Evaluation of Strategies for Improving the Maintenance of Workshop and Equipment in Industrial Technology Education for Effective Service Delivery in Tertiary Institutions

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Abstract
The study examined strategies to enhance the maintenance of workshop and equipment in industrial technology education for efficient service delivery in tertiary institutions in Delta State. The study was guided by the following objectives: to identify suitable preventive and reactive maintenance strategies for enhancing the maintenance of workshop and equipment in industrial technology education, and to determine appropriate corrective and predictive maintenance strategies for the same purpose, among others. Two research questions and two hypotheses were established to direct the investigation. A structured questionnaire was employed to gather pertinent data from fifty (50) respondents, consisting of thirty (30) lecturers and twenty (20) technicians from the Department of Technical Education at Delta State University, Abraka, and the Federal College of Education (Technical) Asaba. The study employed a survey research design. No sample is required for the study as the population can be well regulated. The instrument was validated by three specialists in the field of technical education, comprising two from Delta State University, Abraka, and one from Federal College of Education (Technical) Asaba. The instrument undergo face validation. The findings indicated that routine maintenance, including daily lubrication and cleaning, is crucial for the preservation of workshop equipment. Additionally, suitable corrective and predictive maintenance skills are necessary to enhance the maintenance of workshop and equipment in tertiary institutions. In light of the study's findings, the following recommendations are proposed: Tertiary institutions should partner with governmental parastatals to secure financial assistance for enhancing the maintenance of workshop and equipment. Additionally, tertiary institutions should implement a comprehensive maintenance schedule to facilitate regular inspections and prompt repairs of workshop and equipment.

Keywords: *Preventive maintenance, Reactive maintenance, corrective maintenance, Predictive maintenance.*

Introduction

Workshop equipment pertains to the diverse instruments and apparatus utilized by scientists in a workshop setting. Workshop equipment is typically utilized to conduct experiments or to monitor and collect data. These devices are either portable or substantial and are utilized for practical-oriented courses. Olaitan (2015) noted that equipment utilization mostly pertains to technically specialized skill practices within instructional and learning contexts. Workshop equipment fulfills several functions in study and experimentation. These tools are crucial for technologists to conduct chemical reactions and measure physical attributes precisely and effectively. The workshop offers students diverse chances for learning and experimentation, which is essential for their continuous intellectual development at all academic levels.

To attain the objective of practical-oriented education, sufficient facilities, including workshop and equipment, are essential for imparting skills, knowledge, and competence at the tertiary level. Olaitan (2015) identifies several factors contributing to the failure to sustain workshop and equipment: a prevalent misconception that maintenance is solely the responsibility of technicians, insufficient personnel knowledgeable in maintenance principles, reliance on technology originating from different cultures, absence of a record-keeping system, inadequate support for departmental innovations, and insufficient funds for acquiring spare parts. The University of Nigeria maintenance committee report (2016) indicated a concerning proliferation of non-operational workshop and scientific equipment. This has led to the inadequate instruction of practical courses, as a significant amount of the equipment in the workshop is nonfunctional. The highest returns in the production business are achieved by strategic planning and the execution of production processes, including the planning and monitoring of production assets. Lee, Bagheri, and Kao (2015) in Cyber-physical systems. Consequently, an industrial production system requires continuous monitoring to maintain its viability and consistency. This monitoring method must be premeditated to ensure consistency in the production process and an effective decision-making strategy.

Preventive maintenance is employed to provide complete and uninterrupted services. Gelberg (2014) emphasized that the industry employs a systematic approach to scheduled preventive maintenance, which is essential for maintaining equipment at optimal productivity and precision, as well as ensuring continuous and uninterrupted service. To guarantee optimal availability and dependability of the current facility, systematic maintenance must be meticulously scheduled and diligently executed to reduce delays and interruptions caused by inadequate performance and malfunctions of these facilities. Thomlingson (2015) asserts that in "Effectiveness Maintenance," the goals of an effective maintenance function are to: support operations by ensuring production equipment remains in optimal condition to achieve production targets; maintain plant facilities by preserving the functionality and aesthetic appeal of the site, buildings, utilities, and grounds; and establish a program to deliver services and execute quality work.

Predictive maintenance is the proactive detection process for monitoring or identifying changes in equipment. Adeniyi, Lion, and Sanni (2004) assert that predictive maintenance occurs when there is a warning signal indicating potential hazards in equipment operation. It pertains to the implementation of effective techniques to prevent failure upon the detection of warning signals. Predictive maintenance involves utilizing technologies and early detection methods to monitor and

identify condition changes, facilitating more accurate interventions. Predictive maintenance may encompass vibration analysis, stock pulse methodologies, ultrasonic assessments, thermographic evaluations, oil analysis, electrical surge comparisons, coolant analysis, wear particle analysis, and trend analysis.

Effective teaching and learning necessitate the availability of workshop and equipment. The available workshop and equipment must be employed by technical educators for teaching and thereafter preserved for future usage. Effective teaching is unattainable without sufficient arrangements for the availability, utilization, and upkeep of necessary workshop equipment in postsecondary institutions. There is an undeniable gap between enhancing the maintenance of workshop and equipment for teaching and learning in contemporary higher institutions. A contentious discussion has emerged between technical educators and policymakers regarding the inadequate condition of workshop equipment in universities. Umunadi (2004) concisely asserts that a school of thought posits that the issues confronting the quality of university graduates today stem from the gross inadequacy and poor maintenance of workshop equipment essential for teaching and learning. Another perspective posits that the difficulties encountered by university graduates stem from the manner in which existing equipment is utilized by educators and students.

Ezeji (2016) noted that an effective approach begins with the prudent utilization of available resources and the improvisation of local substitutes for imported materials, aiming to indigenize the production of equipment. The author stated that various facilities utilized for technical instruction necessitate continuous lubrication and require regular cleaning for maintenance. Inadequate coordination and various deficiencies in the interactive human component result in the failure of numerous maintenance services, consequently impairing service delivery in the teaching and learning activities of higher institutions. The necessity of identifying solutions to enhance the maintenance of workshop and equipment for optimal service delivery cannot be overstated.

Statement of the Problem

The workshop and equipment in tertiary institutions suffer from inadequate maintenance and management, resulting in the production of graduates lacking practical skills and interest in the upkeep of these facilities, ultimately rendering them underprepared for the workforce. The workshop, along with the equipment, tools, and facilities, serves as a medium for students' practical skills learning. Nevertheless, adequate maintenance of this equipment is highly advantageous for attaining its specified technology-oriented aims. The acquisition of practical skills cannot be effectively achieved through theoretical instruction alone without the utilization of workshop equipment and tools.

Although workshop and equipment in tertiary institutions are costly and scarce for efficient service delivery, it is prudent and essential to properly maintain and manage the available tools; however, the opposite occurs. The workshop and equipment in our tertiary institutions, including Colleges of Education (Technical), Polytechnics, and Universities, are deficient in maintenance and effective management. Workshop and equipment users in the tertiary institution lack maintenance skills and effective management. This results from their inadequate maintenance abilities acquired throughout official training. Theoretical content supersedes practical application. The evidence indicates a lack of sufficient maintenance strategies for enhancing the upkeep of workshop equipment, inadequate funding for maintenance, insufficient identification of issues impacting

maintenance, and an unclear delineation of governmental responsibilities regarding the maintenance of workshop and equipment in the study area. The study examines suitable preventive and reactive maintenance strategies to enhance the upkeep of workshop and equipment in tertiary institutions, identifies effective corrective and predictive maintenance strategies, highlights issues impacting maintenance, discusses the significance of funding as a strategy for improvement, and delineates the government's role in maintaining workshop and equipment within Industrial Technology Education for optimal service delivery in tertiary institutions.

Purpose of the Study

The primary objective of the study is to assess solutions for enhancing the maintenance of workshop and equipment in industrial technology education to ensure optimal service delivery in tertiary institutions. The study aims to identify the:

1. appropriate preventative and reactive maintenance strategies for enhancing the upkeep of workshop and equipment in industrial technology education to provide optimal service delivery in tertiary institutions in Delta State;
2. appropriate corrective and predictive maintenance solutions to enhance the upkeep of workshop and equipment in industrial technology education for optimal service delivery in tertiary institutions in Delta State.

Research Questions

The study was guided by the subsequent research questions:

1. What are the suitable preventive and reactive maintenance strategies for enhancing the maintenance of workshop and equipment in tertiary institutions?
2. What are the suitable corrective and predictive maintenance procedures that can enhance the maintenance of workshop and equipment in tertiary institutions?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance for the study

$H0_1$ There is no significant difference between the mean perception of lecturers and technicians on appropriate preventive and reactive maintenance strategies that would improve maintenance of workshop and equipment in industrial technology education in tertiary institution.

$H0_2$ There is no significant difference between the mean perception of lecturers and technicians on the appropriate corrective and predictive maintenance strategies that would improve maintenance of workshop and equipment in industrial technical education in tertiary institution.

Research Method

The study employed a survey research design. Gall, Gall, and Borg (2017) define survey research as a data collection approach utilizing questionnaires or interviews to gather information from a sample chosen to represent a population, allowing for the generalization of the data analysis findings. This design is suitable for the study as it gathered the respondents' opinions. The study population comprises fifty (50) individuals. The study's population comprised thirty (30) technical education lecturers, with fifteen (15) from Delta State University, Abraka, and fifteen (15) from Federal College of Education (Technical) Asaba, along with twenty (20) technicians in the department of technical education, consisting of ten (10) from Delta State University, Abraka, and

ten (10) from Federal College of Education (Technical) Asaba. No sampling was conducted for the study as the population was manageable; therefore, the entire population was utilized.

The data gathering tool employed is a structured questionnaire, which is segmented into two distinct sections. Part A of the instrument comprises personal information of the respondents, who are asked to select the applicable alternatives. Part B of the questionnaire consists of items derived from the evaluated literature, organized into five sections: 1, 2, 3, 4, and 5. The instrument underwent face validation by two lecturers from Delta State University, Abraka, and one lecturer from Federal College of Education (Technical) Asaba, Delta State. The experts' comments and suggestions were utilized to revise the final edition of the questionnaire. To ascertain the instrument's reliability, it was administered to 10 academics and 10 technicians at the University of Benin in Edo State. The rationale for this is that Edo State lies outside the study area. After one week, the same was administered to ten lecturers and ten technicians. Cronbach's Alpha was employed to assess reliability, yielding a coefficient of 0.86, indicating strong reliability of the instrument. The questionnaire was disseminated to the respondents following approval from the Heads of Departments and was collected promptly after completion. The questionnaire was completely returned. The questionnaire was evaluated by mean and standard deviation, and hypotheses were examined using t-test statistics. A mean score of 3.00 served as the criterion for decision-making. Consequently, items with a mean score of 3.00 or higher were classified as agreed, while those with a mean score of 2.99 or lower were classified as disagreed. In hypothesis testing, a hypothesis with a P-value beyond 0.05 is deemed not significant, whereas a P-value of 0.05 or lower is regarded as significant.

Results

Table 1: Mean scores and Standard Deviation of the appropriate preventive and reactive maintenance strategies that could be used for improving the maintenance of workshop and equipment

S/N	Items	N	Mean	Std. Dev	Decision
1	Daily maintenance of workshop equipment, including cleaning and lubrication, is performed regularly.	50	3.48	1.40	Appropriate
2	Students aid with the maintenance and sanitation of workplace apparatus and facilities.	50	3.52	1.11	Appropriate
3	Seminars, workshop, and conferences are occasionally organized on maintenance.	50	3.40	1.06	Appropriate
4	Regular adjustments and replacements of defective components are conducted.	50	3.60	1.14	Appropriate
5	Maintenance increase the effectiveness and efficiency of equipment	50	4.72	.45	Appropriate
6	Breakdown (repair) maintenance is applied	50	3.64	.80	Appropriate

Source: Field Study (2024)

Table 1 presents the result of mean scores and standard deviation of the appropriate preventive and reactive maintenance strategies that could be used for improving the maintenance of workshop and equipment. The results show that the mean responses ranged from 3.40 to 4.72, with standard deviations falling between 0.45 and 1.40. These findings indicate a stronger agreement on the strategies' perceived efficacy, which suggests that the strategies are effective. A smaller standard deviation (0.45), which indicates that responses were grouped closely around the mean, indicates that respondents were in agreement on how effective the strategies are. A larger standard deviation (1.40) indicates greater variety in the responses, which may reflect varying perspectives or experiences with the strategy's efficacy. The majority of mean scores for the strategies that were evaluated are above the neutral midpoint, indicating that the strategies are widely thought to be effective. According to the investigation, there is variation in the perception of the benefits associated with reactive and preventive maintenance practices.

Table 2: Mean scores and Standard Deviation of the appropriate corrective and predictive maintenance strategies that could be used for improving the maintenance of workshop and equipment

S/N	Items	N	Mean	Std. Dev	Decision
1	Arrangements are made for servicing equipment and facilities after use	50	3.80	.80	Appropriate
2	Ensure that moving part are always well lubricated or greased after work.	50	4.20	.75	Appropriate
3	Crankcase oil and filter, if necessary, every 100hours of operation.	50	3.80	.69	Appropriate
4	You should Support replacement maintenance principles	50	4.12	.77	Appropriate
5	You should employ skilled maintenance technicians for workshop and equipment	50	4.48	.76	Appropriate
6	Encourage school administrators to provide research for maintenance of workshop and equipment	50	3.76	.82	Appropriate
7	Workshop personnel must educate students on the correct procedure for identifying defective workshop equipment by distinguishing between operational and malfunctioning devices.	50	4.36	.56	Appropriate

Source: Field Study (2024)

Table 2 presents the result of mean scores and standard deviation of the appropriate corrective and predictive maintenance strategies that could be used for improving the maintenance of workshop and equipment. The results show that the mean responses ranged from 3.76 to 4.48, with standard deviations falling between 0.56 to 1.82. These findings indicate that respondents view corrective

and predictive maintenance strategies as effective tools for improving the maintenance of workshop and equipment. There is an agreement among respondents on the efficacy of the method when the standard deviation is on the lower end (0.56). A higher standard deviation (1.82) indicates a greater diversity of viewpoints, maybe as a result of varying experiences with or perspectives on the use of the strategies or their results. Both corrective and predictive maintenance strategies are seen as effective, with mean scores indicating a positive overall assessment. It is believed that both predictive and corrective maintenance strategies work well generally, as indicated by mean scores. Most respondents agreed that these strategies assist in better maintenance. The findings indicate the value of predictive and corrective maintenance strategies for improving maintenance, but stress the need to overcome perceived variability.

Table 3: T-test showing differences between the mean perception of lecturers and technicians on appropriate preventive and reactive maintenance strategies that would improve maintenance of workshop and equipment in industrial technology education in tertiary institution.

S/N	Items	F	Sig.	Df
1	Routine maintenance of workshop equipment, including cleaning and lubrication, is performed daily.	3.164	.349	48
2	Students aid with the maintenance and sanitation of workplace apparatus and facilities.	.018	.538	
3	Seminars, workshop, and conferences on maintenance are organized periodically.	.111	.594	
4	Regular adjustments and replacements of defective components are conducted.	.036	.804	
5	Maintenance increase the effectiveness and efficiency of equipment	4.713	.299	
6	Breakdown (repair) maintenance is applied	.120	.777	

Source: Field Study (2024)

Table 3 presents the result of differences between the mean perception of lecturers and technicians on appropriate preventive and reactive maintenance strategies that would improve maintenance of workshop and equipment in industrial technology education in tertiary institution. According to the findings of the T-test analysis, each item had an F-value of 3.164, 0.018, 0.111, 0.036, 4.713 and 0.120 with a P-value of 0.349, 0.538, 0.594, 0.804, 0.299 and 0.777respectively. The hypothesis that "There is no significant difference between the mean perception of lecturers and technicians on appropriate preventive and reactive maintenance strategies that would improve maintenance of workshop and equipment in industrial technology education in tertiary institution." is clearly accepted because the P-value is greater than 0.05.

Table 4: T-test showing difference between the mean perception of lecturers and technicians on the appropriate corrective and predictive maintenance strategies that would improve maintenance of workshop and equipment in industrial technical education in tertiary institution.

S/N	Items	F	P-Value	Df
1	Arrangement are made for servicing equipment and facilities after use	.033	.725	48
2	Ensure that moving part are always well lubricated or greased after work.	.538	.707	
3	Crankcase oil and filter, if necessary, every 100hours of operation.	.469	.684	
4	You should Support replacement maintenance principles	.043	.035	
5	You should employ skilled maintenance technicians for workshop and equipment	5.022	.155	
6	Encourage school administrators to provide research for maintenance of workshop and equipment	.022	.533	
7	Workshop personnel must educate students on the correct procedure for identifying defective workshop equipment by distinguishing between operational and malfunctioning devices.	.611	.686	

Source: Field Study (2024)

Table 4 presents the result of difference between the mean perception of lecturers and technicians on the corrective and predictive maintenance strategies that would improve maintenance of workshop and equipment in industrial technical education in tertiary institution. According to the findings of the T-test analysis, each item had an F-value of 0.033, 0.538, 0.469, 0.043, 5.022, 0.022 and 0.611 with a P-value of 0.725, 0.707, 0.684, 0.035, 0.155, 0.533 and 0.686 respectively. The results indicate that there is no significant difference in perceptions between lecturers and technicians on most of the items (items 1, 2, 3, 5, 6, and 7). However, there is a significant difference in perception for item 4. This means that for this specific item, the opinions of lecturers and technicians differ significantly. The hypothesis that "There is no significant difference between the mean perception of lecturers and technicians on the corrective and predictive maintenance strategies that would improve maintenance of workshop and equipment in industrial technical education in tertiary institution" is clearly accepted by these data. This is because the P-value of most items is greater than 0.05.

Discussion

Findings of the study revealed that, according to respondents, regular maintenance such as daily lubrication and cleaning is essential for preserving workplace equipment. Gaither (2003), proposed that the routine maintenance approach, on the other hand, should be planned on a weekly, monthly, quarterly, or even yearly basis, depending on when scheduled timetable, to prevent facility disintegration. Additionally, it was found that tools and equipment wear out from use since they aren't maintained and are only replaced after they break altogether. This works contrary to the good maintenance culture, which calls for routine inspections of tools and equipment to ascertain their state before they break down. Staff and students at the school may get injuries or possibly may die

as a result of this, according to Szuba and Young (2003). A reactive strategy for equipment failures is to replace and modify malfunctioning pieces on a regular basis. This method places less emphasis on scheduling maintenance tasks in advance and instead concentrates on getting the equipment back to normal operational condition as soon as feasible (Gackowiec, 2019). However, according to Brown (2022), unexpected repairs made in response to failures, which increase downtime, increase repair costs, generate unpredictability, and decrease the equipment's lifespan, are some fundamental aspects of reactive maintenance.

The results of the study further indicate that methods for enhancing maintenance procedures that are supported by both lecturers and technicians are widely acknowledged to be beneficial and also no significant difference in perceptions between the mean perception of lecturers and technicians on the corrective and predictive maintenance strategies that would improve maintenance of workshop and equipment in industrial technical education in tertiary institution. The significance of making arrangements for facilities and equipment maintenance after usage was strongly agreed upon by the respondents. This is in agreement with the findings of Jardine et al. (2006), who found that scheduling maintenance for facilities and equipment after usage guarantees that the latter is kept in optimal operating condition, hence extending its lifespan and averting unplanned malfunctions. Frequent maintenance improves overall equipment performance and dependability by spotting possible problems before they become larger ones. Respondents appear to appreciate proactive maintenance techniques based on their acceptance of replacement maintenance concepts. In order to prevent unplanned breakdowns and keep equipment operating at its best, replacement maintenance entails scheduling the replacement of parts based on time or use data (Mobley, 2002). The importance placed on hiring qualified maintenance personnel is a reflection of the understanding that knowledge is essential to efficient maintenance. According to Pintelon et al. (2006), skilled technicians are capable of handling difficult diagnostic and repair jobs, which are necessary to uphold high standards for the performance and dependability of equipment. It is essential for early identification and intervention to teach workshop staff and students how to identify malfunctioning equipment. According to Bertolini et al. (2004), adequate training guarantees that malfunctioning equipment is found quickly, preventing the escalation of issues and guaranteeing effective repairs.

Conclusion

There appears to be a common understand of the most important strategies for workshop and equipment maintenance, as evidenced by the lack of significant differences in perceptions between lecturers and technicians. The results of the study highlight the need of putting in place thorough maintenance procedures, obtaining sufficient money, and encouraging favorable governmental regulations. Prospective investigations may delve into particular tactics of implementation and case studies to provide further perspectives on optimal approaches for upkeep in technical education. Higher education institutions may improve their maintenance procedures by taking care of these issues, which will ultimately result in better service delivery and academic results. It was therefore concluded that predictive maintenance strategies, which employ data and analytics to identify possible problems before they arise, are enhanced by corrective maintenance, which entails fixing equipment after failures. According to the general agreement on these strategies, utilizing predictive analytics and implementing sophisticated diagnostic tools may significantly

save maintenance expenses and downtime, which will eventually lead to a more effective and responsive maintenance framework. In order to further improve maintenance practices in industrial technology education, future efforts should concentrate on converting these insights into workable methods and investigating creative alternatives.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Institutions should establish comprehensive maintenance schedules that incorporate regular inspections, timely repairs, and updates to prevent equipment failures.
2. Collaboration with government bodies can lead to more substantial financial support and improved maintenance infrastructure. Institutions should advocate for stronger governmental policies and funding initiatives that support the maintenance of workshop and equipment.
3. Collaborative approach to address these issues of maintenance challenges should be encouraged. This includes engaging both lecturers and technicians in developing solutions, sharing best practices, and creating joint committees to oversee maintenance strategies.
4. Institutions should prioritize securing sufficient funding for maintenance activities, including grants and budget allocations specifically designated for equipment upkeep.

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