Assessment of Accidents in Electrical and Electronics Engineering Laboratories

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ABSTRACT

The research investigates accident management in electrical and electronic engineering laboratories throughout a five-month period, from September 2022 to January 2023, at eight polytechnics in the north-eastern state of Nigeria. Only students and departmental staff contribute to the research's population, focusing on regular accidents using a survey-based method that combines qualitative and quantitative tools. The study utilised questionnaires to collect data, randomly selected a model population, and analysed the data using descriptive statistics. The outcome of the investigation revealed that there were most accidents in the electrical measurement and instrumentation lab (2.89), electrical installation lab (2.76), and electrical repair and maintenance lab (2.72), with the majority taking place in the electrical labs. Injuries in the Electrical Power and Machines lab and Electronic and Telecommunication lab (2.56) were lower because they were not subjected to an electrical experiment setup frequently, and the computer's hardware and software (2.50) had fewer accidents.

***Key Words**: lab, accidents, polytechnic, electrical and electronics Engineering*

INTRODUCTION

1.0 BACKGROUND OF THE RESEARCH

Polytechnic education is a blended learning process that integrates technology and science with practical training, preparing individuals for jobs and higher education. It focuses on applied sciences, engineering, and industrial arts, preparing adults for the workforce and laying the groundwork for technology-related higher education. (Umar, F.K., 2017).

A laboratory is a type of study environment that supports conducting experiments, practice, and peer observation in order to produce goods that are used by organisations and businesses. Laboratory experiments are essential in electrical learning because they teach students skills like observation, classification, measurement, communication, interpretation, and conclusion-making. They improve the classroom experience, foster cognitive abilities, and guide curriculum creation. Laboratory work can help students develop academic and social skills by

teaching them to value different points of view, convey ideas, and collaborate. (Gunawan, G., 2017).

Engineering laboratory skills include sampling, testing, measuring, documenting, and analysing data as you study electronics, measurement and instrumentation, power and machines, electrical repair and maintenance, and electrical installation. These abilities are used in enterprises, government agencies, and educational institutions and are critical to the advancement of modern scientific and technical advancements. Technicians' laboratory abilities help teachers, lecturers, and engineering students. (Umar, F.K., 2017).

The engineers must be able to deal with unpredictability, unresolved information, contradictory objectives, institutional and technological advances, business realities, and regulatory consequences.

The programme created to educate the learner to enter the workforce with a grasp of the rules of science and technology as they relate to the creation and building of modern technology is considered technical education by the common working definition. It places a focus on the engineering parts of mechanics learning, including electrical and electronic, mechanical, and automotive trades. It does, after all, call upon a comprehension of and use of the fundamental ideas in maths and science (Pritchard, A., 2017).

Technical colleges and polytechnics are educational institutions aimed at producing the manpower for a country's economic growth and development. Yekinni in Abdulrauf, (2012) viewed polytechnic as an institution where specific knowledge and practical skills are required for specific causes, employment or professional practice. It is to produce, craftsmen, technicians, technologists, scientists or similar levels in business are imparted or taught. Polytechnic aims to provide functional skills to technicians, technologists and also provide engineering skills, knowledge and attitudes which individuals need to gain entry to and progress in their selected occupation.

Prospective operations like academic study, practical investigations, and measurement tasks frequently call for the use of reactive materials, prone procedures, and complex equipment configurations. Depending on the situation, laboratory personnel and facilities may be exposed to a variety of risk factors, including electrical and electronic ergonomic, physical, chemical, biological, and radiological dangers (Hallman, M.G. and McCullough, M.A., 2022).

Accidents are anxiety driven, sudden and unexpected events or situations without forewarning that can result in loss of materials, injury and even death. According to Yekinni at Tuuli (2016), it is the result of a series of unfortunate circumstances. Electrical accidents, according to Tuuli, are incidents involving electrical installations that could cause burns, electrical shock from a source in excess of electronics and electrical labs, personnel action, or equipment malfunction. There are various types of electronics and electrical labs and workshops. general laboratory accidents.

Thus, due to the occurrence of accidents in institutional laboratories, a series of preventive measures were prescribed by experts, technicians, technologists, engineers and researchers to be implemented the prescriptions range from taking necessary precautions while working in the laboratories and workshops, keeping laboratories and workshops safe, working with healthy machines, and using appropriate safety equipment while working with machines, among others.

1.1 PROBLEM OF THE RESEARCH

This study aims to assess accidents in electronics and electrical engineering laboratories in Nigeria's north-east polytechnics to increase student enrolment and support technological and economic growth. It emphasises the need for staff and students to be aware of potential hazards and take necessary precautions.

1.2 RESEARCH AIM'S AND OBJECTIVES:

The purpose of the study is to determine the management of electronics and electrical engineering laboratory accidents at the Polytechnic of Nigeria. Specifically, the study seeks to find out the types of accidents that frequently occur in electronics and electrical engineering laboratories.

1.3 RESEARCH QUESTIONS

The study question is to determine what the common accidents are in electronics and electrical engineering laboratories.

1.4 SIGNIFICANCE OF THE RESEARCH

Incidents in electronics and electrical engineering laboratories occur frequently at educational facilities around the world, and polytechnic schools in Nigeria and the country's north-east are not exempt from this issue. This study will inform interested parties on the different kinds of accidents that occur in polytechnics in north-eastern Nigeria.

1.5 SCOPE OF THE RESEARCH

This study focuses solely on the assessment of electronics and electrical engineering laboratory accidents in the north-eastern region of Nigerian polytechnics, with specific issues to: identify the types of accidents that frequently occur in electronics and electrical engineering laboratories

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter offers a thorough cognitive explanation, theoretical context, and research review to provide readers with a thorough understanding of the subject.

2.1 COGNITIVE EXPLANATION

The results from investigating the causes of electrical accidents emphasised the necessity of developing a culture of safety in communities, especially among employees who are engaged in occupations related to electricity, construction workers, and schoolchildren, to reduce the rate of such accidents.

Yekinni (2016) reported about the management of electrical and electronics engineering workshop accidents in technical colleges in Oyo and Ogun states, Nigeria.

The population for the study was sixty-six (66), comprised of forty-two (42) electrical and electronics teachers from polytechnics in Ogun State and twenty-four (24) electrical and electronics teachers from technical colleges in Oyo State.
The findings of the study revealed that: nine accidents do occur at least once in a month in electrical and electronics workshops; accidents in electrical and electronics engineering workshops are caused by failure to de-energise or isolate the electrical energy source prior to maintenance activities; accidents in school workshops can result in a reduction in students' enrolment.
The findings of the study revealed that electrical and electronics workshop accidents can be managed by providing well-stocked first aid boxes to the workshop and giving adequate training to teachers and workshop attendants on the method of administering them.

2.3 ASSESSING RISKS

Risk assessment entails determining the context, risks, and potential negative effects of an activity. Based on the current control trials, the likelihood of each outcome is assessed. Extreme outcomes are low-likelihood events that make calculating possibilities challenging. The overall risk is calculated by considering all possible outcomes at the same time. Risk evaluations are subjective and rely on data quality, making assigning probability and quantifying severity problematic. Probabilities are frequently employed for verifying decisions, whereas severity is quantified by an aspect selected to support such decisions. (Al-khursan, A.T.S. and Alghabban, T.S., 2023)

2.4 ELECTRICAL ACCIDENTS

Inadequate wiring in electrical systems can cause accidents, resulting in considerable monetary damage. Technicians must take safety procedures, perform regular maintenance, and be aware of threats to avoid burns and eye infections.

2.5 CAUSES OF ELECTRICAL SHOCKS

Unprotected live conductors: Live conductors exposed to metalwork that surrounds equipment or energised metallic elements transporting live voltage might cause electric shocks. This occurs when the voltage increases partially or completely during fault current passage.
Inadequately earthed equipment: Live conductors exposed to metalwork that surrounds equipment or energised metallic elements conveying live voltage might cause electrical shocks. This can happen when the voltage increases partially or completely during fault current passage. (Al-khursan, A.T.S. and Alghabban, T.S., 2023)

2.6 ELECTRICITY

Hazards and precautions

Electrocution is also the most serious outcome of an electrical mishap and can result in death. However, there are alternative possibilities. This section examines the implications of electric shock, how it occurs, and some common methods for reducing the likelihood of it occurring. It closes with a discussion of the other effects of electrical problems in devices.

2.7 PHYSIOLOGICAL PROPERTIES OF ELECTRIC CURRENT

The Physiological Effects of Electric Current Electric shock is the physical stimulation caused by an electric circuit passing through the body. The effect of an electric shock on the body is determined by the size of the current flow, the body sections through which the current passes, and the general physical condition of the individual being shocked. Electric shock may have several effects on the human body, depending on the current path through the body as well as the magnitude and duration of the current sent. Tissue burns and damage: Current from

electricity can cause serious tissue damage by burning. Involuntary muscle contractions: a result of current. (Fish, R.M. and Geddes, L.A., 2009.)

METHODOLOGY

3.1 INTRODUCTION

This chapter covers research design, population, size, area, sampling technique, data collection, analysis, and sample procedure validity or reliability.

3.2 RESEARCH DESIGN

This study will use a descriptive survey research design as its research methodology. The purpose of the survey is to gather information in order to respond to inquiries regarding the topic's present state.

at order to better understand how electrical and electronics engineering lab accidents are handled at technical schools' laboratories and workshops in north-eastern Nigeria, (Nwankwo, I.N., 2020) pointed out that this study used descriptive research.

3.3 RESEARCH POPULATION

The study investigates frequent, distinct characteristics across eight Nigerian polytechnics' electrical and electronics engineering laboratories, including academic staff and students, to develop findings and conclusions. (Sherbinin, A.D., 2007)

3.4 RESEARCH'S POPULATION SIZE

The research sample size comprises all employees of the electrical engineering department, ensuring the practicality and extent of data collection within the community.

NBTE stated a single ND/NID or HND curriculum requires at least four qualified lecturers, or three lecturers and one teacher. More lecturers are needed at the HND level to provide more options. Teaching personnel may be prorated for two or more streams. In 2023, there will be 1,200 personnel and students in ND and HND departments, with 30 teaching staff members. Due to the exceptionally large population, the sample size for the study was 120 (10%). (Frankham, R., 1996.)

3.5 THE RESEARCH AREA:

The study area refers to the geographical location where the research is conducted, defining the setting and limits for data collection and evaluation. electrical and electronics engineering laboratories of eight Nigerian polytechnics located in the Northeast region, comprising Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe states, which is Nigeria's largest regional zone, spanning 272,451 km2. Northeastern Nigeria is located at (N 9° 4' 55.1964", E 8° 40' 30.9972") on a map. The study focuses on eight Nigerian polytechnics' electrical and electronics engineering laboratories in the north-east geopolitical zones, including Bauchi, Adamawa, Yobe, Borno, and Taraba, forming the basis of the research.

(Mustapha, I., 2023)

3. 6 SAMPLING METHODS

A representative sample of the research area's staff members and students within the electrical engineering departments was chosen for this study using a random sample technique as much as possible, which ensures accurate analysis and generalizability of the results.

3.7 DATA COLLECTION

This research, using a questionnaire, demonstrated that data collection is a systematic process of gathering and documenting information from all electrical engineering departments of these polytechnics in the northeast laboratories to support research objectives and analyse incidents. (Vaughan, L., 2001).

3.8 ANALYSIS

Researchers use descriptive statistics as a statistical technique to evaluate and interpret data in order to produce relevant findings, reliable conclusions, and guidance with decisions.

3.8.1 SIMPLICITY

The descriptive statistics are easily comprehensible and available at a wide range of statistical competence levels. They offer a succinct overview of the data without requiring sophisticated assumptions. (Vaughan, L., 2001).

3.8.2 DATA EXPLORATION

They are very helpful when examining figures for the first time. Before moving on to more complex studies, researchers can quickly grasp the dataset's central tendencies (such as mean, median, and standard deviation) and variance (such as standard deviation) by using descriptive statistical techniques. (Zuur, A.F., Ieno, E.N. and Elphick, C.S., 2010).

3.8.3 THE RESEARCH OF DATA

Summary information allow for identifying outliers, data inaccuracies, and potential concerns in a dataset, allowing for data cleansing and quality management.
(Ilyas, I.F. and Chu, X., 2019).

3.8.4 DATA PRESENTATION

Descriptive statistics, using graphic representations like histograms, box plots, and bar charts, effectively summarize and display data to both technical and non-technical audiences, converting questionnaire data into percentages. (Clutterbuck, J., Hardy, I. and Creagh, S., 2023).

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

This chapter contains the results, and discussion of the findings.

4.2 RESULTS

From the 150 allocated, 120 assessments came back, including 60 staff, 54 students, and 6 others. To draw conclusions, amending information and inductive and descriptive statistics were used.

The research results are in line with the investigation's objectives, which are systematically organized in
Q1. What are the types of accidents that frequently occur in electrical engineering laboratories?
Table 1: which displays the types of accidents

Types of accidents	Electrical and electronics engineering laboratories						$\sum\bar{X}$	σ	Remark
	$\bar{X}1$	$\bar{X}2$	$\bar{X}3$	$\bar{X}4$	$\bar{X}5$	$\bar{X}6$			✓ or ×
Shocks and wounds caused	3.00	2.90	2.80	2.60	3.10	3.00	2.89	0.16	✓

by contact with live wire.									
Sparks caused by incorrect wiring	3.00	2.90	2.50	3.00	2.90	2.50	2.77	0.21	✓
Exposing unprotected electricity	3.00	3.80	2.50	2.00	2.00	3.20	2.67	0.65	✓
Electrical overloaded	2.30	3.00	2.40	3.10	2.50	2.70	2.65	0.29	✓
Items slipping, and falling. poor sanitation, poor maintenance, and poor repair procedures	2.90	2.80	2.60	2.60	2.20	2.90	2.66	0.26	✓
A soldering accident ignites a fire, causing significant damage to the material	2.50	3.00	2.50	2.30	3.00	2.70	2.65	0.26	✓
Electric burns, lightning, stun guns, poor maintenance	3.00	2.80	2.60	2.90	2.90	3.10	2.87	0.15	✓
Fire Outbreak inside lab environment, poor sanitation	2.20	2.20	2.20	2.20	2.20	2.20	2.67	0.61	×
All	21.9	23.4	20.1	20.7	20.8	222.3	21.83	2.59	✓
$\sum\bar{X}$	2.72	2.89	2.50	2.56	2.56	2.76	2.72	0.28	✓
σ	0.32	0.40	0.16	0.37	0.4	0.30	0.09	0.18	✓

Researcher fieldwork-2023, types of accidents that frequently occur.

Key: X1= Electrical repair and maintenance lab, X2=Measurement and Instrumentation lab, X3= software lab and hardware lab, X4= Electrical Power and Machines lab, X5= Electronic and Telecommunication lab, X6= Electrical Installation lab, $\sum\bar{X}$= mean, σ = Standard Deviation (sN-1) for staff and student respondents, respectively; $\bar{X}$– mean of respondents in all laboratories; σ- the standard deviation of respondents in all laboratories. The mean and standard deviation of respondents' responses indicate that they agree with all frequent causes of electrical accidents at Polytechnics institution in northeast Nigeria, except for one, and all types of electrical incidents in laboratories.

X2=Measurement and Instrumentation lab (2.89), X6= Electrical Installation lab (2.76), X1= Electrical repair and maintenance lab (2.72), X4= Electrical Power and Machines lab (2.56), X5= Electronic and Telecommunication lab (2.56), X3= software lab and hardware lab (2.50), $\sum\bar{X}$= 2.72, 0.28, σ = Standard Deviation (sN-1) for staff and student respondents, = 0.09, 0.18 respectively. The mean and standard deviation of respondents' responses indicate that they agree with all frequent causes of electrical accidents at Polytechnics institution in northeast Nigeria, except for one, and all types of electrical incidents in laboratories.

Table 2:Electrical and electronics engineering labs accidents respondents

Year 20:	Months	Electrical and electronics engineering labs accidents respondents					
		$T\text{-}_1$	$T\text{-}_2$	$\sum t$	$\bar{X}\text{-}_1$	$\bar{X}_2$	$\sum\bar{x}$
22	October	8.44	7.49	19.2	8.38	7.52	3.2
22	November	8.45	7.53	19.3	8.42	7.57	3.22
22	December	8.33	7.39	18.95	8.26	7.43	3.16
23	January	8.29	7.35	18.85	8.22	7.38	3.14
2023	February	8.47	7.51	19.26	8.41	7.54	3.21
2023	March	8.41	7.45	19.11	8.36	7.49	3.19
Total		50.39	44.72	114.67	50.05	44.93	19.12
Mean		8.39	7.45	19.11	8.341	7.488	3.186
σ		0.066	0.065	0.163	0.075	0.065	0.028

Researcher fieldwork-2023

Key: T-1 = staff total, T-2 = staff total , ∑Total, $\bar{X}$-1 = staff mean, $\bar{X}$-2 = student mean

$\sum\bar{X}$, σ = Standard Deviation (sN-1),
Mean $\bar{X} \equiv p = 3.187$ V
Standard Deviation σ (sN-1) = 0.031
Standard uncertainty (SN) = 0.031 / √6 = 0.0126
K = 2.57
95% confidence limits = ± 0.0126 x 2.57 = ± 0.032

4.3 ANALYSIS AND FINDINGS

This research assessed the accidents management exercises in electrical engineering laboratories used by students and departmental staff in the polytechnic's institutions in northeast area of Nigeria, the study procedures, the frequent causes of electrical accidents, the different types of electrical accidents, these goals are accomplished through the use of a descriptive survey technique, in which the respondents were given a formatted survey created by the observer in order to collect data.

As a result, the analysis of the results is structured in accordance with the goals that served as the reason for the study.

4.4 DISCUSSION OF FINDINGS

The discussion of the findings of this research is organized under the following headings:

4.4.1: Laboratories:

X2=Measurement and Instrumentation lab (2.89), X6= Electrical Installation lab (2.76), X1= Electrical repair and maintenance lab (2.72), X4= Electrical Power and Machines lab (2.56), X5= Electronic and Telecommunication lab (2.56), X3= software lab and hardware lab (2.50), $\sum\bar{X}$= 2.72, 0.28, σ = Standard Deviation (sN-1¬) for staff and student respondents, = 0.09, 0.18, respectively.

The study assessed the types of electrical accidents in North East Polytechnic's electrical engineering laboratories, revealing that shocks and wounds caused by contact with live wire accidents were the most common (2.89). Electric burns, lightning, and stun guns due to inadequate handling of sockets and switches were the leading causes (2.87), followed by sparks caused by incorrect wiring due to human error or inadequate staff (2.77).

4.4.2: Types of accidents:

The research reveals common incidents in electrical engineering labs of polytechnics, including electrical shocks and wounds caused by contact with live wire, burn, and fires. Common incidents include falling below working level, active against objects, contact with unsafe substances, and sliding to lab surfaces. The lab experienced minor accidents such as falling objects, unsafe sounds, severe devices, and extreme temperatures.

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These incidents, with falling objects being the most frequent accident type, were in line with Afeez, Y.S., (2016), findings.

4.4.3: Remark:

The mean and standard deviation of respondents' responses indicate that they agree with all frequent causes of electrical accidents at Polytechnics institution in northeast Nigeria, except for one, and all types of electrical incidents in laboratories.

4.5: SUMMARY OF FINDINGS

Monthly accidents in Nigerian polytechnic institutions' electronics and electrical labs occur, primarily due to human error or inadequate staff, resulting in four incidents per semester.

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter consist of recommendations and conclusions of the research.

5.2 CONCLUSIONS

Poor sanitation, maintenance, and repair procedures in electronics and electrical labs lead to numerous accidents, including explosions, burns, electrocutions, and failure to disconnect electricity supply. Preventive measures include reviewing common types.

5. 1 RECOMMENDATIONS

The study recommends comprehensive management of personnel accidents and injuries, provision of lab facilities, annual monitoring for work-related accidents, comprehensive training for medical care personnel, and the establishment of a network of cameras in Polytechnics' electrical and electronics engineering course to assess injuries.

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