 2015) in comparison to the global standard of 2.6%, whereas the average on-target completion rate of planned maintenance for transmission infrastructure is 67% (Advisory Power Team Office of the Vice President, Federal Government of Nigeria, 2015b). The number of grid system collapses in 2014, 2015, and 2016 was 13, 10, and 16, according to [2].

The transmission grid in Nigeria can only cover 40% of the nation aerially, according to [14]. The grid, which is mainly installed in urban areas, has a detrimental effect on rural settlements. Mini-grids are rare in the country and, when they are, are usually located in rural areas. They are not very robust, have a small capacity, and are mainly powered by expensive and ineffective power generating sources, especially diesel generators. Nigeria's transmission grid infrastructure has always been a state-owned monopoly, even if it is currently run under a private sector management arrangement.

Power Distribution Infrastructure

According to [15], Nigeria distributes 3.1 GW on average and uses 43% of its power distribution infrastructure's capacity. In the country's power sector value chain, the power distribution segment is considered to be the weakest link, with a distribution aggregate loss of 46% (technical: 12%, commercial: 6%, and collection: 28%), according to the Advisory Power Team Office of the Vice President of the Federal Republic of Nigeria and Power Africa 2015c.

The Electric Power Sector Reform Act of 2005 enables the division of Nigeria's power distribution assets into eleven new power distribution companies (DISCOs). However, these companies struggle with safety, maintenance, and financial obligations. To address these issues, the federal government is considering a central repository for collected tariffs. Issues include insufficient capacity, low utilization, frequent power outages, poor maintenance, and high power losses.
These problems have led to Nigeria's low electrification rate of 45%, meaning 93 million people do not have access to power (Nigerian Energy Support Programme, 2015). Nigeria Energy Hub [15], states that 151 kWh is one of the lowest yearly energy consumptions per capita in Africa. Specific to the energy resources and power supply sectors are the following problems with maintenance procedures: increased load or demand above existing capacity; problems with generation, transmission, and distribution; old and broken equipment, including faulty turbines, transformers, alternators, and power lines. environmental problems, a dearth of contemporary tools and equipment, a personnel shortfall for maintaining specialist machinery, acts of vandalism and militancy against equipment, and atmospheric and meteorological circumstances...

Overview of the current status of the transport system
The infrastructure for transportation has generally been in bad shape. For many years, Nigeria's air, sea, and rail transportation networks have been in appalling shape. Conditions were so bad that many rural villages were isolated, and many more had been isolated without access to link roads connecting them to the rest of the country. Also, there is a lack of appropriate connections between the various modes of transportation [16]. The transport system in Nigeria includes the following: road transport through highways and road networks; rail transport with coaches on rail lines, rail stations, etc.; water transport with ships, flying boats, sea ports, etc.; and air transport with aircraft through airports, runways, towers, etc. [16].

Road Transport
Nigeria's road network spans 195,500 km, with state highways covering 33,000 km and federal roads covering 32,000 km. 75% of municipal government roads are in poor condition, with poor maintenance contributing to 30% of federal roads. Issues include inadequate road networks, lack of parking, poor driving habits, unequal urbanization, lack of enforcement of driving laws, inadequate traffic management, inadequate transport administration, inadequate equipment, over-elapsed life span of major roads, insufficient manpower, poor planning, poor material quality, inexperienced contractors, and weather and environmental conditions.

Rail Transport
Nigeria's rail network, covering 3,505 km, is a single-track, narrow-gauge system with no east-west connectivity and no connection between the Federal Capital and 14 states. The system is neglected, with only 50% of the 280 stations operational. Issues affecting its development include inadequate funding, corruption, poor management, stagnation, loss of patronage, high costs, poor track structure, shortage of locomotives, poor equipment, government neglect, labor unions, corruption, and weather and climatic conditions.

Water Transport
Nigeria's water transportation infrastructure is mostly undeveloped, with 3,300 km of navigable inland waterways hindered by inadequate dredging and the unavailability of modern river-going vessels. The country's seaports, like Lagos and Calabar, lack modern infrastructure and face challenges like lack of government funding, poor maintenance, inadequate facilities, corruption, stagnation, loss of patronage, high operational costs, and weather conditions.

Aviation (Air Transport)
The Nigerian aviation industry is facing challenges due to outdated facilities, outdated aircraft, poor airport facilities, and frequent touting and pilfering. The national carrier, Nigerian Airways Limited, also performs poorly. Factors affecting infrastructure development include government funding, inadequate infrastructural facilities, high maintenance costs, corruption, weak management, and weather conditions. Public organizations also face issues related to poor maintenance.

THE NECESSARY UPKEEP REQUIRED FOR THE EFFICIENT MANAGEMENT OF PUBLIC INFRASTRUCTURE IN PUBLIC ORGANIZATIONS IN NIGERIA
These differ from corrective maintenance, or breakdown maintenance, when the machinery is used until it breaks down and is then fixed. By foreseeing wear or failure and performing an appropriate inspection, replacement, or adjustment in a timely manner, preventive maintenance aims to avoid breakdown. In most cases, preventive maintenance is thought to be more costly than corrective or breakdown care. On the other hand, this extra cost helps reduce the likelihood of the plant failing.
Preventive maintenance involves routine inspections, lubrication, and adjustments to equipment to prevent future malfunctions. It's a planned procedure to prevent breakdowns while the asset is still functional. Manufacturers' maintenance schedules can help, but tracking unplanned breakdown frequency and associated costs is crucial for improving preventative maintenance programs.

Breakdown (corrective) maintenance: Corrective maintenance (breakdown): There are benefits to centralizing this activity to guarantee greater staff development and utilization. The maintenance personnel who oversee repair work ought to receive fault-finding training. Diagnostic tools should be provided to the personnel, and circuit schematics and maker's manuals should be easily accessible. If replacement components are easily found in stores instead of having to order them from equipment manufacturers when needed, repair periods can be shortened.

THE NEED FOR EFFECTIVE MAINTENANCE OF INFRASTRUCTURAL FACILITIES

One element that helps to foster industrial expansion is the effective and efficient use of public infrastructure. The detrimental effects of not having an efficient maintenance system can be taken into account when determining the necessity of effective maintenance. These effects include frequent machine breakdowns, disproportionate expenditures on maintenance supplies and spare parts, underutilization of staff, low-quality services, abnormal overtime costs, irregular operating hours, shortened facility life spans, lost production output, and excessive machine breakdowns.

The aforementioned factors all lead to a loss of profit, which impedes the accomplishment of some organizational goals. Nonetheless, to guarantee maximum machine availability and usage, maintenance productivity effectiveness must be regularly assessed [17].

MAINTENANCE EFFECTIVENESS AND PERFORMANCE MEASUREMENT

The ratio of output to input is known as productivity. It gauges the correlation between the real input and the real output. There are two ways to quantify productivity: by unit or by monetary value. Operational productivity, or the proportion of units of output to units of input, is measured per unit; per dollar, on the other hand, is known as financial productivity. Productivity gauges how well a system works to accomplish the aims and objectives of the company. Therefore, the efficiency of the time, labor, material, energy, and capital needed for maintenance is measured by the efficacy of maintenance [2].

Performance measure: The effectiveness of maintenance is typically assessed using the performance measure for effective maintenance**.** You have two options for doing this: manually or using a computer. To counter the trend on a monthly, quarterly, or annual basis, a few chosen parameters (relevant to any maintenance organization seeking to gauge its efficacy) need to be plotted on charts on a regular basis. It has been discovered that mathematical models may be created to represent queuing conditions that are defined by various combinations of the three fundamental components: input process, queuing discipline, and service mechanism. Then, by manipulating these models, one may demonstrate what the service system under examination ought to be able to accomplish [2].

Condition-based input for the queuing system: Plant breakdown at the maintenance department, pending repair, or plant repair: These metrics can be used, for example, to determine (usually on a cost basis) whether to add more channels operating at the same rate as the current ones, accelerate the current service rate of each channel operating at the same rate as the current ones, or even consider reducing the number of service facilities. Consequently, it is necessary to monitor the upkeep of these facilities. Maintaining records serves as a database for wise decisions and deeds, as manufacturer-recommended maintenance plans are frequently insufficient because they do not account for all socioeconomic and political factors. Precise documentation of all these amenities will increase the likelihood of efficient upkeep. Every facility under consideration needs to have a record sheet where data gathered from operators and users is kept. The following columns should be included in the record sheet: the length of time the facilities were operational; the quantity of fuel they consumed; the kind of spare component that was replaced or repaired; the facilities' age; and the sort of maintenance chores that were carried out on them.

Because of this, it is possible and straightforward to perform the following computations using these records: Calculate the cost of repairs, maintenance, and operating per hour. What trends may be seen in the details and performance of the facilities that are being evaluated? Keep track of when things begin to go wrong and—more importantly—predict with precision when certain replacement components will be needed. By doing this, idle time can be greatly decreased because steps can be taken to get the components earlier than planned.

Evaluation of maintenance activities: [18]. discovered that the following elements could be taken into consideration when assessing maintenance activities: the utilization of craft hours, the status of work orders, the functionality of plant and equipment, the price of the services provided, and the explanation of expenditures.

The five work criteria listed above are the basis for determining the maintenance performance measurements for public organizations [19]: The product of total hours worked and total hours logged is known as craft-hours utilization (CU); Work done turnover (WT) is the sum of all jobs completed less all jobs competed; The sum of all service outages minus all shift hours worked is the amount of downtime that results from maintenance. The cost of supplies and spares is equal to the total of supplies and spares minus the total of maintenance costs. The cost of regular service or maintenance hours matches the effort put into cost reduction.

The aforementioned ratios give public organization maintenance departments the ability to evaluate their operations, pinpoint the precise maintenance tasks that are problematic, and concentrate their efforts on making improvements.

THE MAINTENANCE FRAME WORK

It is not feasible to separate the maintenance department or workshop from other organizational departments in order to enhance the efficient maintenance of public organizations. Therefore, it is necessary to integrate and involve other

departments that directly impact the administration and organization of maintenance in the overall maintenance framework and, subsequently, on its costs and efficiency. Along with the maintenance department, these departments need to share a single goal and work together to accomplish it. These other departments are:

Projects and new work department (mainly for building): This department is necessary to manage upkeep tasks like selecting new work businesses, installing projects, installing investment plans (both forming and creating), installing projects, ensuring projects are reliable and maintainable, standardizing materials and technical documentation, and receiving equipment..

Purchasing department: This department is necessary to help with and resolve equipment guarantee issues, inspect performance and technical quality specifications, and obtain the technically appropriate dossier that complies with the requirements of the company's maintenance policy, particularly for maintenance and operational documents.

Financial department: This department's functions include assessing the financial feasibility of plants and equipment, replacing and revising economic and replacement decisions, and establishing the economic relationship between depreciation and maintenance. When choosing when to get a replacement.

Human resources department: This department requires: hiring and training, career progression, post-transfers, promotions, retirement departures, and qualification level estimation in particular; Organizing the workplace; figuring out the organogram or structure;

A security department is required for effective work organization, work post planning, integrated prevention, and other aspects of equipment and staff security.

Spare and supply management department: Maintaining accurate records and a strong supply management policy are critical components of a successful maintenance strategy. Since the maintenance schedules recommended by manufacturers are frequently insufficient for our public utilities when socioeconomic factors are taken into account, its primary function is to provide basic information about the purchase date, condition, and life cycle of all plants and equipment, etc., to help with appropriate decision-making and actions. The most important component of the maintenance strategy is the availability of replacement parts, either through contract or direct supply. Many maintenance initiatives need rules that provide adequate spare parts to support them in order to be successful.

The Impact of Procurement of Spare Parts on the Upkeep of Public Facilities

In Nigeria, spare parts are either directly supplied or acquired under contract for the upkeep of public infrastructure. Having extra components on hand is the most important component of a maintenance plan. In the Nigerian public sector, many maintenance initiatives are unable to be completed without the backing of efficient regulations for the provision of replacement parts. The degree of success attained is determined by the accessibility of replacement components required for any essential repairs, regardless of size.

The public sector's spare parts purchases are influenced by factors such as government policies, demand, fault accumulation, and financial capacity.

To prevent repetition, the technical person in charge of this task should gather documentation of planned acquisitions along with verification. The game's following rules may be helpful when looking for replacement parts: being truthful about the task and the cost of the replacement parts; Steer clear of middlemen and only purchase authentic, accurate spare parts. Continue to request outdated and worn-out parts for routine inspections. To take care of the business, keep accurate statistical records, check the spare parts on a regular basis, and hire trustworthy and knowledgeable staff.

Cost and quality should always be taken into serious consideration by an enterprise. As such, the cost of replacement parts must not be excessively high or too low [20].

Efficient use of spare components will lead to a reduction in inventory. Using the Economic Order Quantity (EOQ) model, the necessary spare part should be identified. Since the public sector guarantees the security of its spare component inventory, this inventory procurement strategy is extremely beneficial there [21]. Having trouble getting original replacement parts? Obtaining authentic replacement parts remains a challenge, even in cases where funding becomes available. It is argued that government funds are limited and should not be spent on purchasing spare parts in advance, making them hard to get when they are needed immediately. Thus, $1,000,000 worth of spare parts might keep a piece of capital equipment that costs more than $2,000,000 and can provide services to a facility inoperable. This issue is exacerbated when basic parts that are readily fabricated in workshops cannot be completed due to a shortage of the necessary equipment.

Spare parts stocking: This requires maintaining statistical data on the movement and demand for spare parts, which must be made evident and help in the selection of the most important parts to keep on hand. The majority of public buildings are constructed using a range of spare components, similar to those found in our cars and plants, and each one has a different need for regular maintenance. Nonetheless, the retailer should store these extra parts with the highest level of security. Experience has taught us that spare parts should always be carefully considered for storage. To ensure longevity, spare parts need to be properly stored and stocked. For instance, rubber components should be kept in talcum powder and bearings sealed in grease paper. A hundred racks that hold a large variety of spare parts require a very methodical and controlled positioning technique. The most important thing is to use control or stock cards to identify and manage all spare parts.

Equipment standardization: Public buildings like cars are not immune to the challenges surrounding the acquisition of spare parts, which are made worse by Nigeria's policy of sourcing goods from all over the world. As a result, obtaining

replacement parts for the many brands of equipment he is responsible for maintaining is challenging for a maintenance officer. even in sizable engineering setups. This is how a lot of our public buildings are constructed. Its upkeep is therefore difficult. The most crucial thing to remember is that businesses should make it a policy to only purchase standard equipment.

Cost estimate: Accurate material (spare part) costing is essential for public facility maintenance initiatives. An accurate assessment of the preparation will result in less work and lower maintenance expenses. On the history sheet, the total projected cost of repairs for every facility should be recorded. Periodically reviewing this history sheet is necessary to assess when maintaining such facilities becomes unprofitable. This will help ensure that the life cycle of future facilities is appropriately determined, which will improve the effectiveness of maintenance for both the current and upcoming facilities. Identifying the right cost target, tracking actual costs, ensuring that actual costs are controlled throughout the project's lifecycle, tracking cost overruns to specific units, and determining the causes of negative deviations are the main functions of cost estimates.

Life Cycle Costing: A Focus on Cost Reductions and Recovery

These days, public organizations should take into account the facility's life cycle before approving the money designated for the purchase. This is due to the fact that the most significant challenge that organizations now face is the increasingly shortening life cycle of many new goods due to the speed at which technological advances are made and the way in which competition affects a certain facility. In light of these developments, it is crucial to first use life cycle costing to ascertain whether it is possible to recoup all of the expenses paid in purchasing an asset, such as machinery or a facility, through efficient use that generates money over the facility's lifespan. A catastrophe is likely to result from avoiding the application of life cycle costing when purchasing an asset or manufacturing a new product, given the intense competition on a worldwide scale and other relevant factors [22].

As per the Chartered Institute of Management Accountants (CIMA) Official Terminology, life cycle costing is designated as Ensuring that decisions about the acquisition, use, or disposal of an asset can be made in a way that optimizes asset usage while keeping the entity's costs as low as possible is ensured by maintaining physical asset cost records during the lifespan of the asset. This phrase can be used to describe the cost profiling of a product over its life, encompassing the pre-production phase (tero-technology) as well as the life cycles of the industry and the company.

In the service sector, like governmental organizations, the total cost—which includes all acquisition, operating, and maintenance expenses—determines the facility's life cycle. Purchasing replacement parts is one aspect of maintenance expenses.

In order to prevent product or service failure and to calculate the accurate cost of a product or service by taking into account variables like investment cost, number of years to maturity, expected demand, and imitations, life cycle costing is justified for the suggested investment opportunities.

Therefore, it is important for public organizations involved in road transportation to understand the associated expenses. [23]. identified three goals for road transport expenses: to calculate the cost of operation per kilometer, manage the vehicle's operating expenses, and decide whether to replace the vehicle.

INVESTIGATIONS THAT IMPAIR EFFECTIVE MAINTENANCE OF PUBLIC FACILITIES IN NIGERIA, AS WELL AS DIFFICULTIES FACING MAINTENANCE PRACTITIONERS

Nigerian engineering practitioners face challenges in maintenance practices, including inadequate funding, poor spare parts management, underutilization of resources, incompetent maintenance staff, irregular power supply, obsolete machinery, insufficient tools, poor maintenance culture, poor monitoring, and inadequate storage facilities. Issues include poor quality materials, inadequate storage facilities, indigenous contractors, lack of manpower development, corruption, poor worker attitudes, and low support for the COREN-Engineering Regulation Monitoring program.

RECOMMENDED STRATEGIES AND MEASURES

From what has been said thus far, it is clear that our infrastructure has to be critically examined immediately in order to identify the practical solutions that will guarantee that it is delivered effectively and sufficiently. Given that the rates of deterioration of our infrastructure facilities significantly exceed the rates of provision, the degree of appropriateness and efficiency of these facilities is undoubtedly well below expectations, resulting in a nightmare for social and economic life. The following are some suggested tactics and steps for efficient maintenance of infrastructure facilities and resolving issues that face maintenance procedures in Nigeria, as reported by agencies, building companies, and engineering practitioners:

- For Nigeria to see sustainable industrial progress, the government at all levels should be more committed to providing financing for the upkeep of its infrastructure. Policymakers and managers ought to create guidelines that emphasize the value of the maintenance role. To increase labor productivity, employees should receive a fair wage.
- By adding elements of infrastructure maintenance to school curricula, professional, technical, and artisan training programs will help cultivate the local skills needed to enhance infrastructure maintenance. The government must plan and fund short-term maintenance skills courses for qualified staff in certain local institutions. All governmental levels should support periodic workshops and conferences on the need and complexities of maintenance

management for their maintenance workers; operators, technicians, and other personnel involved in the actual practice of maintaining infrastructure facilities should undergo training and retraining;

- A sufficient quantity of maintenance infrastructure, comprising amenities such as suitable spare parts, maintenance tools, equipment, and repair garages and yards, should be supplied by the government. A policy governing the acquisition of equipment ought to be developed by the government. The opinions of all users, equipment operators, and other providers of resources and facilities should be taken into account in such a policy. In addition to providing direct support to the maintenance sector, the government could encourage community involvement by educating a few local organizations on the need for maintenance. It is necessary to increase public awareness of the necessity of a maintenance culture. For accounting purposes, the government should set up a maintenance audit system.
- Public enterprises ought to implement the balancing scorecard, which emphasizes four unique but connected views of organizational performance management: financial performance, internal processes, customer satisfaction and value, and workforce support.
- Plant and equipment history cards, as well as appropriate maintenance planning, should be created. Plants, machinery, and automobiles should all receive routine maintenance to ensure proper operation, longer lifespans, and lower capital costs. At every level, the maintenance staff should receive more in-depth training and retraining. To lower the cost of downtime and increase the effectiveness of maintenance, sufficient funds should be allotted and made easily accessible to the maintenance workshop.
- Reducing the frequency of infrastructure failures requires better oversight and the implementation of preventive maintenance. The needs of the workshop should receive enough consideration. Employees in maintenance should receive recognition for their creative solutions that increase productivity. Work-study should be used to create standard operating procedures for maintenance tasks, such as establishing a time for each task. ICT should be utilized to address the issue of engineering maintenance management.

CONCLUSION

This paper discusses the importance of effective maintenance practices in building resilient infrastructure, enhancing engineering professionalism, and promoting national development. It discusses the current status and availability of engineering infrastructural facilities in Nigeria, highlighting the role of spare parts and departments. The article also discusses the challenges faced by engineering practitioners and the problems that inhibit effective maintenance. It recommends strategies and measures for improving maintenance practices, aiming to achieve sustainable industrial growth for employment opportunities, agricultural production, and exports.

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