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IMPROVING THE REHABILITATION AND MAINTENANCE OF WORKSHOP EQUIPMENTS USING ARTIFICIAL NEURAL NETWORK BASED SYSTEM. A CASE STUDY OF CARITAS UNIVERSITY ENUGU

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Abstract

The efficient operation of workshop equipment is crucial for academic institutions, particularly in technical and vocational education. However, frequent breakdowns, inadequate maintenance schedules, and delayed rehabilitation processes often hinder the performance of such facilities. This study investigates the application of an Artificial Neural Network (ANN)-based system to improve the rehabilitation and maintenance of workshop equipment at Caritas University, Enugu. The proposed system leverages the predictive capabilities of ANN to monitor equipment usage, diagnose faults, and recommend optimal maintenance schedules. By analyzing historical maintenance data, operational parameters, and real-time feedback, the system aims to minimize downtime, reduce maintenance costs, and extend the equipment's lifespan. A case study approach was employed, integrating the ANN-based system into the university's existing maintenance framework. Preliminary results indicate significant improvements in fault detection accuracy, response time, and resource allocation. This research highlights the potential of intelligent systems to revolutionize workshop maintenance practices, ensuring the sustainability and reliability of educational infrastructure.

Keywords: Artificial Neural Network (ANN), Workshop Equipments, Optimal Maintenance Schedule.

I. INTRODUCTION

The effective rehabilitation and maintenance of workshop equipment are critical to ensuring the smooth operation of technical and vocational education institutions. Workshop equipment plays a pivotal role in the hands-on training of students, enabling them to acquire practical skills necessary for industry readiness (Okoro & Eze, 2020). However, in many institutions, the lack of a robust maintenance strategy often leads to frequent breakdowns, reduced equipment lifespan, and diminished training quality (Nwafor et al., 2022). Caritas University, Enugu, like many other institutions, faces challenges in maintaining its workshop facilities due to limited technical expertise and inefficient maintenance systems.

Traditional maintenance practices, which rely heavily on manual inspection and corrective actions, often fail to predict potential failures, resulting in costly repairs and downtime (Eze & Nnamani, 2021). This inadequacy underscores the need for innovative approaches to workshop maintenance. Artificial Neural Networks (ANNs), a subset of Artificial Intelligence (AI), have proven their efficacy in predictive maintenance across various industries. ANNs can analyze complex datasets, identify patterns, and predict equipment failures with remarkable accuracy, enabling proactive maintenance actions (Zhang et al., 2020). Implementing an ANN-based system can transform the maintenance processes at Caritas University by enhancing the accuracy of fault

detection, reducing downtime, and optimizing resource allocation. This study seeks to explore the application of an ANN-based maintenance system to improve the rehabilitation and maintenance of workshop equipment at Caritas University, Enugu. By leveraging intelligent systems, the study aims to develop a sustainable framework that ensures the reliability and longevity of workshop equipment, ultimately enhancing the quality of technical education provided at the university.

Technical workshops are essential in providing practical training and skill acquisition for students in technical and vocational education institutions. However, the frequent breakdown of workshop equipment due to inadequate maintenance practices has significantly affected the quality of education delivered in such institutions (Chinedu & Uka, 2021). Poor equipment maintenance leads to delayed practical sessions, increased operational costs, and compromised safety standards for both students and instructors (Amadi et al., 2020). Caritas University, Enugu, represents a typical scenario where maintenance challenges impede the optimal performance of workshop equipment. These challenges stem from insufficient funding, the lack of trained personnel, and the absence of advanced maintenance systems (Okafor & Anayo, 2022). Traditional reactive maintenance methods, which involve repairing equipment only after a failure has occurred, are no longer sustainable due to the complexity and increased demand placed on workshop equipment in modern technical education.

In recent years, Artificial Neural Networks (ANNs) have emerged as a transformative tool for predictive maintenance in engineering and industrial applications. ANNs, with their ability to analyze large volumes of data, detect anomalies, and forecast equipment failures, have been successfully implemented in various sectors to enhance equipment reliability and minimize maintenance costs (Chen et al., 2019). Their ability to adapt and improve through training makes them particularly suitable for dynamic environments such as technical workshops. Integrating an ANN-based system into the maintenance framework at Caritas University offers a promising solution to these challenges. Such a system can facilitate real-time monitoring of equipment conditions, identify early signs of deterioration, and recommend timely interventions. This approach not only extends the lifespan of workshop equipment but also ensures uninterrupted training for students, thereby contributing to the university's mission of providing quality technical education. This study aims to develop and implement an ANN-based maintenance system tailored to the specific needs of Caritas University's workshops. By addressing the root causes of equipment failure and optimizing maintenance schedules, the research seeks to provide a model that can be replicated across similar institutions, fostering a culture of proactive and intelligent maintenance.

II. MATERIALS AND METHOD

In this study, several materials and resources were utilized to develop and implement an Artificial Neural Network (ANN)-based system for improving the rehabilitation and maintenance of workshop equipment at Caritas University, Enugu. The following materials are essential to the research and its successful execution:

1. Computer Hardware

2. Software Tools

3. Workshop Equipment

METHOD

To achieve the goal of improving the rehabilitation and maintenance of workshop equipment at Caritas University, Enugu, an Artificial Neural Network (ANN)-based system was developed and implemented. The methodology consists of several key steps that involve data collection, model development, and system implementation.

III. Results and analysis

Table 3.1. comparison of conventional and ANN based system Inadequate Funding that cause of poor rehabilitation and maintenance of workshop equipments (%)

Time (s)	Conventional Inadequate Funding that cause of poor rehabilitation and maintenance of workshop equipments (%)	ANN based system Inadequate Funding that cause of poor rehabilitation and maintenance of workshop equipments (%)
1	20	17.23
2	20	17.23
3	20	17.23
4	20	17.23
10	20	17.23

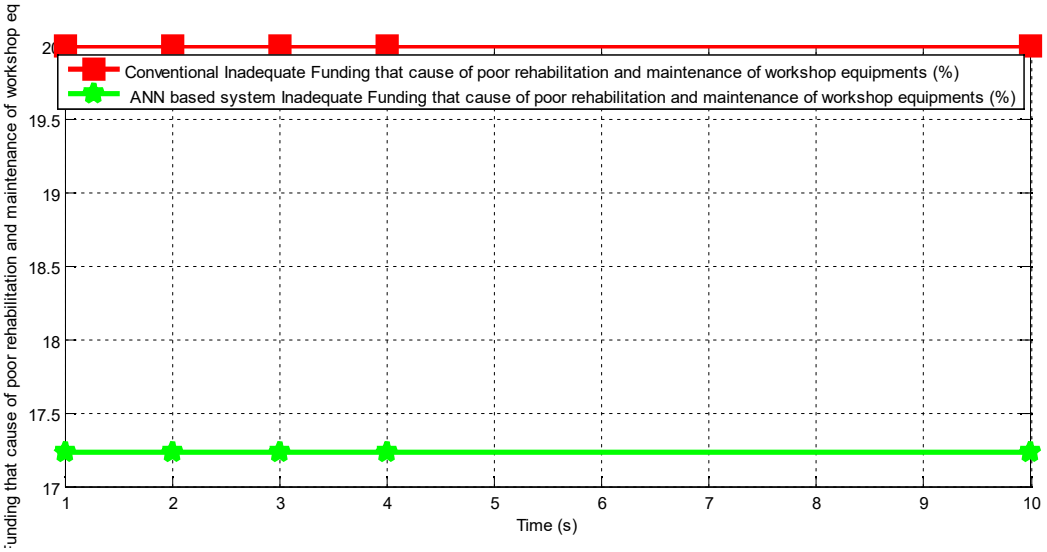

Fig 3.1.comparison of conventional and ANN based system Inadequate Funding that cause of poor rehabilitation and maintenance of workshop equipments

The conventional Inadequate Funding that cause poor rehabilitation and maintenance of workshop equipments was 20%. On the other hand, when an ANN based system was incorporated in the system, it drastically reduced to 17.23%.

Table 3.2. comparison of conventional and ANN based system Lack of Skilled Personnel that cause of poor rehabilitation and maintenance of workshop equipments

Time (s)	Conventional Lack of Skilled Personnel that cause of poor rehabilitation and maintenance of workshop equipments (%)	ANN based system Lack of Skilled Personnel that cause of poor rehabilitation and maintenance of workshop equipments (%)
1	15	12.92
2	15	12.92
3	15	12.92

4	15	12.92
10	15	12.92

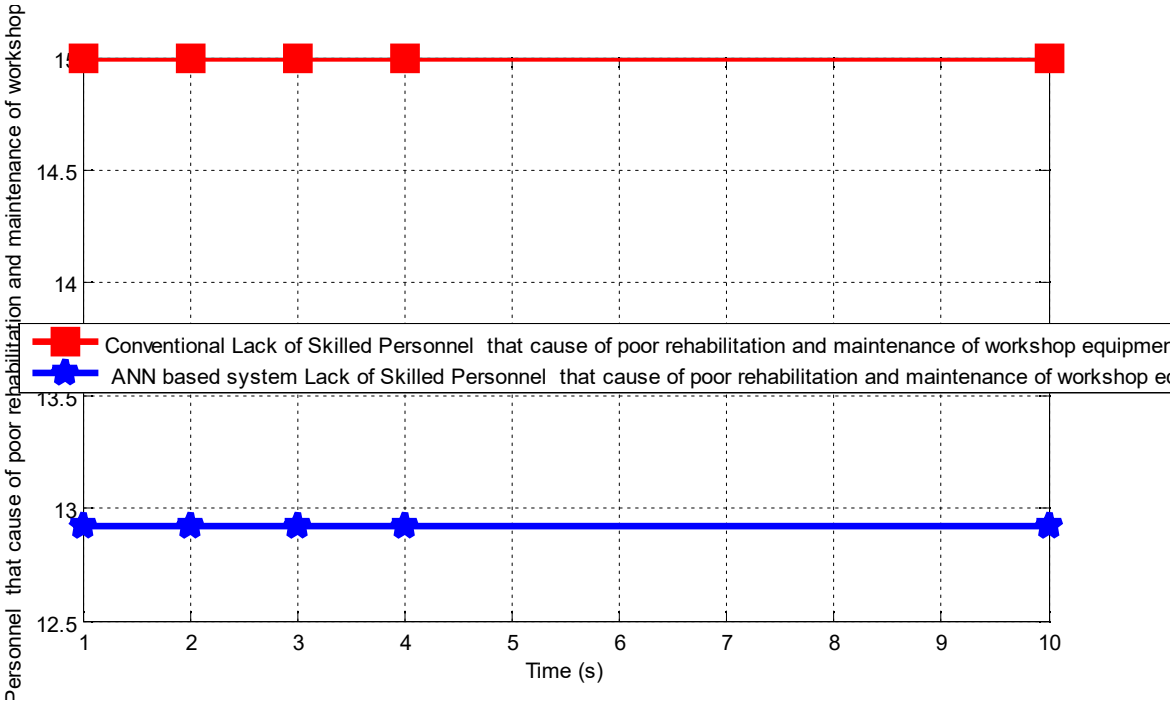

Fig 3.2.comparison of conventional and ANN based system Lack of Skilled Personnel that cause of poor rehabilitation and maintenance of workshop equipments

The conventional Lack of Skilled Personnel that cause of poor rehabilitation and maintenance of workshop equipments was 15%. However, when an ANN based system was injected in the system, it decisively reduced to 12.92%.

Table 3.3: comparison of conventional and ANN based system improvement in rehabilitation and maintenance of workshop equipments in CARITAS University

Time (s)	Conventional improvement in rehabilitation and maintenance of workshop equipments in CARITAS University (%)	ANN based system improvement in rehabilitation and maintenance of workshop equipments in CARITAS University (%)
1	15	20.22
2	15	20.22
3	15	20.22
4	15	20.22
10	15	20.22

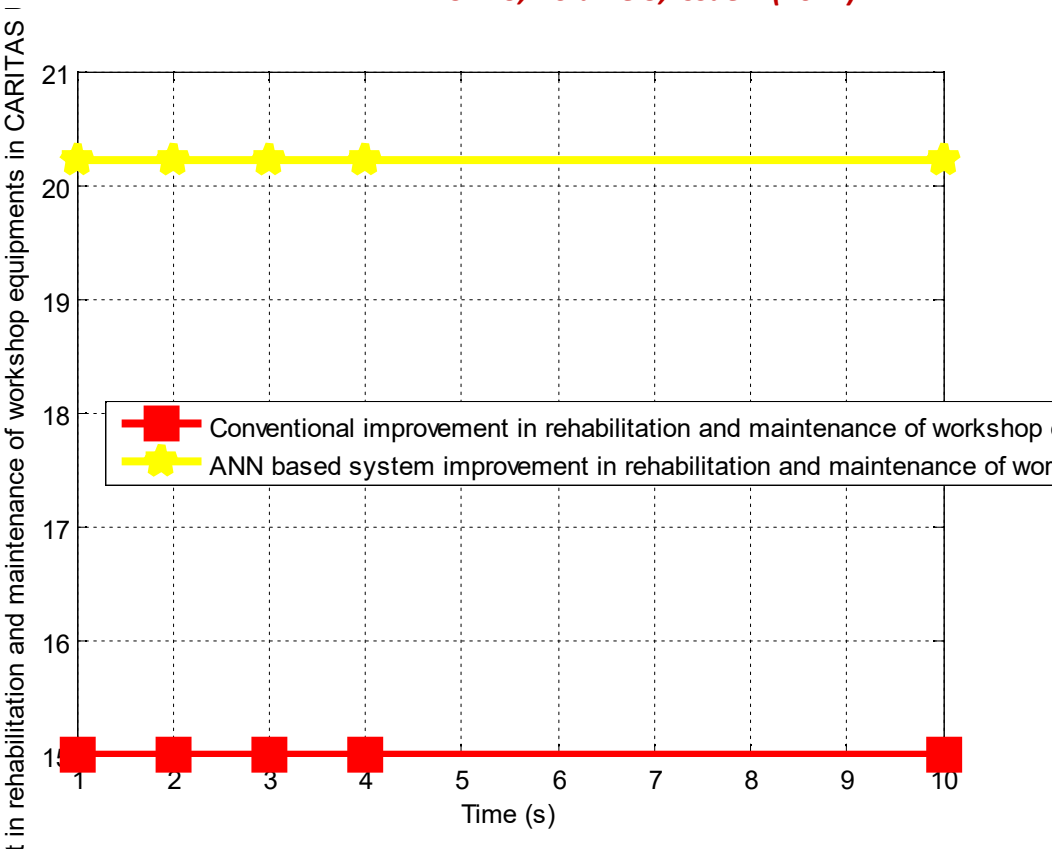

Fig.3.3.comparison of conventional and ANN based system improvement in rehabilitation and maintenance of workshop equipments in CARITAS University

The conventional improvement in rehabilitation and maintenance of workshop equipments in CARITAS University was 15%. On the other hand, when ANN based system was integrated in the system, it simultaneously increased to 20.22%. Finally, the percentage improvement in the rehabilitation and maintenance of workshop equipments in CARITAS University when ANN base system was inculcated in the system was 5.22%.

IV. CONCLUSION

The study on improving the Rehabilitation and Maintenance of Workshop Equipment Using an Artificial Neural Network (ANN)-Based System: A Case Study of Caritas University Enugu offers significant insights into the potential benefits of integrating artificial intelligence into the maintenance management of workshop equipment. The application of an ANN-based predictive maintenance system holds considerable promise in enhancing the reliability and performance of workshop machinery at the university. By utilizing real-time sensor data, the proposed system will allow for continuous monitoring of equipment conditions, facilitating early detection of potential failures and thus preventing costly downtime and extensive repairs. The system's ability to predict maintenance needs before they occur ensures that repairs are scheduled proactively, leading to optimized resource allocation, reduced maintenance costs, and extended equipment lifespan. Moreover, the use of ANN algorithms in this study allows for the processing and analysis of complex datasets, enabling accurate failure predictions based on historical and real-time data. This data-driven approach improves decision-making and enhances the overall efficiency of maintenance operations, making the university's workshop more productive and cost-effective. It not only supports operational efficiency and reduces downtime but also provides a scalable model that can be replicated in other institutions or industries.

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