STRATEGIES FOR IMPROVING MAINTAINANCE OF LABORATORIES AND EQUIPMENT OF ELECTRICAL AND ELECTRONICS PROGRAMME FOR EFFECTIVE SERVICE DELIVERY IN TERTIARY INSTITUTIONS

BY

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2016/1/63788TI

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION, SCHOOL OF TECHNOLOGY EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF TECHNOLOGY (B. TECH) DEGREE IN INDUSTRIAL AND TECHNOLOGY EDUCATION.

April, 2023

DECLARATION

I, NMADU**, Elijah jiya** with matriculation number **2016/1/63788TI**, an undergraduate student of the department of Industrial and Technology Education, certify that the work embodied in this project is original and has not been submitted in part or full for any other diploma or degree of this or any other University.

NMADU, Elijah Jiya

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Sign and Date

2016/1/63788TI

CERTIFICATION

This project has been read and approved as meeting the requirement for the award of B. Tech degree in Industrial and Technology Education, School of Technology Education, Federal University of Technology, Minna.

Mr. I.K. Kalat

Project Supervisor _____ Signature and Date

DR. T.M. Saba

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Head of Department Signature and Date

_____

External Examiner Signature and Date

DEDICATION

This project is dedicated to the one and only true God, the creator of the universe, the fountain of Knowledge and the Sustainer of Life and the great Provider for seeing me throughout my studies in Federal university of technology, Minna Niger State.

ACKNOWLEDGEMENT

First, I give thanks to the Lord Jesus Christ, the creator of the universe, for the strength, knowledge and health which he granted to me through the period of this academic research work.

I acknowledge my project supervisor Mr. I.K kalat, for guiding me through and meticulously going through this project, with these I am very grateful, may God bless him. And also, not forgetting all my lecturers for the life time learning experience I have acquired from them all, the researcher is really great and saying thanks to you all.

Finally, my gratitude goes to friends and family who have in one way or the other contributed to the success of this work. I say thanks to you all.

Abstract

The research was design to investigate the strategies for improving maintenance of laboratories and equipment of vocational and technical education for effective service delivery in tertiary institutions. three research questions were answered and three hypotheses tested at 0.05 level of significance were formulated for the study. A survey research design was adopted for the study. The major purpose of this study is to look at to find out the strategic improvement needs of electrical technologists for the maintenance of electrical laboratory equipment in technical institution in Niger State, to determine the skill improvement needs of electrical technologists in: Preventive, Predictive and Corrective maintenance of electrical laboratory equipment and to find out the effectiveness of vocational and technical education in service delivery. the literature was reviewed in line with the three research questions, and the null hypotheses were formulated to guide the study, in which several sub-headings were discussed as regard to the purpose of the study. The research design used for this study is survey research design in which questionnaire was formulated to solicit information from respondents. The targeted population comprised of automobile technology teachers and automobile workshop supervisors. 75 males electrical trade staff and 25 females electrical trade staff. Data obtained was analyzed using mean, standard deviation, and t-test statistics. the study concluded and recommended the following: Adequate resources should be allocated to technical and vocational education. Inadequate funds affect the provision of essentials such as well – equipped laboratories and workshops, relevant textbooks and training manuals, vocational and technical education requires skilled and proficient teachers. Teachers preparation should be given a priority attention. there is the need for regular in-service training for teachers of technology to upgrade their skills. Periodical industrial training for teacher is a sine-qua-non in other to keep them abreast with the technological changes in the industry, there is the need for our technical institutions to establish good relationship and linkages with similar institutions abroad as this will promote cross – fertilization of ideas and enhance technology transfer. By doing this the technical institutions will have access to new developments, exchange programmes and other numerous benefits available at those institutions whose technical programmes are well developed and Further research should be carried out on the pre-caution measures to be taken during service delivery to ensure its effectiveness.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Maintenance of laboratory and equipment is imperative in the provision of effective vocational and technical education service delivery in tertiary institution. Technical education according to Federal Republic of Nigeria (2004) is that aspect of education that leads to the acquisition of practical and applied skills as well as basic scientific knowledge. In the same vein, (UNESCO, 2007), defined technical and vocational education as a comprehensive term referring to those aspect of educational process involving, in addition to general education the acquisition of practical skills, attitudes and understanding of knowledge relating to educational life.

Electrical technology according to Alegbemi (2010) is that aspect of technical education which deals primarily with electricity and principles of magnetism and devoted to the utilization of forces of nature and materials for the benefits of mankind. Some of the training received in Nigeria schools under technical education in electrical/electronic technology includes; electrical installation and maintenance, radio, television and electronic work instruments mechanism, domestic appliance repair, machine and power engineering, electronics and communication, instrumentation and control.

Technical and vocational education is used as a comprehensive term in the educational process involving, in addition to general education, the study of technologies and related sciences and acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life (FGN, 2004). Okoro (1993) quoted in Agapu and Andural (2007) and Momoh (2012) defines vocational education as a form of

education whose primary purpose is to prepare persons for employment in recognized occupation. In the same vein he defines technical education as a post-secondary vocational training programme which the major purpose is the production of technicians.

Unfortunately, despite all the glaring contributions of technical and vocational education in our nation, Nigeria is yet to accord this type of education the attention it deserves. This is one of the major reasons for the rising unemployment, poverty and unabated crimes in the society today. This study is an attempt to explore some issues, challenges and the way forward for vocational and technical education in Nigeria.

Electrical laboratory equipment is major appliances, microcontroller, power tool and small appliances. Peter (2006) referred to electrical laboratory equipment as the backbone of the teaching in science, technology, engineering, and vocational courses. Cannon (2001) stated that electrical equipment includes any machine powered by electricity which usually consist of an enclosure, a variety of electrical components, and often a power switch. Typical electrical laboratory equipment is meter, test clips, deflection galvanometer, oscilloscopes, portable Wheatstone bridge, A.C motors, DC motor alternator set, multimeter, wattmeter, DC motor, batteries, AC ammeter and voltmeter. Due to long year of usage of electrical equipment which causes deterioration or failure, maintenance of electrical equipment is essential.

Maintenance is one of the essential activities in electrical laboratories. Ogbuanya (2009) viewed maintenance as action taken to restore or keep an item in good functional order. Maintenance may be defined as actions necessary for retaining or restoring a piece of equipment, machine, or system to the specified operable condition to achieve its maximum useful life (Uche & Ogbonnaya, 2012). This signifies that the electrical teachers need to know how to maintain available laboratory equipment. Maintenance is a set of organised

activities that are carried out in order to prolong the service life of equipment in its best operational condition with minimum cost acquired. These activities have to be appropriate and timely to ensure equipment effectiveness and efficiency.

1.2 Statement of the Problem

Most laboratory equipment doesn't reach their expected life span due to inappropriate maintenance by the technicians. However, if the technicians are not giving proper orientation on the operation and maintenance of equipment this can cause breakdown and reduce the life span of machine. More also, some technicians don't pay adequate attention to the present working condition of the equipment being used in the laboratory can be dangerous not only to the laboratory but also to lives and properties. Finally, students cannot gain the required practical skills needed for employment if they are not trained with functional equipment. Hence the need of this study.

1.3 Aim and Objectives of the study

This project is aimed evaluating the strategies for improving maintenance of laboratories and equipment of vocational and technical for effective service delivery in tertiary institution with the following objectives as outlined below:

1. To find out the strategic improvement needs of electrical technologists for the maintenance of electrical laboratory equipment in technical institution in Niger State.
2. To determine the skill improvement needs of electrical technologists in: Preventive, Predictive and Corrective maintenance of electrical laboratory equipment.
3. To find out the effectiveness of vocational and technical education in service delivery.

1.4 Significance of the Study

This related study will be beneficial to both the Technologist and Technicians in Tertiary Institutions, the Principals of Technical Colleges, Electrical trade teachers, Electrical trade students, State Ministry of Education and Science, National Board for Technical Education and the society. The findings of this study will be beneficial to tertiary institutions on the need to send electrical technicians for refresher course in the area of maintenance of electrical laboratory equipment where Electrical trade technicians will be trained on predictive maintenance of electrical laboratory equipment which in return will minimize the rate of failure of equipment.

Applying the findings of this study will be of immense benefit to electrical trade students in tertiary institution. The students will be able to acquire different maintenance through their lecturers and technologists in order to be able to carry out practical with functional equipment. Electrical trade students can apply different types of electrical maintenance skills learnt in their places of work or establish a maintenance service company after graduation.

The findings of the study will assist the State Ministry of Education and Science to appreciate the relevance of skill improvement needs of electrical teachers the Ministry engaged in teaching. The Ministry can use the findings of the study to organize programme like workshop or seminar for technical teachers to update them with preventive and other maintenance skills of electrical laboratory equipment.

The findings of this study will also be of benefit to the society. The society will also benefit from the findings of the study in the sense that electrical technologists or electrical graduate can apply the identified predictive maintenance to help the people in the society in maintaining their electrical equipment at home and abroad.

1.5 Research Question

1. What is the strategic improvement needs of electrical technicians in preventive maintenance of electrical laboratory equipment?
2. What is the strategic improvement needs of electrical technicians in predictive maintenance of electrical laboratory equipment?
3. What is the strategic improvement needs of electrical technicians in corrective maintenance of electrical laboratory equipment?

1.6 Hypothesis

The following null hypotheses are formulated to guide this study and were tested at 0.5 level of significance.

- **H1:** Preventive maintenance of electrical laboratory equipment require any skill improvement;
- **H2:** Predictive maintenance of electrical laboratory equipment require any skill improvement;
- **H3:** Corrective maintenance of electrical laboratory equipment require any skill improvement;

1.7 Scope of the Study

The study will be limited to maintenance skills such as preventive, predictive and corrective maintenance; but delimiting other aspect of electrical trade such as electrical installations, cable joining, battery charging, winding of electrical machines etc. The other wide area to which this study can be taken is on the Electrical Installation of Laboratory equipment, cabling techniques to mention but few due to the time factor and financial cost implication.

CHAPTER TWO

2.0 LITERATURE REVIEW

The related literature to this study will be reviewed under four main subheadings namely: Conceptual Framework, Theoretical Framework, Review of Related Empirical Studies and Summary of Reviewed Related Literature.

2.1 Conceptual Framework

i. Technical Colleges and Electrical Programme in Nigeria
   - Skills in Electrical Technology

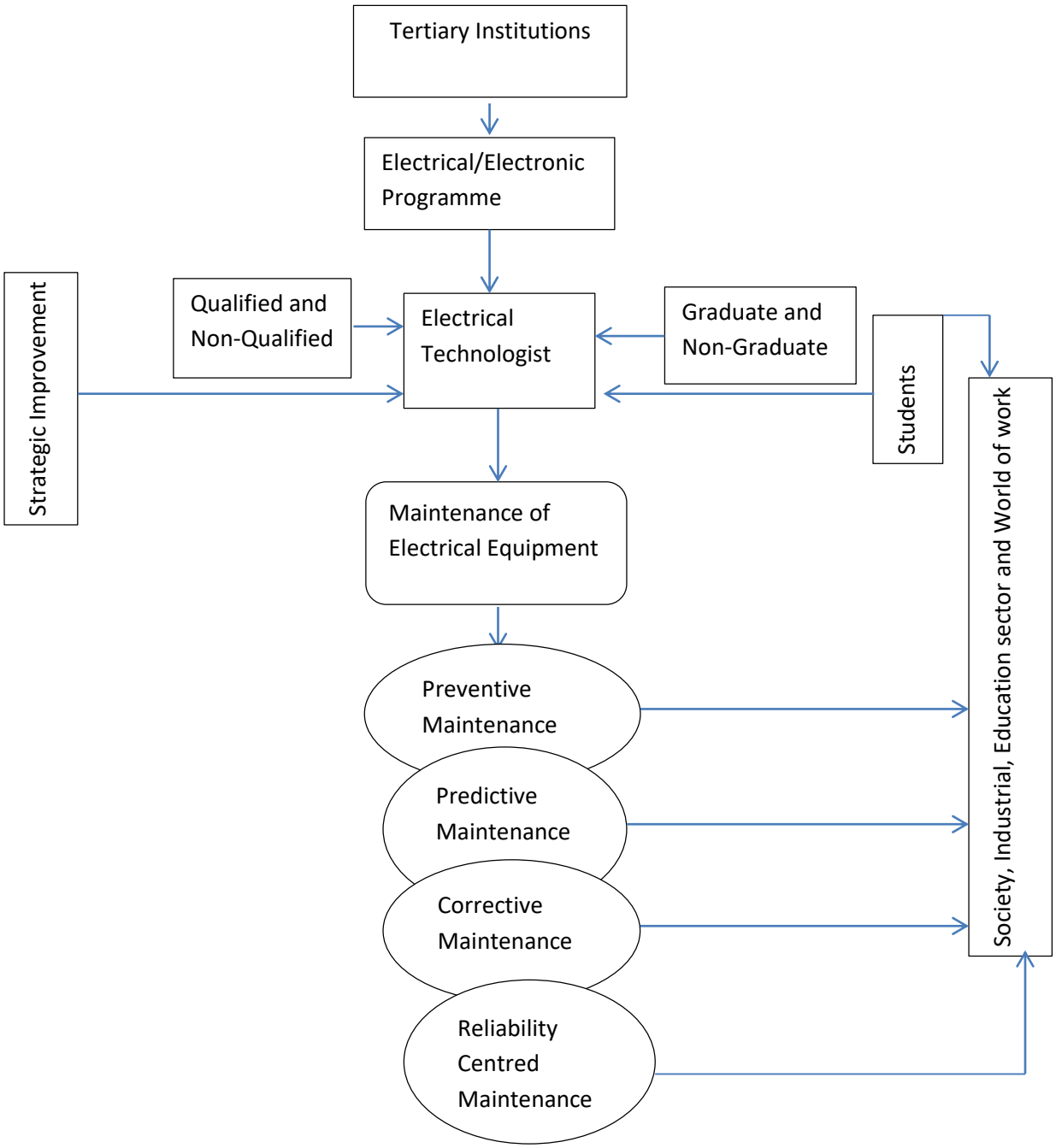
ii. Concept of Vocational and Technical Education
   - Objectives of Vocational and Technical Education
   - Problems of Vocational and Technical Education
   - Funding Vocational and Technical Education and the Implications for Carrying Capacity in Tertiary Institution

iii. Electrical Technology Technician and Maintenance of Laboratory Equipment
   - Electrical Laboratory Equipment

iv. Concept of Maintenance
   - Preventive Maintenance
   - Predictive Maintenance
   - Corrective Maintenance

CONCEPTUAL FRAMEWORK

2.1 Conceptual Framework



Schematic diagram of the conceptual frame work

2.1.2 Technical Colleges and Electrical Programme in Nigeria

Vocational education or vocational education and training is an education that prepares trainees for jobs that are based on manual or practical activities, traditionally non-academic, and totally related to a specific trade, occupation, or vocation. It is sometimes referred to as technical education as the trainee directly develops expertise in a particular group of techniques (One Economy Corporation, 2012). Federal Government of Nigeria (2004) emphasized that the aim of technical education is to give training and impart the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who shall be enterprising and self-reliant.

Abassah (2011) opined that technical education contends with training that borders on acquisition of knowledge and skills in woodworks metalwork, electrical/electronics, welding and fabrication, building, auto mechanics etc. including workshop organization and management. There are five technical institutions in Nigeria outside the universities namely; Prevocational and Vocational schools at post primary level, the Technical Colleges, the Polytechnics and the Colleges of Education (Technical) at the post-secondary level established to provide a base for technological take off in Nigeria.

Electrical trades offer adequate theoretical background to students as well as acquainting them with practical skills in the laboratories and workshops of the department. Students who specialize in electrical trades study in details various types, characteristics, operation, maintenance, and testing of these machines (including all types of AC and DC machines). Students also study in details electrical device used to control these machines at the electrical laboratory.

2.1.3 Skills in Electrical Technology

Skill can be described as human capability to perform technical work very well ability that comes from knowledge, practice and attitude to be able to do something. Electrical technology program provides graduates with the technical skills for careers in their chosen discipline. Okorie (2000) stressed that skill refers to expertness in practical ability with dexterity and fact.

Merriam (2005) defined skill as the ability and capacity acquired through deliberate systematic and sustained effort to smoothly and adaptively carryout complex activities or job functions involving ideas (cognitive) skills, things (technical) skills and/or people. So to possess a skill is to demonstrate the habit of acting, thinking and behaving in a specific activity in such a way that the process becomes natural to the individual through repetition or practice.

2.2.0 Concept of Vocational and Technical Education

Vocational education is education that prepares people to work as a technician or in various jobs such as a tradesman or an artisan. Vocational education is sometimes referred to as *career and technical education*. Historically, almost all vocational education took place in the classroom or on the job site, with students learning trade skills and trade theory from accredited professors or established professionals. However, in recent years, online vocational education has grown in popularity, making learning various trade skills and soft skills from established professionals easier than ever for students, even those who may live far away from a traditional vocational school.

2.2.1 Objectives of Vocational and Technical Education

The objectives of vocational and technical education as stipulated in the National Policy on Education (2004) are:

i. To provide trained manpower in applied science, technology and commerce particularly at sub-professional grades.
ii. To provide the technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development.
iii. To provide people who can apply scientific knowledge to the improvement and solution of environmental problems for the use and convenience of man;
iv. To give an introduction to professional studies in engineering and other technologies;
v. To give training and impart the necessary skills leading to the production of craftsmen, Technicians and other skilled personnel who will be enterprising and self-reliant, and
vi. To enable our young men and women to have an intelligent understanding of the Increasing complexity of technology.

In view of the above objectives, the philosophy of technical education. According to Ojutaric and Lawal (2008) is to provide saleable skills to the youths and make them more labour asset for industries and useful to the society. In electrical workshop, this can only be achieved effectively by adopting some techniques for managing the available facilities by the technical technology

2.2.2 Problems of Vocational and Technical Education

The government cannot come out openly in support of the benefits inherent in vocational and technical education while at the same time paying lip-service to its funding and existence. Also the provision of equipment, facilities and tools cannot be carried out in some tertiary institutions and others left without any equipment or facilities.

However, anybody who has at least a little experience of what it means to give practical technology training to university students, that are inadequately equipped with materials, equipment and facilities will understand that it is almost impossible to get 100 or more students in one classroom to individually practice how to effectively use the only available machine, equipment or tool. Equipment, machines, facilities and instructional materials for the purpose of vocational and technical education should mean that these training items are provided in adequate quantity to a degree where it is possible for individual students to use during practical lesson in workshop.

2.2.3 Funding Vocational and Technical Education and the Implications for Carrying Capacity in Tertiary Institution

The Vocational and Technical education institutions in Nigeria face serious financial problems today because the industries and the existing organizations that are the main consumers of the vocational products are not supporting and financing vocational and technical education programmes. The vocational and technical education in this regard does not have funds needed to execute developmental research projects/programmes.

In Nigeria, we have engineers who cannot produce scientific or technical invention since most of our institutions do not have the equipment and where this equipment are available, there is shortage of personnel in technology, engineering profession and the professionals

prefer to work in industries for more pay than teaching in schools. In the next millennium, Nigeria should take after the developed world like USA, Japan, India, France and West Germany, that usually support, sponsor the vocational and technical institution by industries, individual or organizations in addition to government subventions to enable these Institutions execute their vocational and technical education programmes.

2.3.0 Electrical Technology Technicians and Maintenance of Laboratory Equipment

The introduction of Technical and Vocational Education and Training (TVET) subject in the technical college curriculum is aimed at providing an opportunity to all learners to acquire relevant knowledge and skills in technical and vocational occupations and to impart in learners' positive attitudes toward the world of work. Wanjala (2012) emphasized that technical college electrical technology teacher must have both technical skills and pedagogical/teaching methodology to effectively prepare students in TVET.

Electrical Laboratory Equipment is uniquely identifiable object that can be installed, maintained separately from building, laboratory or room location, and removed. Laboratory equipment can be described as: various equipment used by scientists working in a mechanical, electrical or chemical laboratory. Laboratory equipment is generally used to either perform an experiment or to take measurements and gather data. Electrical laboratory equipment are equipment used in the training of electrical students, which include AC ammeter, DC ammeter, DC voltmeter, AC voltmeter, rheostats, deflection galvanometer, A.C motors, drilling machine, portable drilling machine, portable Wheatstone bridge, shunt wound, DC motor, batteries, portable digital multimeter, non-contact tachometer, transformers, cables, circuit breakers.

Electrical laboratory helps students in getting a first-hand experience of the practical and industrial world. The establishment of electrically laboratories is aimed at giving the students

hands-on adequate knowledge, which qualifies them to operate electric machineries and electric power system (transmission and distribution). This hands-on training introduces the students to basic electrical theory. For successful functioning of equipment, maintenance is one of the essential components in electrical teaching laboratories. The maintenance of the electrical laboratory equipment can represent significant operating expenses. One person is designated and responsible for the maintenance program.

Maintenance Schedule for Electrical Laboratory Equipment Battery systems provide “last resort” power for performing communication, alarm, control, and protective functions (relaying and breaker tripping) when other sources of power fail. Battery system maintenance should have highest priority. Computerized, online battery monitoring systems can be installed to supplement a maintenance program and reduce costs. Battery chargers require regular maintenance as well.

Exciters and Voltage Regulators Components of excitation systems (e.g., transformers, circuit breakers, protective relays, annunciators, and bus-work) require maintenance. Exciter and voltage regulator manufacturer’s instructions may recommend supplemental maintenance tasks. Automatic voltage regulator (AVR) performance testing (“alignment”) is a specialty, requiring specialized training and unique equipment as well as knowledge of current power system stability requirements. It is recommended that performance testing be performed by qualified personnel.

Switches - Medium and High Voltage When open, disconnect switches permit isolation of other power system components, thus, facilitating safety during maintenance procedures. Disconnect switches may be manually or motor operated and, in some cases, may integrate fuse protection. Preventive maintenance shall be considered synonymous with any type of

general maintenance, major maintenance, or overhaul functions to be performed on the equipment.

Ground Connections Grounding: is an essential part of protecting staff and equipment from high potential caused by electrical faults. Grounding conductors of switchyard equipment and gate structures are subject to failure due to corrosion, loose connections, and mechanical damage.

Grounding also may be compromised during equipment addition and removal or other construction type activities. Verifying grounding system integrity through periodic testing is an important maintenance activity.

2.4.0 Concept of Maintenance

Maintenance can be described as the act of keeping things something such as cars, equipment, or houses in good conditions by checking or repairing it regularly. Olaitan, Igbo, Ekong, Nwachukwu and Onyemachi (1999) defined maintenance as taking specific approved steps and precautions to care for a piece of equipment, machinery, or facility and ensure that it attain specific maximum functional self-life. Obi in Mohammed and Abbas (2001) defined maintenance as the totality of measures employed to ensure that a given piece of capital asset, equipment or infrastructure is kept in good operational order until it attains its maximum life span. Activities of maintenance function could be either repair or replacement activities, which are necessary for an item to reach its acceptable productivity condition and these activities, should be carried out with a minimum possible cost.

Basically, the purpose of maintenance is to extend equipment lifetime, or at least the mean time to the next failure whose repair may be costly. Furthermore, it is expected that effective maintenance as one of the strategies can reduce the frequency of service interruptions and the

many undesirable consequences of such interruptions. Maintenance clearly has great impact on component and system reliability: if too little is done, this may result in an excessive number of costly failures and poor system performance and, therefore, reliability is degraded; if it is done often, reliability may improve but the cost of maintenance will sharply increase. In a cost-effective scheme, the two expenditures must be balanced. Many engineers use the concept of a maintenance season to describe the timeframe for performing maintenance scheduled on an annual interval.

Maintenance Strategies: The purpose of maintenance is to extend equipment lifetime, or at least the mean time to the next failure whose repair may be costly. Furthermore, it is expected that effective maintenance as one of the strategies can reduce the frequency of service interruptions and the many undesirable consequences of such interruptions. Maintenance clearly has great impact on component and system reliability: if too little is done, this may result in an excessive number of costly failures and poor system performance and, therefore, reliability is degraded; if it is done often, reliability may improve but the cost of maintenance will sharply increase. In a cost-effective scheme, the two expenditures must be balanced. Maintenance is just one of the devices for up keeping or, if necessary, improving the level of reliability of components and systems. Others include increasing system capacity, reinforcing redundancy and employing more reliable components.

Electric power utilities have always employed maintenance programs to keep their equipment in good working condition for long as it is feasible. Traditional maintenance approaches mostly consisted of predefined activities carried out at regular intervals (schedule maintenance). However, such a maintenance policy may be quite inefficient: it may be overly costly (in the long run), and may not extend component lifetime as much as possible. In the last ten years, therefore, many utilities replaced their maintenance routine using fixed schedules with more flexible programs based on an analysis of needs and priorities, or on a

study of information obtained through periodic or continuous condition monitoring (predictive maintenance).

Accurate and documentation is essential to an effective maintenance program. Whether performing preventive, predictive, corrective, or reliability-centered maintenance, keeping track of equipment condition and maintenance is critical. Maintenance schedules can be done as frequencies as multiyear, annually, monthly, weekly, etc.

i. Weekly: Calendar week (Sunday to Saturday)
ii. Monthly: Calendar month (first day through the last day of the month)
iii. Quarterly: A calendar quarter consisting of 3 calendar months
iv. Semi-annually: Six calendar months
v. Annually: A calendar year (January 1 through December 31)
vi. Multiyear: Multiple calendar years (e.g., 5-year – January 1, 2011, through December 31, 2015)

2.4.1 Preventive Maintenance

There are many definitions of preventive maintenance, but all preventive maintenance management programs are time-driven. Preventive maintenance mission is to maintain a level of certain service on equipment, programming the interventions of their vulnerabilities in the most opportune time. Preventive maintenance is a set of activities that are performed on plant equipment, machinery, and systems before the occurrence of a failure in order to protect them and to prevent or eliminate any degradation in their operating conditions. It is used to be a systematic character, that is, the equipment is inspected even if it has not given any symptoms of having a problem.

Preventive maintenance (PM) measures are performed at relatively fixed intervals. The primary goal of PM is to prevent the failure of equipment before it actually occurs. It is designed to preserve and enhance equipment reliability by replacing worn components before they actually fail. Recent technological advances in tools for inspection and diagnosis have enabled even more accurate and effective equipment maintenance. The ideal PM program would prevent all equipment failure before it occurs. This type maintenance is performed to circumvent equipment failure or malfunction. A preventive maintenance program can help improve reliability of equipment. Preventive maintenance is predetermined work performed to a schedule with the aim of preventing the wear and tear or sudden failure of equipment components.

Cleaning: The intent of cleaning is to remove all dirt and contamination, including any grease or oil film on the windings. Cleaning methods should not utilize high pressure flow or any abrasive methods that could cause damage to the windings.

Record Keeping: The electrical preventive maintenance program should be well documented as to scope and frequency of maintenance. Record all routine maintenance activities and the results of routine testing for trending purposes. Document all repair and/or replacement of electrical components. When changes are made to the electrical distribution system, update all applicable drawings and maintenance schedules to reflect the changes. Ensure that spare parts inventories are updated for any new equipment added based on the manufacturer's recommendations.

2.4.2 Predictive Maintenance:

Predictive maintenance is a type of maintenance used for measuring and/or monitoring of equipment in order to observe or predict equipment degradation or failure. Mobley (2002) defined predictive maintenance as monitoring the vibration of rotating machinery in an

attempt to detect incipient problems and to prevent catastrophic failure. It is also the monitoring the infrared image of electrical switchgear, motors, and other electrical equipment to detect developing problems. The common premise of predictive maintenance is that regular monitoring of the actual mechanical condition, operating efficiency, and other indicators of the operating condition of machine-trains and process systems will provide the data required to ensure the maximum interval between repairs and minimize the number and cost of unscheduled outages created by machine-train failures. When used properly, predictive maintenance can provide almost unlimited benefits; however, when the scope of the program is artificially limited by the scope or work or restrictions imposed by the plant, the benefits may be substantially reduced.

Typically, predictive maintenance is implemented for one of the following reasons:

1. As a maintenance management tool
2. As a plant optimization tool
3. As a reliability improvement tool

Tools that are used in this type of maintenance include vibration analysis, thermography and fluid analysis, among others. These measurements are able to detect the onset of problems or degradation of the equipment or a particular mechanism within the equipment before partial or total failure occurs. Predictive maintenance bases maintenance requirements on the actual state of the equipment, rather than a pre-set schedule. Predictive maintenance can increase the life of the equipment and decrease downtime, parts and labour costs, while providing energy savings. Through the monitoring, pre-emptive measures can be taken to prevent equipment failure, increasing the environmental safety as well.

Predictive maintenance is a significant component of the condition-based maintenance (CBM) strategy. Condition-based maintenance (CBM) is a proactive way to get in front of

potential failures. It pursues constantly know and report the status and operational capacity of the installations by knowing the values of certain variables, which represent such state and operational ability. To apply this maintenance, it is necessary to identify physical variables (temperature, vibration, power consumption, etc.). Which variation is indicative of problems that may be appearing on the equipment? This maintenance it is the most technical, since it requires advanced technical resources, and at times of strong mathematical, physical and/or technical knowledge. The common premise of predictive maintenance is that regular monitoring of the actual mechanical condition, operating efficiency, and other indicators of the operating condition of machine-trains and process systems will provide the data required to ensure the maximum interval between repairs and minimize the number and cost of unscheduled outages created by machine-train failures (Mobley, 2002).

Evans (2007) emphasized that the primary diagnostic technologies utilized to assess equipment health include vibration analysis, infrared thermography, airborne ultrasound, oil analysis, and motor circuit evaluation. Vibration analysis uses sensors placed on equipment to provide a detailed spectrum of vibration frequencies. This technology can identify equipment imbalance, misalignment, bearing faults, and abnormal installation conditions like soft foot. Ultrasonic equipment is used to measure sound frequencies outside human capacity and can be used to identify bearing problems, air system leaks, steam trap leaks, and valve leaks.

2.4.3 Corrective Maintenance

Corrective maintenance is another type of maintenance; it is aimed to restore already repaired failed equipment (Ogbuanya, 2009). The set of corrective tasks is destined to correct the defects to be found in the different equipment and that are communicated to the maintenance department by users of the same equipment. This maintenance is often most expensive because worn equipment can damage other parts and cause multiple damage. Corrective

maintenance is probably the most commonly used approach, but it is easy to see its limitations. When equipment fails, it often leads to downtime in production. In most cases this tends to be costly to the business. Also, if the equipment needs to be replaced, the cost of replacing it alone can be substantial. Corrective maintenance is carried out on all items where the consequences of failure or wearing out are not significant and the cost of this maintenance is not greater than preventive maintenance. This type of maintenance can be regarded as unplanned, emergency, breakdown maintenance.

This type of maintenance, according to Alshayea (2012) is subdivided into three types:

- Remedial maintenance, which is a set of activities that are performed to eliminate the source of failure without interrupting the continuity of the production process.
- Deferred maintenance, which is a set of corrective maintenance activities that are not immediately initiated after the occurrence of a failure but are delayed in such a way that will not affect the production process.
- Shutdown corrective maintenance, which is a set of corrective maintenance activities that are performed when the production line is in total stoppage situation.

The way to perform corrective maintenance activities is by conducting four important steps:

1. Fault detection.

2. Fault isolation.

3. Fault elimination.

4. Verification of fault elimination.

In the fault elimination step, several actions could be taken such as adjusting, aligning, calibrating, reworking, removing, replacing or renovation. Corrective maintenance has

several prerequisites in order to be carried out effectively. Alshayea (2012) enumerated them as follows:

1. Accurate identification of incipient problems.

2. Effective planning which depends on the skills of the planners, the availability of well-developed maintenance database about standard time to repair, a complete repair procedures, and the required labour skills, specific tools, parts and equipment.

3. Proper repair procedures.

4. Adequate time to repair.

5. Verification of repair.

Theoretical framework

Theoretical framework for the study is based on management theories and vocational education theories. In management theories, Scientific Management Theory will be used for the study, while in vocational education theories, The Process Habit Theory will be used for the study.

Theory is a general explanation of natural events which will better, explain as a set of tested common-sense values or principles which help managers to understand, interpret or predict real actions (Ogbonna, 2003). In schools' management, theories are used to back up management actions in educational practices. It influences the educational practices when properly applied.

The Scientific Theory of Management

The scientific theory of management states that the overall output of a worker can be increased and improve upon through a scientific management process. The theory was propounded by Fredrick Winslow Taylor in (1912).

According to his philosophy of man as machine the regular jobs of an employee should be clearly defined by the employer for optimal utility. However, materials, tool and equipment that are required for successful execution of the defined tasks must be made available to the workers to enable them accomplish set standards of performance. Thus, works should be exposed to training relevant to their assigned tasks.

The theory relates to the present study in the sense that materials, tools and equipment must be made available to workers and also assigned task. Therefore, if electrical technology teachers are provided with materials, tools and, equipment relevant to their work, they will improve on their teaching.

The Process Habit Theory

The process habit theory states that effective vocational training can be given where the training jobs are carried on in the same way, with the same operations, the same tools and the same machines as in the occupation itself. This implies that for the leaner to be effectively prepared, he/she must be trained to possess the habit of doing each task or job in the way with the same tools, machines and operation as in the occupation itself. The functionality of these tools and machines in order to be used in preparing students is hinged on the proper management and maintenance.

The theory relates to the present study in the sense that it talks about proper management and maintenance of tools and machines for training the students. Therefore, in electrical

technology workshops, if this done, electrical technology teacher will improve on their teaching.

Review of related empirical study

In this section of the study, relevant works carried out by various researchers through experimental design pertaining to management techniques to ensure effective instructions in technical schools' workshops have been reviewed in support of this study.

Ede and Attama (2010) conducted a study on the workshop management techniques needed for improving the performance of metalwork teachers in Technical Colleges in Abia and Enugu States. The main purpose of the study was to identify the planning, organizing, coordinating and the evaluating techniques that are required by metalwork teachers for improving their performance in managing the technical schools' metal workshops. The survey research design was employed for the study. A total sample size of 62 (16 heads of departments and 46 metal work teachers) respondents were randomly selected and used for the study.

This work is related to the present study because both studies focus on improvement of workshops in technical colleges and polytechnics. However, they differ in the sense that Mkpozi's study was to determine whether the equipment maintenance project (EMP) has improved workshops, while the present sought to identify workshop management techniques required by electrical technology teachers. Ibeneme (1997) investigated the perceived roles of technical teachers in the maintenance of workshop equipment in Anambra and Enugu States. The research design was a cross-sectional survey that covered all secondary schools and technical colleges in the two states. The population of the study consisted of 706 technical teachers, 519 principals and 519 vice principals (administration) in the service of the two states. Through random sampling technique, 624 subjects were selected and used for the

study. Questionnaire was used for data collection, while frequency counts, percentages, mean, analysis of variance, Chi-square and t-test were used for data analysis. Results showed that technical teachers perceived roles included carrying out preventive maintenance services, maintenance management and teaching students how to maintain school workshop equipment.

This work is related to the present study because both studies focus on workshop management in technical colleges. However, they differ in the sense that the past study was concerned with maintenance of workshop equipment, while the present study is concerned with workshop management techniques in technical colleges. Ogbuanya (1999) worked on the development of a system for the maintenance of technical college workshop equipment. This developmental study was designed to provide a system for maintenance of technical college workshop equipment. The study was a survey that covered five Eastern States of Nigeria and questionnaire was used for data collection. Population of the study was made up of 466 technical college personnel and 35 technical education lecturers making a total of 501 respondents. No sampling was taken as the entire population was used. Frequency counts, percentages, mean and t-test were used for data analysis.

The results showed the maintenance roles to be performed by various technical college personnel including technical college students and the method to be adopted in maintenance of equipment. The findings from the study were used to develop a system for the maintenance of technical college workshop equipment. That should be adopted for effective implementation of maintenance programme in technical colleges.

This study is related to the present study because both studies focus on workshop management, in technical colleges. However, Ogbuanya's work differs in the sense that it was concerned with maintenance of workshop equipment. The present study focuses on

workshop management technique. Amadi (2003) surveyed on evaluation of practical utilization of workshop facilities in technical colleges in Abuja municipal Area Council. The purpose of the study was to find out: The workshop facilities available for electrical/electronic practical in the technical colleges, the facilities that are in actual use in the workshops of the technical colleges, and the personnel available for the practical utilization of the facilities available in the workshop. Forty electrical technology teachers and sixteen principals were randomly sampled for the study. A structured questionnaire was used for data collection. Simple percentages were used to analyse the data. The findings of the study were:

Basic tools and equipment in electrical fields were inadequate, most machinery such as soldering machines, drilling machines, piping machine etc were not in actual use in the workshop due to lack of adequate power supply, the workshops lack trained attendants and skilled field personnel. This work is related to the present study because both studies focus on workshop management in technical colleges. Amadi's work differs in the sense that, it dealt with utilization of workshop facilities in technical colleges, while the present study focused on workshop management techniques in technical colleges.

Summary of review of related literature

Literature reviewed in this study covered concepts of electrical technology workshop management as it relates to planning techniques, organizing techniques, coordinating techniques, techniques for implementing workshop instruction and evaluation techniques for electrical workshop instruction. The literature reviewed has shown how these management techniques can be applied for effective electrical workshop instruction in technical colleges.

The literature reviewed also has highlighted and provided important and useful information on how best the principals, electrical technology teachers, electrical technology students and

other workshop personnel should manage the limited resources such as staff, money, materials and machines available for them to achieve the school objectives in techniques that would help to review any deficiency in the management of electrical technology workshops. The study was anchored on Scientific Management Theory and the Process Habit Theory.

CHAPTER THREE

3.0 METHODOLOGY

This chapter presents the methodology to be used in carrying out the study under the following sub-headings: Design of the Study, Area of the Study, Population for the Study, Sample and Sampling Technique, Instrument for Data Collection, Validation of Instrument, and Reliability of the Instrument, Method of Data Collection, and Method of Data Analysis.

3.1 Design of the Study

A survey research design was adopted for the study. According to Gall, Gall and Borg (2007), survey research is a method of data collection using questionnaire or interviews to collect data from a sample that has been selected to represent a population to which the findings of the data analysis can be generalized. This design is appropriate for this study because it allowed the respondents i.e. electrical teachers to put down their views and opinions on skill improvement needs for the maintenance of electrical laboratory equipment using questionnaire.

3.2 Area of the Study

This study was carried out in Niger State. Niger State was used for the study because it has many tertiary institutions. The tertiary institutions also have well equipped electrical laboratory that their technicians need to maintain to help the equipment last longer for equipping students with needed skills.

3.3 Population of the Study

The population for the study made up of 100 Electrical trade staff in some selected tertiary institutions. The 100-population sample was evenly distributed to the various selected institutions in Nigeria. The sampling is shown in the Appendices.

3.4 Sample and Sampling Technique

The entire population was studied. This is because the population size is manageable. No sampling technique was used for the study.

3.5 Instrument for Data Collection

The instrument for data collection is a structured questionnaire that is divided into two different parts. Part I of the instrument contains personal information of the respondents and they are required to simply check options that apply to them. Part II of the questionnaire is made up of items generated from the literature reviewed which are clustered into three sections, A-C.

Section A with 10 items was packaged to elicit information on skill improvement needs in preventive maintenance of electrical laboratory equipment. Section B was used to seek for information on skill improvement needs in predictive maintenance of electrical laboratory equipment. It has 12 items. Section C was designed to seek for information on skill improvement needs in corrective maintenance of electrical laboratory equipment. The section has 10 Items.

For Sections A, B and C; close-ended questions were used with five response categories. The items are structured on a five-point response options of: Very Highly Needed (VHN) = 5, Highly Needed (HN) = 4, Moderately Needed (MN) = 3, Slightly Needed (SN) = 2 and Not Needed (NN) = 1.

3.6 Reliability of the Instrument

To establish the reliability of the instrument, the validated instrument was trial tested on five Electrical trade staff. The data from the trial testing was analysed using Cronbach Alpha (α) reliability coefficient to establish internal consistency of the instrument for the study. The reliability coefficient (α) of 0.77 indicated that the instrument is reliable for the study.

3.7 Method of Data Collection

The instrument was administered on the respondents by the researcher, with help of three assistants. The assistants were briefed by researcher on how to distribute and retrieved the instrument from the respondents. The respondents were given a week to respond to the instrument, after which the researcher and the assistants collected the instrument for analysis.

3.8 Method of Data Analysis

The data collected from the respondents were analysed using mean to answer the research questions. Each item was accepted as required skill improvement needs, when the calculated mean of any item is greater or equal to 3.50; while mean of any item below 3.50 was considered as skill not required.

The three hypotheses were tested using Chi-Square test at 0.05 level of significance. Null hypothesis was accepted when the computed value is less than the table value. On the other hand, when the computed value is equal or greater than the table value, the null hypothesis was rejected.

CHAPTER FOUR

4.0 PRESENTATION AND DATA ANALYSIS

This chapter deals with the presentation and analysis of data with respect to the research questions formulated for this study, the result of this data analysis for the research questions are presented first, followed by those of the hypotheses tested for the study.

4.1 Research Question 1

What is the strategic improvement needs of electrical technicians in preventive maintenance of electrical laboratory equipment?

Table 4.1: mean response on the strategic improvement needs of electrical technicians in preventive maintenance of electrical laboratory equipment N1=75 N2=25.

S/N	ITEMS STATEMENT	X_1	X_2	X_t	Remark
1	Review and update when there are changes in Equipment.	3.8	3.5	3.7	Agreed
2	Carryout weekly routine maintenance activities for all electrical equipment.	3.8	3.5	3.7	Agreed
3	Clean all loose dirt with link free rags.	3.6	3.4	3.5	Agreed
4	Examine for evidence of moisture that may lead to tracking or flashover.	4.0	3.7	3.9	Agreed
5	Inspect equipment before and after use for symptoms of any problem.	3.2	3.3	3.3	Agreed
6	Proper storage of equipment to prevent degradation.	3.6	3.1	3.4	Agreed
7	Inspect insulators and conductor supports for signs of cracking, broken pieces, and other physical damage or deterioration.	3.5	3.6	3.6	Agreed
8	Ensure that spare parts inventories are updated for any new equipment.	3.5	3.0	3.3	Agreed
9	Examine surrounding areas for signs of tracking, arcing, or overheating.	3.5	3.0	3.3	Agreed
10	Update records when changes are made to equipment.	3.4	2.8	3.1	Agreed

KEY:

X1= average mean responses of male electrical trade staff**,**

X2= average mean responses of female electrical trade staff**,**

N1= number of male electrical trade staff,

N2= number of female electrical trade staff**.**

Table 4.1 reviews that the respondents agreed with item 1,2,3,4,5,6,7,8,9 and 10 with a mean score above 2.50 respectively. While none disagreed with a mean score below 2.50. this means that item 1,2,3,4,5,6,7,8,9 and 10 agreed to the strategic improvement needs of electrical technicians in preventive maintenance of electrical laboratory equipment. While none disagreed.

4.2 Research Question 2

What is the strategic improvement needs of electrical technicians in predictive maintenance of electrical laboratory equipment?

Table 4.2: mean response on the strategic improvement needs of electrical technicians in predictive maintenance of electrical laboratory equipment. N1=75 N2=25.

S/N	ITEM STATEMENT	X1	X2	Xt	Remark
1	Monitor the infrared image of electrical switchgear, motors, and other electrical equipment.	3.3	2.9	3.1	Agreed
2	Measure sound frequencies outside human capacity.	2.9	2.8	2.9	Agreed
3	Identify bearing problems, air system leaks, steam trap leaks, and valve leaks	2.4	2.9	2.7	Agreed
4	Employ thermal imaging system to provide a thermal profile of temperatures on operating equipment	3.1	2.9	3.0	Agreed
5	Eliminate unnecessary downtime, both scheduled and unscheduled.	1.9	2.1	2.0	Disagreed
6	Develop maintenance database about standard time to repair equipment.	2.7	2.5	2.6	Agreed

7	Evaluate the vibration energy created by these electromechanical systems.	3.3	2.8	3.1	Agreed
8	Utilize microprocessor-based instrument to check vibration of equipment.	3.8	3.0	3.4	Agreed
9	Detect thermal anomalies of equipment by using thermography.	3.2	3.8	3.5	Agreed
10	Identify physical variables (temperature, vibration, power consumption).	3.3	2.9	3.1	Agreed
11	Verify grounding system integrity through periodic testing.	2.1	1.9	2.0	Disagreed
12	Estimate amount of time that the equipment will operate.	1.8	2.0	1.9	Disagreed

KEY:

X1= average mean responses of male electrical trade staff,

X2= average mean responses of female electrical trade staff**,**

N1= number of male electrical trade staff,

N2= number of female electrical trade staff.

Table 4.2 shows that both respondents agreed on the problems associated with the management of motor vehicle mechanics workshop in technical colleges, item 1,2,3,4,5,7,8,9 and 10 as reflected by their own mean score greater than 2.50 respectively. Which item 5,11 and 12 disagreed with the mean score below 2.50.

4.3 Research Question 3

What is the strategic improvement needs of electrical technicians in corrective maintenance of electrical laboratory equipment?

Table 4.3: mean response on the strategic improvement needs of electrical technicians in corrective maintenance of electrical laboratory equipment. N1=75 N2=25.

S/N	ITEM STATEMENT	X1	X2	Xt	Remark
1	Repair damaged equipment parts.	2.8	2.7	2.8	Agreed
2	Replace worn out parts which replacement.	2.9	2.8	2.9	Agreed
3	Verify specific type of equipment repair.	1.8	2.0	1.9	Disagreed
4	Isolate beginning problem of equipment.	3.1	2.8	3.0	Agreed
5	Isolate equipment after the occurrence of a failure.	2.9	2.7	2.8	Agreed
6	Refurbish tools, parts and equipment when damaged.	2.6	2.8	2.7	Agreed
7	Rectify failure without interrupting the continuity use of the equipment.	2.5	3.0	2.8	Agreed
8	Overhaul any laboratory equipment when in total stoppage situation.	2.8	2.7	2.8	Agreed
9	Overhaul the equipment on schedule after breakdown.	2.9	2.8	2.9	Agreed
10	Eliminate the source of equipment failure without interrupting the continuity of the production process.	2.0	1.8	1.9	Disagreed

KEY:

X1= average mean responses of male electrical trade staff,

X2= average mean responses of female electrical trade staff,

N1= number of male electrical trade staff,

N2= number of female electrical trade staff.

Table 4.3 shows that both respondents agreed on the strategies for improving the acquisition of building technology skills among technical college students in Niger State, item

1,2,4,5,6,7,8 and 9 as reflected by their own mean score greater than 2.50 respectively. While item 3 and 10 disagreed.

Testing of Hypotheses

4.4 Hypotheses 1:

There will be no significant difference in the mean response of male and female electrical trade staff on the strategic improvement needs of electrical technicians in preventive maintenance of electrical laboratory equipment in Niger State.

Table 4.4: t-test analysis of the respondents of male and female electrical trade staff on the strategic improvement needs of electrical technicians in preventive maintenance of electrical laboratory equipment in Niger State.

S/N	ITEM STATEMENT	SD_1	SD_2	t-test	Remark
1	Review and update when there are changes in Equipment.	0.74	0.96	2.16	NA
2	Carryout weekly routine maintenance activities for all electrical equipment.	0.93	0.94	0.93	A
3	Clean all loose dirt with link free rags.	0.91	1.04	-0.92	A
4	Examine for evidence of moisture that may lead to tracking or flashover.	1.08	1.01	-2.04	NA
5	Inspect equipment before and after use for symptoms of any problem.	1.13	0.86	0.41	A
6	Proper storage of equipment to prevent degradation.	1.01	0.92	0.44	A
7	Inspect insulators and conductor supports for signs of cracking, broken pieces, and other physical damage or deterioration.	0.94	1.02	-0.90	A
8	Ensure that spare parts inventories are updated for any new equipment.	0.91	1.10	1.35	A
9	Examine surrounding areas for signs of tracking, arcing, or overheating.	0.74	0.96	2.16	NA
10	Update records when changes are made to equipment.	0.93	0.94	0.93	A

table 4.4: presents test of this hypotheses

Key

SD1= Standard deviation of male electrical trade staff
SD2= Standard deviation of female electrical trade staff
A= Accepted

NA= Not Accepted

The result shown in table 4.4 above indicates the Comparism between male and female electrical trade staff. Data revealed that items 2,3,5,6,7,8 and 10 has a calculated t-value less than the t-critical value of ±1.68, hence hypothesis for these items were upheld at 0.05 level of significance. Except for item 1,4 and 9 which has a t-calculated value above the t-critical value ±1.68, thus HO was not accepted for this item.

4.5 Hypotheses 2:

There will be no significant difference in the mean response of male and female electrical trade staff on the Skill improvement needs in predictive maintenance of electrical laboratory equipment in Niger State.

Table 4.5: t-test analysis of the respondents of male and female electrical trade staff on the Skill improvement needs in predictive maintenance of electrical laboratory equipment Niger State.

S/N	ITEM STATEMENT	SD_1	SD_2	t-test	Remark
1	Monitor the infrared image of electrical switchgear, motors, and other electrical equipment.	0.44	0.50	2.88	NA
2	Measure sound frequencies outside human capacity.	0.41	0.50	2.99	NA
3	Identify bearing problems, air system leaks, steam trap leaks, and valve leaks	0.50	0.49	1.74	NA
4	Employ thermal imaging system to provide a thermal profile of temperatures on operating equipment	0.00	0.46	5.65	NA
5	Eliminate unnecessary downtime, both scheduled and unscheduled.	0.44	0.44	-0.98	A
6	Develop maintenance database about standard time to repair equipment.	0.50	0.78	3.72	NA
7	Evaluate the vibration energy created by these electromechanical systems.	0.51	0.49	-0.86	A
8	Utilize microprocessor-based instrument to check vibration of equipment.	0.53	0.48	0.84	A
9	Detect thermal anomalies of equipment by using thermography.	0.51	0.77	3.70	NA

10	Identify physical variables (temperature, vibration, power consumption).	0.51	1.01	3.87	NA
11	Verify grounding system integrity through periodic testing.	0.44	0.50	2.88	NA
12	Estimate amount of time that the equipment will operate.	0.41	0.50	2.99	NA

table 4.5: presents test of this hypotheses

Key

SD1= Standard deviation of male electrical trade staff
SD2= Standard deviation of female electrical trade staff
A= Accepted
NA= Not Accepted

The result shown in table 4.5 above indicates the Comparism between the male and female electrical trade staff. Data revealed that items 5,7 and 8 has a calculated t-value less than the t-critical value of ±1.68, hence hypothesis for these items were upheld at 0.05 level of significance. Except for item 1,2,3,4,6,9,10,11 and 12 which has a t-calculated value above the t-critical value ±1.68, thus HO was not accepted for these items.

4.6 Hypotheses 3:

There will be no significant difference in the mean response of male and female electrical trade staff on the Skill improvement needs in corrective maintenance of electrical laboratory equipment in Niger State.

Table 4.6: t-test analysis of the respondents of male and female electrical trade staff on the Skill improvement needs in corrective maintenance of electrical laboratory equipment in Niger State.

S/N	ITEM STATEMENT	SD1	SD2	x-test	Remark
1	Repair damaged equipment parts.	0.46	0.99	3.41	NA
2	Replace worn out parts which replacement.	0.64	0.84	0.00	A
3	Verify specific type of equipment repair.	0.43	0.48	7.82	NA
4	Isolate beginning problem of equipment.	0.38	042	-6.66	NA

5	Isolate equipment after the occurrence of a failure.	0.78	1.02	2.05	NA
6	Refurbish tools, parts and equipment when damaged.	0.86	0.87	0.50	A
7	Rectify failure without interrupting the continuity use of the equipment.	1.04	0.98	-2.11	NA
8	Overhaul any laboratory equipment when in total stoppage situation.	1.00	1.07	0.85	A
9	Overhaul the equipment on schedule after breakdown.	0.99	1.12	-0.85	A
10	Eliminate the source of equipment failure without interrupting the continuity of the production process.	0.98	0.91	0.90	A

table 4.6: presents test of this hypotheses

Key

SD1= Standard deviation of male electrical trade staff
SD2= Standard deviation of female electrical trade staff
A= Accepted
NA= Not Accepted

The result shown in table 4.6 above indicates the Comparism between male and female electrical trade staff. Data revealed that items 2,6,8,9 and 10 has a calculated t-value less than the t-critical value of ±1.68, hence hypothesis for these items were upheld at 0.05 level of significance. Except for item 1,3,4,5 and 7 which has a t-calculated value above the t-critical value ±1.68, thus HO was not accepted for this item.

4.7 Findings of the study

The following are the principle findings of the study, they are organized based on the research questions and hypothesis.

The findings related to the skill improvement needs in preventive maintenance of electrical laboratory equipment in Niger State:

1. Review and update when there are changes in Equipment.
2. Carryout weekly routine maintenance activities for all electrical equipment.
3. Clean all loose dirt with link free rags.

4. Examine for evidence of moisture that may lead to tracking or flashover.
5. Inspect equipment before and after use for symptoms of any problem.
6. Proper storage of equipment to prevent degradation.
7. Inspect insulators and conductor supports for signs of cracking, broken pieces, and other physical damage or deterioration.
8. Ensure that spare parts inventories are updated for any new equipment.
9. Examine surrounding areas for signs of tracking, arcing, or overheating.
10. Update records when changes are made to equipment.

The findings related to the Skill improvement needs in predictive maintenance of electrical laboratory equipment in Niger State:

1. Monitor the infrared image of electrical switchgear, motors, and other electrical equipment.
2. Measure sound frequencies outside human capacity.
3. Identify bearing problems, air system leaks, steam trap leaks, and valve leaks
4. Employ thermal imaging system to provide a thermal profile of temperatures on operating equipment
5. Develop maintenance database about standard time to repair equipment.
6. Evaluate the vibration energy created by these electromechanical systems.
7. Utilize microprocessor-based instrument to check vibration of equipment.
8. Detect thermal anomalies of equipment by using thermography.
9. Identify physical variables (temperature, vibration, power consumption).

The findings related to Skill improvement needs in corrective maintenance of electrical laboratory equipment in Niger State:

1. Repair damaged equipment parts.
2. Replace worn out parts which replacement.

3. Isolate beginning problem of equipment.
4. Isolate equipment after the occurrence of a failure.
5. Refurbish tools, parts and equipment when damaged.
6. Rectify failure without interrupting the continuity use of the equipment.
7. Overhaul any laboratory equipment when in total stoppage situation.
8. Overhaul the equipment on schedule after breakdown.

4.8 Discussion of the findings

The discussion of findings Are based on the research questions posed for the study and the hypothesis. The findings in table 1 related to research question 1 revealed that the respondents agreed with the majority of items on the skill improvement needs in preventive maintenance of electrical laboratory equipment in Niger State. The findings revealed that review and update when there are changes in Equipment. carryout weekly routine maintenance activities for all electrical equipment, clean all loose dirt with link free rags, examine for evidence of moisture that may lead to tracking or flashover, inspect equipment before and after use for symptoms of any problem, proper storage of equipment to prevent degradation, inspect insulators and conductor supports for signs of cracking, broken pieces, and other physical damage or deterioration, ensure that spare parts inventories are updated for any new equipment are the skill improvement needs in preventive maintenance of electrical laboratory equipment.

The findings in table 2 related to research question 2 revealed that the respondents agreed the majority of items on the Skill improvement needs in predictive maintenance of electrical laboratory equipment in Niger State. The findings revealed that monitor the infrared image of electrical switchgear, motors, and other electrical equipment, measure sound frequencies outside human capacity, identify bearing problems, air system leaks, steam trap leaks, and

valve leaks, employ thermal imaging system to provide a thermal profile of temperatures on operating equipment, develop maintenance database about standard time to repair equipment, evaluate the vibration energy created by these electromechanical systems are the skill improvement needs in predictive maintenance of electrical laboratory equipment.

1. The findings in table 3 related to research question 3 revealed that the respondents agreed with the majority of items on the Skill improvement needs in corrective maintenance of electrical laboratory equipment in Niger state. The findings revealed that Repairing damaged equipment parts, replacing worn out parts which replacement, isolate beginning problem of equipment, isolate equipment after the occurrence of a failure, refurbish tools, parts and equipment when damaged, rectify failure without interrupting the continuity use of the equipment, overhaul any laboratory equipment when in total stoppage situation, overhauling the equipment on schedule after breakdown are the skill improvement needs in correction maintenance of electrical laboratory equipment.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter deals with summary, conclusion and recommendations based on the findings. Suggestions for further studies were also highlighted.

5.1 Summary of the Study

The research was conducted to investigate the strategies for improving maintenance of laboratories and equipment of vocational and technical education for effective service delivery in tertiary institutions in Niger state. The chapter one of the study discussed a lot of issues concerning the strategies for improving maintenance of laboratories and equipment of vocational and technical education for effective service delivery in tertiary institutions in the background of the study, the statement of the problem was well stated which stated that Most laboratory equipment doesn't reach their expected life span due to inappropriate maintenance by the technicians. More also, some technicians don't pay adequate attention to the present working condition of the equipment being used in the laboratory can be dangerous not only to the laboratory but also to lives and properties, purpose of the study, significance of the study, the research questions and hypotheses were all formulated to guide the study.

The review of related literature looked at the historical background of technical college education system in Nigeria, skills in electrical technology, concept of vocational and technical education, objectives of vocational and technical education, problems of vocational and technical education electrical technology technicians and maintenance of laboratory equipment and electrical laboratory are the sub-headings that were discussed, and different views concerning the topic which was harmonized in a comprehensive literature review.

The study used a survey design method and sought to investigate the factors inhibiting acquisition of building technology skills among technical college in Niger state. three research questions were formulated based on the purpose of the study. A structured questionnaire was developed by the researcher. The instrument was in three sections and it was validated and used to get information from respondents. The population of the study was 100 electrical trade staff, which are made up of 75 males electrical trade staff and 25 females electrical trade staff in Niger state. A total of 100 questionnaires were distributed with a 100% return rate. The data collected was analyzed using mean standard deviation and t-test. A mean response of 2.50 was used as a cut-off point, t-test however was employed to test the null hypotheses at 0.05 level of significance.

5.2 Implication of the Study

From the findings it is expected that electrical trade staff both male and female technical and vocational colleges will adhere to the Skill improvement needs in preventive maintenance of electrical laboratory equipment as these is of tremendous important to them. The findings revealed that the skill improvement needs in predictive maintenance of electrical laboratory equipment will lead to improve monitoring of infrared image of electrical switchgear, motors, and other electrical equipment, measuring sound frequencies outside human capacity, identifying bearing problems, air system leaks, steam trap leaks, and valve leaks, employing thermal imaging system to provide a thermal profile of temperatures on operating equipment, developing maintenance database about standard time to repair equipment. these will enhance their productivity by saving time and reduction of work as well as the formulation of new ideas.

Secondly, Skill improvement needs in corrective maintenance of electrical laboratory equipment will also help to improve electrical trade staff knowledge on Repairing damaged

equipment parts, replacing worn out parts which replacement, isolate beginning problem of equipment, isolate equipment after the occurrence of a failure, refurbish tools, parts and equipment when damaged, rectify failure without interrupting the continuity use of the equipment, overhaul any laboratory equipment when in total stoppage situation, overhauling the equipment on schedule after breakdown.

5.3 Contribution to Knowledge

This research work result has added so much value to male and female electrical trade staff on the strategies for improving maintenance of laboratories and equipment of vocational and technical education for effective service delivery in tertiary institutions in Niger state, by improving the maintenance skills of male and female electrical trade staff in the application of maintenance skill in caring out their activities effectively and efficiently. The clients will also gain from this work by understanding the different procedures in the finishing achievement of clients' satisfaction and this will also lead to the improvement of long lasting business relationship.

5.4 Conclusion

Technicians and all who pass through the technical oriented institutions should be adequately and equitably remunerated. The dichotomy in the civil service between holders of ‘General Studies’ certificates and technical certificates must not only be eradicated as a matter of policy but in the thinking and attitude of government official. Technicians or technologists are not inferior to their counterparts. It is a matter of choice and we should make this known to our children right from the primary schools. There is an urgent need to overhaul the educational system in Nigeria. Investment in Vocational and technical Education and Skill training must be accorded priority attention. Since no country can favourably compete in the emerging global market place with poorly and unskilled labour. The Nigeria law makers,

stakeholders in the education sector need to learn from the international experience as we struggle to establish a more responsive Technical Vocational Education (TVE) system as to meet the ever-evolving demands of Nigerians towards our technological development.

5.5 Recommendations

- Adequate resources should be allocated to technical and vocational education. Inadequate funds affect the provision of essentials such as well – equipped laboratories and workshops, relevant textbooks and training manuals.
- Vocational and technical education requires skilled and proficient teachers. Teachers preparation should be given a priority attention. There is the need for regular in-service training for teachers of technology to upgrade their skills. Periodical industrial training for teacher is a sine-qua-non-in other to keep them abreast with the technological changes in the industry.
- There is the need for our technical institutions to establish good relationship and linkages with similar institutions abroad as this will promote cross – fertilization of ideas and enhance technology transfer. By doing this the technical institutions will have access to new developments, exchange programmes and other numerous benefits available at those institutions whose technical programmes are well developed.
- Further research should be carried out on the pre-cautive measures to be taken during service delivery to ensure its effectiveness.

5.6 suggestions for further research

The following related areas have been suggested for further research:

1. Workshop management techniques for improving teaching of electrical technology in technical colleges of other states of the federation, Nigeria

2. Workshop management techniques for improving teaching of electrical technology in colleges of education or polytechnics in Nigeria
3. Capacity building needs of teachers for effective teaching of electrical/ electronic technology to students in technical colleges in Niger State.

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APPENDIX A

Department of Industrial and Technology Education,
Federal University of Technology,
P.M.B. 65,
Minna,
1th April, 2023

Dear Respondent,

REQUEST FOR RESPONSE TO QUESTIONNAIRE

I am a final year student of the above-mentioned institution, undertaking a study titled: "**strategies for improving maintenance of laboratories and equipment of electrical and electronics programme for effective service delivery in tertiary institutions".** Your objective responses are highly needed in ascertaining the facts under investigation. Please feel free and open to share your mind objectively, for your responses have great impact on the findings. All collected responses will be used only for this research and treated confidentially.

Thank you

Yours faithfully

Nmadu, Elijah Jiya

2016/1/63788TI

APPENDIX B

REQUEST LETTER TO VALIDATORS

Industrial and Technology Education Department
Federal University of Technology,
P.M.B. 65,
Minna,
4th January, 2023.

Dear Sir,

REQUEST FOR FACE VALIDATION OF INSTRUMENT FOR ASSESSMENT OF INFORMATION TECHNOLOGY APPLICATION AT BUILDING CONSTRUCTION SITES IN ABUJA, NIGERIA

I am an undergraduate student of the above-named address currently undertaking a study on the topic: **strategies for improving maintenance of laboratories and equipment of electrical and electronics programme for effective service delivery in tertiary institutions.** Attached is the draft copy of the instrument. As an expert in this area, your assistance is hereby solicited to enable me accomplish this task. Kindly go through the item to verify their clarity, relevance and appropriateness in the use of language. In addition to this you can also make further suggestions that will improve the status and quality of the instrument. Your contribution to this work is highly appreciated.

Thanks

Yours faithfully,

Nmadu, Elijah Jiya

2016/1/63788TI

APPENDIX C

QUESTIONNAIRE

STRATEGIES FOR IMPROVING MAINTAINANCE OF LABORATORIES AND EQUIPMENT OF VOCATIONAL AND TECHNICAL EDUCATION FOR EFFECTIVE SERVICE DELIVERY IN TERTIARY INSTITUTIONS

PART I: Personal Information Read the following statement carefully and put down your responses in the space provided by checking the alternatives that is applicable to you.

Highest Educational Qualification:

NCE (Technical) ()

HND ()

B.Sc. ( )

M.Sc. ()

B.Ed. (Technical) ()

M.Ed. (Technical) ()

Ph.D. (Technical) ()

PART II: Questionnaire Items Instruction: Five options were given against each of the statement in the entire sections. Please, check (√) the appropriate column that represents your opinion.

1. Very Highly Needed VHN
2. Highly Needed HN
3. Needed N
4. Not Needed NN
5. Highly Not Needed HNN

SECTION A

Skill improvement needs in preventive maintenance of electrical laboratory equipment?

S/N	Skill improvement needs in preventive maintenance of electrical laboratory equipment is the ability to:	VHN	HN	N	NN	HNN
1	Review and update when there are changes in Equipment.					
2	Carryout weekly routine maintenance activities for all electrical equipment.					
3	Clean all loose dirt with link free rags.					
4	Examine for evidence of moisture that may lead to tracking or flashover.					
5	Inspect equipment before and after use for symptoms of any problem.					
6	Proper storage of equipment to prevent degradation.					
7	Inspect insulators and conductor supports for signs of cracking, broken pieces, and other physical damage or deterioration.					
8	Ensure that spare parts inventories are updated for any new equipment.					
9	Examine surrounding areas for signs of tracking, arcing, or overheating.					
10	Update records when changes are made to equipment.					

SECTION B

Skill improvement needs in predictive maintenance of electrical laboratory equipment?

S/N	Skill improvement needs in predictive maintenance of electrical laboratory equipment are the ability to:	VHN	HN	N	NN	HNN
11	Monitor the infrared image of electrical switchgear, motors, and other electrical equipment.					
12	Measure sound frequencies outside human capacity.					
13	Identify bearing problems, air system leaks, steam trap leaks, and valve leaks					
14	Employ thermal imaging system to provide a thermal profile of temperatures on operating equipment					
15	Eliminate unnecessary downtime, both scheduled and unscheduled.					
16	Develop maintenance database about standard time to repair equipment.					
17	Evaluate the vibration energy created by these electromechanical systems.					
18	Utilize microprocessor-based instrument to check vibration of equipment.					
19	Detect thermal anomalies of equipment by using thermography.					
20	Identify physical variables (temperature, vibration, power consumption).					
21	Verify grounding system integrity through periodic testing.					
22	Estimate amount of time that the equipment will operate.					

SECTION C

Skill improvement needs in corrective maintenance of electrical laboratory equipment?

S/N	Skill improvement needs in corrective maintenance of electrical laboratory equipment are the ability to:	VHN	HN	N	NN	HNN
23	Repair damaged equipment parts.					
24	Replace worn out parts which replacement.					
25	Verify specific type of equipment repair.					
26	Isolate beginning problem of equipment.					
27	Isolate equipment after the occurrence of a failure.					
28	Refurbish tools, parts and equipment when damaged.					
29	Rectify failure without interrupting the continuity use of the equipment.					
30	Overhaul any laboratory equipment when in total stoppage situation.					
31	Overhaul the equipment on schedule after breakdown.					
10	Eliminate the source of equipment failure without interrupting the continuity of the production process.					