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Assessment of the Extent of Electrical Safety Practices Among Staff and Students of Electrical Engineering Department of Bayero University, Kano, Nigeria

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Abstract

Researchers globally conducted several studies on electrical safety awareness and practices for improving occupational safety and health of workers. However, most of these studies were limited to industry workers, with few focusing on academic workshops/laboratories, and almost none in the case of Bayero University, Kano, Nigeria. This study therefore, aims to assess the extent of electrical safety practices among staff and students of electrical engineering department, Bayero University, Kano, Nigeria. The authors used descriptive research design in which 50-item structured questionnaire was used to collect data from 42 staff and 99 students of electrical engineering department, Bayero University, Kano, Nigeria. The results show that staff and students do not strictly observe electrical safety practices in the workshops/laboratories. The results also revealed the common causes of electrical accidents in the workshops/laboratories; nature of frequent electrical accidents; and measures to reduce electrical accidents and promote students' compliance to electrical safety rules and regulations. The researchers limit this study to only department of electrical engineering in the faculty of engineering. Also, only quantitative data was collected from the respondents, without giving consideration to the in-depth information qualitative data (such as interview) would have provide. As such, conclusions derived using quantitative approach from the respondents relies on the genuineness of the information provided by them. The findings provide the faculty of engineering with a basis to introduce 'Electrical Safety Awareness and Practices' course into the curriculum.

Keywords: electrical safety, electrical accident, electrical engineering

1. Introduction

The most vital innovation ever in the history of mankind is electricity. It is instrumental to the growth and development of all facets of human life. This includes domestic applications such as operating all appliances, entertainment, lighting, its uses in transportation, schools, hospitals, retail facilities, etc. Furthermore, the industrial and manufacturing applications of electricity are of utmost important, because all businesses require electricity to operate. However, working with electricity can pose a lot of dangers especially to industrial workers such as engineers, electricians, and other workers dealing directly with electricity, for instance, working on overhead lines, electrical installations and circuit assemblies.

Although electrical work is not regarded as an exceptionally dangerous occupation (BLS, 2015), contact with electricity has a much higher percentage of fatal injuries. For this, the Bureau for Labour Statistics suggests that worker safety programmes need to make electrical hazard awareness a priority. To this end, this paper aims to examine the extent of electrical safety practices among staff and students of electrical engineering department, Bayero University, Kano, Nigeria. Albeit globally, studies on electrical safety awareness and practices have reached an advanced stage and have contributed in reducing occupational injuries, the majority of these studies are industry-based. There is need for these studies to be extended to academic workshops/laboratories since they are the initial avenues for training electrical personnel. Probing the electrical safety awareness and practices of workers from the perspective of academic workshops/laboratories and adequate implementation of the findings will directly help in curbing out the incidences of electrical accidents and injuries in the school workshops as well as industries.

2. Problem Background

Technological innovations have been the key to the world economic growth and prosperity, and engineering has been an important driver of these innovations. Certainly, the development and institutionalization of engineering disciplines in the world provided much talent behind the technological domination of the world market. Engineering disciplines integrate scientific principles with practically oriented research, providing systems and process of acquiring knowledge, skills and attitudes.

The acquisition of practical skills in engineering is very important aspect in which it teaches the students techniques of the major aspects of engineering subjects including the basic techniques of the experiment and the use of instrument; such as manipulation of tools, equipment and apparatus. In engineering, teaching practical skills serves as a consolidator of the subject- matter discussed in class. Practical skills is the ability to perform kinesthetic activity in an easy, precise, harmonious way with the constant changing circumstances. Practical skills, according to Soebagio (2016) are the ability of graduates to perform several activities which are needed in the process to find solutions in the work place. The practical skills are most conveniently acquired in the workshop and laboratories. Patrick and Babatope (2013) pointed out that workshop/laboratory is the right place by which effective teaching for development of skill in the students is carried out. Similarly, Mukhtar (2014) argued that the workshop manipulative approach of teaching was significantly superior to passive transmission of abstract concepts. The workshop is the backbone of any functional technical and engineering education seen by Simpson (1998) as home for all kinds of materials, equipment, tools, and machines using electricity. Nevertheless, Araneo, Dehghanian, and Mitolo (2019) stressed that engineering faculties are faced with the challenges of introducing unqualified engineering undergraduates to the culture of workshop/laboratory safety. By this, they are required to work on electrical installations and electrical equipment with almost no safety background.

Electricity is the major contributor of technological development in the world, as technology has been a dialectical and communicative process at the center of human experience. Electricity in modern society is the most convenient and useful form of energy, without which, the present social infrastructure would not all be possible. However, Taylor, McGwin, Valent and Rue (2002) reported that electricity is ranked fifth in the causes of work-related injuries leading to death (responsible for 7% of all workplace fatalities), and it can create a specific peril to employees who work consistently in propinquity to electrical sources. This therefore, indicates the needs for requisite safety practices in the academic workshops and laboratories for the students, instructors and the teachers. The World Health Organization describes an accident as “an unplanned and an unanticipated event”. Similarly, the International Labour Organization defines occupational accident as unanticipated and unplanned events that caused a certain damage or injury (Gulhana, Ilhanb, and Civilc, 2012). Accidents are caused and all staff and students in the workshops and laboratories are prone to it (Alake, 1998). However, accidents can be avoided with proper knowledge, skill and positive safety attitude on the part of individual in the workshops, offices and laboratories. According Saba, Tsado, Raymond and Adamu (2014), increasing awareness for electrical safety hazards and understanding the importance of electrical safety programme are critical first step for improving electrical safety practices in the workplace.

Safety is the most important practice in an academic laboratory as *“safety and productivity are on the same team”.* Henderson (2000), defined safety as the state of being “safe”, (from French Sauf), the condition of being protected against physical, social, spiritual, financial, political, educational or other types of consequences or failure, damage, error, accident, harm or any other event which could be considered non-desirable. Safety can also be defined as the control of recognized hazards protected from the event or from expose to something that causes health or economical losses. A safe situation is one where risk of injury or property damages is low and manageable. Safety consciousness could be defined as the mental awareness of an individual which serve as a guide to his conduct, behaviors and overt actions to the end that he will be free from injury, accident or damage (Sara, 2004). It could also mean emotional guide for personal conduct which leads to minimizing danger and risk. According to Jain (2009), the result of safety practices will improve production stability; cost and quality, reduces cost in maintenance and materials wastage, absentee and medical bills.

The workshop/laboratory is a place where all sort of equipment, machines, tools and materials are used, and Simpson (1998) stressed that such place is prone to accident occurrences. Ersoy (2013) argued that the main causes of accidents especially in industries are untidiness, noise, too hot or too cold environments, old or poorly maintained machines, and lack of training or carelessness of employees. On the other hand, Jain (2009) categorized courses of workshop accidents into the following:

a. Environmental factors: This includes inadequate illumination, dust, and lack of good ventilation, non-cleanliness, and temperature extremes.

b. Mental factors: This includes broken safety guards, inadequate maintenance, poor distribution of safety signs, faulty machines design, leaking valves and lack of personal protective equipments.

c. Human factors: This includes ignorance, age, taking chances, forgetfulness, alcoholism, fatigue/boredom, carelessness and personal instability.

Furthermore, several workers are exposed to electrical energy during executing their tasks. According to National Institute for Occupational Safety and Health (NIOSH) (1998), four main types of electrical injuries exist. These are: electrocution, electric shock, burns, and falls due to contact with electrical energy. Electrocution is usually a result of the current passing through the body or head causing cardiac arrest or damage to vital centers of the brain. Stride voltage plays an important role in fatal electrocution. Electric shock occurs when a person comes into contact with an electrical energy source. The electrical energy flows through a portion of the body causing a shock. Onuoha (2001) maintained that electrical shock in the workshop/laboratory occurred from unprotected conductors, machines etc. resulting to the shock risk, fire outbreak or even fatal cases and other serious consequences. Burns are tissue damages that results from heat, overexposure to the sun or other radiation, or chemical or electrical contact. Burns are characterized by severe skin damage that caused the affected skin cells to die. There are three types of burns including first-, second-, and third-degree burns. Each degree is based on the severity of damage to the skin. Lastly, falls due to contact with electrical energy usually occurs while installing moving or repairing power lines or poles.

Accident prevention is usually based on analysis of occurred accidents and removal of accidents causes. Afeez (2016) stated that arrays of measures for reducing the occurrences of accidents in academic workshops/laboratories were recommended by experts. This includes, but not limited to, observing essential precautions while working in the workshops/laboratories, keeping the workshops/laboratories safe, working with healthy machines, equipment and devices. Groeneweg, et al., (2007) urges that accident prevention should focus on organizational factors, which cause human error. Bearing in mind that human behavior and those errors occur at every organizational level, the investigation of human errors and especially the surrounding errors provoking condition is an important part of accident prevention.

Meanwhile, Okafor (1998) argued that university teachers in Nigeria have placed much emphasis on theory and neglecting practical knowledge in their teaching. She also pointed out that available workshops resources are not been utilized by students and teachers. This is a serious situation since engineering cannot effectively and efficiently be taught and/or learned without good and adequate workshop and laboratories. Consequently inadequate utilization of the available resources influences students' negative performance in the future engineering practical activities. Electrical safety practice is an important field concerned with the safety, health, and welfare of people at work. It aims to equip future engineers with the basic knowledge and skills of identifying safety, health, and environmental hazards; determining control measures; and developing and implementing safety policies and programs. Many studies in Nigeria assessed electrical safety practices among construction and manufacturing workers, with no study on assessment among staff and students of engineering department in the university. The researchers argued that institution-based assessment of electrical safety practices will help in saving the industries millions of dollars in workers' compensation, medical costs, and work efficiency. Upon this background, this study is set to assess the extent of electrical safety practices among staff and students of electrical engineering department, Bayero University Kano.

3. Problem Statement

The need for electrical safety awareness and practices among workers has been demonstrated by Bureau for Labour statistics, Campbell and Dini (2015), Burdge and Floyd (2014) among others. This is perhaps due to the frequent work-related injuries and deaths caused by industrial electrical accidents. These electrical accidents do not only occur in industries, but also in academic workshops and laboratories as attested to by Araneo, Dehghanian, and Mitolo (2019), and Afeez (2016). This is also confirmed in a pre-study interview with some staff (lecturers and workshop instructors) in the department being investigated (i.e., Department of electrical engineering, Bayero University, Kano, Nigeria).

To help minimize the occurrences of these accidents, a catch-them-young-approach is suggested in which the electrical safety practices of staff and students of electrical engineering department of Bayero University, Kano, Nigeria is thoroughly assessed. Several research studies on electrical safety practices are industry-based focusing only on workers and/or organizational management, which left the present problem unanswered. If this problem is not adequately and effectively addressed, there will be continual occurrence of accidents in the workshop/laboratories which will indisputably extend to the industries. This will lead to injuries, loss of life and properties, and will undoubtedly lead to having insufficient trained engineering graduates with clear awareness on

the electrical safety practices for the industries. This consequently will affect negatively the country's level of technological education vis-avis economic growth and economic development. A country with the above mentioned problems will experience massive youth unemployment, political thuggery, drug, addiction, and corrupt society. In view of these problems, this study is designed to assess the extent of electrical safety practices among staff and students of electrical engineering Bayero University Kano.

4. Research Objective and Questions

The main objective of this study is to assess the electrical safety practices of staff and students of electrical engineering department of Bayero University, Kano, Nigeria. Specifically, the study answered the following questions:

i. To what extent do the staff and students observed electrical safety practices in the workshops and laboratories of Bayero University, Kano, Nigeria?

ii. What are the common causes of electrical accidents in the workshops and laboratories of Bayero University, Kano, Nigeria?

iii. What are the nature of electrical accidents that frequently occur in the workshops and laboratories of Bayero University, Kano, Nigeria?

iv. What precautionary measures are to be taken to reduce accident occurrence, and promote students' compliance to safety rules and regulations in the workshops and laboratories of Bayero University, Kano, Nigeria?

5. Method

This study employed a survey design method. The target population for the study consists of 99 final year students and 42 staff (lecturers and instructors) of the department of electrical engineering, Bayero University, Kano, Nigeria. Altogether the total population is 141. No sampling was made, as the size of the target population is manageable. Therefore, the entire target population was used as respondents for the study. The instrument for data collection used was a 50-item structured questionnaire designed by the researcher for eliciting the information from the respondents. The initial draft of the questionnaire was presented to six (6) lecturers in the department of science and technology education, faculty of education, to check the face and content validity of the instrument. Based on their necessary suggestions and observations, the final draft of the questionnaire was produced. The reliability of the instrument was later established through pilot-testing the questionnaire on 32 staff and students of electrical engineering, Kano State University of Science and Technology, Wudil, Kano, Nigeria. The reliability coefficient was computed with the aid of SPSS statistical software version 20, using cronbach's Alpha method to ascertain the extent of homogeneity of the items. The reliability coefficient of the questionnaire was found to be 0.875, which indicates that the items in the questionnaire are internally consistent in measuring what was intended to be measured for the study. The researchers used mean and standard deviation in analyzing the research data and answering all the research questions with the aid of SPSS statistical software. Any item with mean value of 2.50 and above is accepted while items with a mean value below 2.50 are rejected.

6. Results

The results of the study are presented below in accordance with the research questions that guided the study.

6.1 Research Question 1: To what extent do the staff and students observe electrical safety practices in the workshops and laboratories of Bayero University, Kano?

Table 6.1 Mean and standard deviation of the responses of staff and students on the extent of observance of electrical safety practices in the workshops and laboratories

N_1=42, N_2=99

S/N	Items	$\bar{x}_1$	SD_1	$\bar{x}_2$	SD_2	$\bar{x}_t$	SD_t	Remark
1.	Staff and students are always using protective safety wears in the electrical engineering workshops/laboratories.	1.98	.898	1.97	.770	1.97	.818	Rejected
2.	Staff and students always observed safety precaution in electrical engineering workshops/laboratories	1.76	.781	1.82	.738	1.79	.705	Rejected
3.	Electrical engineering department have safety club	1.88	7.6.2	1.82	.628	1.85	.709	Rejected
4.	Staff and students are not using faulty equipment in	2.20	.758	2.13	.817	2.25	.835	Rejected

	electrical engineering workshops/laboratories							
5.	Safety training courses are periodically organized in electrical engineering workshop/laboratories	2.34	.813	2.08	.911	2.21	.824	Rejected
6.	Safety procedure are not well observed in electrical engineering workshop/laboratories	2.13	.965	1.95	.835	2.04	.509	Rejected
7.	Precautionary strategies are periodically carried out on machines, equipment and devices to avoid electrical shocks in electrical engineering workshops/laboratories	2.18	.061	1.98	.835	2.08	.141	Rejected
8.	Causes of electrical accidents are always investigated and analyzed and subsequently reported to the Department/Faculty member supervising the laboratory	2.25	.197	1.97	.941	2.11	.268	Rejected
9.	Safety demonstrations are occasionally conducted to students by safety personnel in electrical engineering workshops/laboratories	2.15	.260	1.97	1.050	2.06	.374	Rejected
10.	Safety awareness (such as safety signs) are made available in electrical engineering workshops/laboratories	2.25	.449	2.40	.835	2.32	.505	Rejected
11.	Machines are always checked before and after use in electrical engineering workshops/laboratories	2.41	.621	2.03	.274	2.22	.593	Rejected
12.	Unobstructed access to all exits, fire extinguishers, electrical panels, emergency showers, and eyewashes are maintained	2.48	.709	2.02	.274	2.25	.702	Rejected
13.	All new students are given safety orientation by staff before using any equipment in electrical engineering workshops and laboratories	2.52	.813	2.45	.393	2.48	.830	Rejected
14.	Staff and students wear safety goggles when soldering or wire-cutting with side-cutters.	2.46	.141	2.49	.590	2.47	.512	Rejected
15.	Staff and students wash hands before leaving the workshop.	2.46	.141	2.49	.590	2.47	.512	Rejected

Key: N_1 and N_2 - population of staff and students respectively; $\bar{x}_1$ – mean of staff; $\bar{x}_2$ - mean of students; $\bar{x}_t$ - Mean of all respondents; SD_1 – Standard deviation of staff; SD_2 - Standard deviation of students; SD_t - Standard deviation of all respondents

Table 6.1 above shows the mean and standard deviation of the responses of respondents in this study. Analysis of mean responses of the two groups of respondents revealed low observance of electrical safety practices by the staff and students in the workshops and laboratories of Bayero University, Kano.

6.2 Research Question 2: What are the common causes of electrical accidents in the workshops and laboratories of Bayero University, Kano, Nigeria?

Table 6.2 Mean and standard deviation of the responses of staff and students on the common causes of electrical accidents in the workshops and laboratories

N_1=42, N_2=99

S/N	Items	$\bar{x}_1$	SD_1	$\bar{x}_2$	SD_2	$\bar{x}_t$	SD_t	Remark
1.	Use of improper clothing (such as shorts, sandals) in workshops and laboratories	2.74	.258	2.50	.660	2.62	.623	Accepted
2.	Use of powered tools, machines and equipment without adequate knowledge of their operation and/or being briefed/trained as a user.	2.64	.141	2.85	.796	2.74	.719	Accepted
3.	Overconfidence on workshop procedures	3.18	.352	3.35	.765	3.26	.776	Accepted
4.	Use of faulty tools, devices, equipment and machines	3.11	.470	2.87	.093	2.99	.321	Accepted
5.	Using machine without machine guard	3.16	.627	3.04	.967	3.10	.502	Accepted
6.	Working in an unsafe condition such as splash of oil and grease	3.46	.612	3.34	1.23	3.24	.325	Accepted
7.	Unsafe acts by persons like playing, eating, indulging in	3.58	.744	3.40	.029	3.49	.319	Accepted

	reckless behavior such as running, sitting on the workbenches etc							
8.	Performing unauthorized experiments, jobs and tasks in the laboratory and workshop	3.32	0.290	3.18	.25	3.25	.420	Accepted
9.	Working with hazardous/ flammable materials and/or equipment in an unsafe condition such as unable to wear safety glasses or face shields	3.11	.260	2.75	.532	2.93	.529	Accepted
10.	Unsafe installation of electrical devices, equipment and machines such as faulty/loose connections,	3.51	.290	3.49	.377	3.31	.679	Accepted
11.	Powering up installations without proper check by the instructors and/or workshop supervisors	3.51	.260	3.34	.55	3.42	.814	Accepted
12.	Leaving the workshop/laboratory unattended without turning off all ignition sources and locking the doors	3.72	.368	3.29	.690	3.50	.944	Accepted

Key: N_1 and N_2 - population of staff and students respectively; $\bar{x}_1$ – mean of staff; $\bar{x}_2$ - mean of students; $\bar{x}_t$ - Mean of all respondents; SD_1 – Standard deviation of staff; SD_2 - Standard deviation of students; SD_t - Standard deviation of all respondents

Table 6.2 shows the mean and standard deviation of the responses of respondents. The results presented in the table indicated that the respondents agreed with all of the items as the common causes of electrical accidents in the workshops and laboratories of Bayero University, Kano, Nigeria.

6.3 Research Question 3: What are the nature of electrical accidents that frequently occur in the workshops and laboratories of Bayero University, Kano, Nigeria?

Table 6.3 Mean and standard deviation of the responses of staff and students on the nature of electrical accidents that frequently occur in the workshops and laboratories

N_1=42, N_2=99

S/N	Items	$\bar{x}_1$	SD_1	$\bar{x}_2$	SD_2	$\bar{x}_t$	SD_t	Remark
1.	A fall in the workshop/laboratory due to shock and slippery floor	3.69	.290	3.50	.930	3.59	.380	Accepted
2.	Accident due to Loose dress with tendency to be caught up by rotating part of electrical machine or equipment	3.93	.610	3.35	.420	3.64	.600	Accepted
3.	Accident as a result of climbing up a movable ladder or pole without safety belt	3.30	.790	3.64	.180	3.47	.790	Accepted
4.	Accident caused by working on machine with wet body	2.93	.940	3.77	.480	3.35	.770	Accepted
5.	Accidents during electrical installation due to short circuit resulting in shock and/or burns	3.20	.920	2.60	.590	2.90	.840	Accepted
6.	Accidents due to unnecessary bending, twisting, reaching out, as a result of lifting heavy objects	3.83	.280	2.82	.690	3.32	.430	Accepted
7.	Accidents during assembling/dismantling of electrical machine or equipment	3.04	.370	3.46	.590	3.25	.560	Accepted
8.	Accidents due to electrical arc flash, flash current flowing through the body, flash over, and thermal spark	3.09	.170	3.29	.760	3.19	.250	Accepted

Key: N_1 and N_2 - population of staff and students respectively; $\bar{x}_1$ – mean of staff; $\bar{x}_2$ - mean of students; $\bar{x}_t$ - Mean of all respondents; SD_1 – Standard deviation of staff; SD_2 - Standard deviation of students; SD_t - Standard deviation of all respondents

Analysis of the mean responses and standard deviation of the respondents as shown in table 6.3 above reveals that the respondents accepted all the eight items describing the nature of electrical accidents that frequently occur in the workshops and laboratories.

6.4 Research Question 4: What precautionary measures are to be taken to reduce accident occurrence, and promote students' compliance to safety rules and regulations in the workshops and laboratories of Bayero University, Kano, Nigeria?

Table 6.4 Mean and standard deviation of the responses of staff and students on the precautionary measures to be taken to reduce accident occurrence, and promote students' compliance to safety rules and regulations in the workshops and laboratories

N_1=42, N_2=99

S/N	Items	$\bar{x}_1$	SD_1	$\bar{x}_2$	SD_2	$\bar{x}_t$	SD_t	Remark
a). Reducing accident occurrences in workshops and laboratories								
1.	No student or group of students should carry out unauthorized experiments, tasks or job	3.55	.15	3.23	.18	3.39	.14	Accepted
2.	Use of film show, safety signs/posters in the workshop/laboratories	3.48	.31	3.07	.33	3.27	.26	Accepted
3.	Conducting safety inspection and safety audit periodically	3.55	.45	3.25	.41	3.40	.16	Accepted
4.	Never work in the workshop/laboratory alone or at least without another person within easy call	3.76	.57	3.39	.50	3.57	.54	Accepted
5.	Provision of automatic fire detection system and automatic fire alert circuit in risk zones	3.76	.72	3.96	.78	3.86	.54	Accepted
6.	Do not use corridors for storage or work areas	3.93	.86	3.90	.78	3.46	.80	Accepted
7.	Ensure all electrical circuits are checked by the technicians or tutor or the relevant technical staff before powering up	3.02	.83	3.87	.91	3.44	.47	Accepted
b). Ensuring students compliance to safety rules and regulations								
8.	All new students should review safety orientation before using tools machine and equipment in the workshop/laboratory	3.02	.16	3.00	.14	3.01	.61	Accepted
9.	Students who disregard workshop safety rules should be punished	3.18	.29	3.95	.11	3.56	.29	Accepted
10.	Formation of departmental safety club	3.04	.47	3.22	.20	3.13	.34	Accepted
11.	Organizing safety training course periodically for staff and students	3.90	.66	3.14	.33	3.52	.46	Accepted
12.	Inform the lecturer/technician of any medical conditions that you may have which could affect your performance in the laboratory, or could be aggravated by the work environments in the laboratory	3.16	.76	3.24	.42	3.12	.59	Accepted
13.	Investigation, analyzing and reporting the causes of electrical accidents	3.20	.91	3.44	.50	3.32	.21	Accepted
14.	Clean working areas and return back equipment after use	3.45	.84	3.19	.67	3.32	.33	Accepted
15.	Keep benches clean and free from apparatus that is not being used	3.44	.96	3.23	.78	3.33	.48	Accepted

Key: N_1 and N_2 - population of staff and students respectively; $\bar{x}_1$ – mean of staff; $\bar{x}_2$ - mean of students; $\bar{x}_t$ - Mean of all respondents; SD_1 – Standard deviation of staff; SD_2 - Standard deviation of students; SD_t - Standard deviation of all respondents

Table 6.4 above shows the mean responses and standard deviation of the respondents on precautionary measures to be taken to reduce accident occurrences, and ensure students' compliance to safety rules and regulations in workshops and laboratories. Analysis of the mean responses indicates that all the proposed measures are accepted by the respondents.

7. Discussion and Implications of Findings

This study assessed the electrical safety practices of staff and students of electrical engineering department of Bayero University, Kano, Nigeria. In particular, the study investigated the extent of respondents' observance of electrical safety practices, the common causes of electrical accidents, the nature of electrical accidents, and the precautionary measures for reducing accident occurrences, and promotes students compliance to safety rules and regulations in the workshops and laboratories. These objectives are achieved using descriptive survey design, where a structured questionnaire designed by the researcher was administered to the respondents for the data collection. As such, the discussion of the findings that follows is organized according to the objectives that guided the study.

7.1 The Extent of Respondents' Observance of Electrical Safety Practices

The findings of the study with regard to this objective revealed that the respondents do not strictly observe electrical safety practices in the workshops and laboratories. This is confirmed by their rejection of all the fifteen statements/items presented to them to probe the degree of their observance to electrical safety practices. This finding is in line with the work of Boubaker, Mekni, and Jerbi (2017), who reported a poor electrical safety cultures among respondents in Hail region in Saudi Arabia. However, the finding is contrary to the study outcome carried out by Aigbodion, Orukpe, and Igbinovia (2014). They reported that secondary school students have a considerably greater knowledge of electrical safety both at home and in the laboratory, which helps them in effective observance of electrical safety practices. The finding is also confirmed by Unnikrishnan, Iqbal, Singh, and Nimkar (2014) that safety management practices among workers in small and medium enterprises (SMEs) in India are inadequate. This implies that these accidents will continue to exist in our academic workshops/laboratories, and will result in immediate consequences such as instructors' loss of job due to their fault/negligence, students' untimely dropout from school, damages to workshop's environment and equipment, loss of school reputation and integrity, cost of repairs of workshop's tools, machines and equipment, and temporary closure of school leading to loss of some days of school period (Afeez, 2016).

7.2 Common Causes of Electrical Accidents in the Workshops and Laboratories

The findings of the study also revealed that the respondents agreed with the proposed items presented to them on the common causes of electrical accidents in the workshops and laboratories. These include use of improper clothing; use of faulty tools, devices, equipment and machines; working in an unsafe condition such as splash of oil and grease; over confidence on workshop procedures; and use of powered tools, machines and equipment without adequate knowledge of their operation amongst others. A study conducted by Ersoy (2013) conformed to this finding in which he affirmed that the main causes of occupational accidents are lack of training or carelessness of employees, old or poorly maintained machines, untidiness, noise, and too hot or too cold environments. Furthermore, this finding is in agreement with the work of Koo, Nurulazam, Rohaida, Teo and Salleh (2013) that reviewed literature and compiled the causes of electrical hazardous situations and conditions in the academic laboratory to include lack of safety knowledge and training, safety beliefs, effects of peers, self efficacy, and personal controllability. Rahmani et al, (2013) also found that lack of protective equipment, insufficient professional skills, and negligence are the main causes of electrical accidents. This findings is also in line with finding of Jain (2008) in which he categorized the causes of accidents as environmental factors, mental factors which include (ignorance, use of broken tools/equipment) and human factor which include (forgetfulness, alcoholisms and carelessness).

Since the respondents confirmed that these causes are the mastermind of one or more of the electrical injuries sustained by either students or staff, then this implies that the staff and students lack good training on electrical safety awareness. Instructors' lack of good training on electrical safety awareness is an outright violation of Electricity at Work Regulation, 1989, that requires any employee necessary to work on or near electrical systems to have suitable training, skills, and knowledge for the task to prevent injury to themselves and others. Anything short of complying with the Electricity at Work Regulation will result in unsafe work practices which will endanger the lives of the inhabitants, the equipment, machines and the work environment.

7.3 Nature of Frequent Electrical Accidents in the Workshops and Laboratories

Furthermore, the respondents in this study accepted all the eight items proposed for probing the nature of accidents in the workshops and laboratories. These comprise a fall in the workshop/laboratory due to shock and slippery floor, accident due to loose dress with tendency to be caught up by rotating part of electrical machine or equipment, accidents due to electrical arc flash, flash current flowing through the body, flash over, and thermal spark among others. This finding is consistent with NIOSH (1998) that the four main types of electrical accidents and/or injuries are electrocution, electric shock, burns and fall caused by contact with electrical energy. This outcome is also agreed by Afeez (2016) in his study where be stressed the following as type of frequent accidents in the workshop/laboratory: falling below the working level, slipping to surface in the workshop, exposure to electric shock among others. Since these electrical accidents do occur frequently as confirmed by the respondents, this implies that the purposes of academic workshops/laboratories as a safe environment where one can teaches, learns and conduct research, are defeated. It also implies that the there is carelessness and negligence on the part of the teachers/instructors/technicians/supervisors on the enforcement of safety rules and regulations, which Umeokafor, Isaac, Jones and Umeadi (2014) described as very crucial in guaranteeing the effectiveness of regulations. Further, Idubur and Osiamoje (2013) opined that devoid of appropriate enforcement, regulations are tantamount to no laws.

This situation of non-compliance to safety regulations will therefore results in serious negative impacts such as loss of income, disability, death inter-alia.

7.4 Measures to Reduce Accident Occurrence, and Promote Students' Compliance to Safety Rules and Regulations

The respondents of the study agreed with all the items presented to them on the precautionary measures to reduce accidents and promote students' compliance to safety rules and regulations in the workshops/laboratories. Accepted measures consists prohibition of conducting unauthorized experiments, tasks or job by students; conducting safety inspection and safety audit periodically; provision of automatic fire detection system and automatic fire alert circuit in risk zones; new students should review safety orientation before using tools, machines, and equipment in the workshop/laboratory; and formation of departmental safety club among others. This finding is in concise with the work of Hodgson, McKinney, and DeGrate, (2011) that safe behaviors and observing all rules and regulations will play a vital role in reducing or even eliminating all kinds of accidents in the workshop and laboratories. Patrick and Babatope (2013) found that the observance and compliance of safety measures in workshops among engineering students in Nigeria was above average. The respondents' outright acceptance of the proposed measures implies that these measures if implemented will go a long way in reducing the incidences of electrical accidents and/or injuries in the workshops/laboratories. As a result, the workplaces will be free from avoidable mishap which causes injury to the person, damage to machines, tools and equipment. This will undoubtedly establish a successful safety services that will improve the outcome of engineering works, add quality and lifespan of workers, and equipment lives.

Ultimately, the findings of the study generally imply that adequate dispositions in electrical safety and awareness should be embedded into the engineering education curriculum in Nigeria. In line with this, Turekova and Bagalova (2018) stressed that educational organizers must ensure occupational safety and hygiene, since this has an economic impact and educational attainment, in addition to humanistic nature. This is also consistent with Endroyo, Yuwono and Mardapi (2015) who believed that to guard against industrial accidents, it becomes essential to enhance the knowledge, skills, attitudes and habits of the people involved by adequately embedding safety education in the school curriculum.

8. Conclusion

An investigation of electrical safety awareness and practices of staff and students in academic workshops/laboratories has two-fold benefits. It helps minimizes the risks of electrical accidents in the workshops/laboratories, and promotes the chances of employing safety-conscious electrical personnel by industries and other organizations. The results demonstrate that staff and students do not strictly observe electrical safety practices in the workshops/laboratories. The results also revealed the common causes of electrical accidents in the workshops/laboratories; nature of frequent electrical accidents; and measures to reduce electrical accidents and promote students' compliance to electrical safety rules and regulations. As a result, the department of electrical engineering, Bayero University, Kano, should, as a matter of urgency, introduce a course on electrical safety awareness into their curriculum. There is also need for periodical training on electrical safety awareness through seminars, workshops and conferences, for instructors and technicians. This will be of utmost important in order to reduce the occurrences of electrical accidents in the workshops/laboratories, which will save the management unnecessary expenses with respect to cost of repairs, loss of job on the part of staff, students' drop-out, injuries leading to disabilities and deaths in case of fatal accidents.

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