



Global Academic Research Consortium (GARC)

ISSN: 2360-9194 | Volume 11 Issues 6 & 7 | October 2021 - August 2022

<http://arcnjournals.org>

International Journal of Information, Engineering & Technology



Global Academic Research Consortium (GARC) Journal Series

International Journal of Information, Engineering and Technology

ISSN: 2360-9194

Volume 11

Issues 6 & 7

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Publisher:

Africa Research Corps Network (ARC�)

www.arcnjournals.org/garc

172 Jose Marti Crescent, Abuja, Nigeria

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Effect of Petrol Engine Model on Academic Achievement and Interest of Motor Vehicle Mechanics Students in Technical Colleges in Borno State

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Abstract: This study examined the effect of constructed petrol engine model on academic achievement and interest of motor vehicle mechanics students in technical colleges in Borno State. The study had three objectives, three research questions and two null hypotheses. The study used quasi-experimental research design. The population of the study was 58 technical college students (Auto-mechanics students). The instrument used for data collection were motor vehicle mechanics achievement test (MVMAT) and motor vehicle mechanics interest inventory (MVMII). Research questions were analyzed using mean and standard deviation while the null hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). Based on the data analyzed the study revealed that motor vehicle mechanics interest inventory before treatment were undecided while motor vehicle mechanics interest inventory after treatment was high and constructed petrol engine model has positive effect on the achievement of motor vehicle mechanics students in technical colleges and the interaction of treatment and gender has no effect on the achievement of motor vehicle mechanics students in technical colleges. The researcher recommended that the constructed petrol engine model should be used in teaching and learning of petrol engine lesson in technical college in Borno State; and government should encourage the funding of construction of petrol model for the purpose of enhancing teaching and learning of motor vehicle mechanic course in technical colleges.

Key words: Engine model, Students academic achievement, Experiment, Teaching, Interest.

Introduction

Models can be used to enhance learning especially where real objects may not serve the purpose. It shows the actual representation of the original. According to Macdonal (1991) a model is a plan, a design, a preliminary solid representation to be followed in construction, something to be copied. Nachimias and Nachimias (1992) sees model as a likeness of something and a representation of reality.

Models can be used to make teaching and learning of automobile technology. Motor vehicle mechanics work is one of the trades offered in technical colleges (Federal Republic of Nigeria, 2013). According to Schaller (2000), motor vehicle mechanics work is the learning of basic knowledge and skills necessary to diagnose and repair mechanical defects in automobiles. A model can be constructed and used in teaching some specific automobile engine parts such as crankshaft, piston, cylinder block, cylinder head, connecting rods, push

rods, plugs, valves and crankshaft. It is simpler in construction, easy to carry and move about because it is not heavy as in the case of a real auto-engine.

Jimoh (2010) observed that students' achievement connotes performance in school subjects as symbolized by a score on an achievement test. Ogwo and Oranu (2006) laid emphasis on the need for teachers to use stimulating strategies which lead to better retention of subject matter without which students' achievement will be minimal. Interest is a persisting tendency to pay attention and enjoy some activities (Jimoh, 2010). However, it is pertinent that auto-mechanics teachers should use teaching strategy which ensures gender active involvement in learning and provide suitable learning environment to improve achievement and retention of automobile students in technical colleges.

Federal Ministry of Education (2004) in her report on Technical Colleges revealed that students in Technical Colleges are always put-off or not interested in vocational education (auto-mechanics inclusive) because of motivating and unchallenging strategy and approach used by their instructors and teachers. If the teaching strategy is fascinating, students would not have difficulty in retention of the subject matter. Therefore, in order to make the students retain and reproduce what is being taught in motor vehicle mechanic class, model is required to arouse their interest.

Report by researchers revealed that the teaching and learning of auto mechanics nowadays in the Technical Colleges is still bedeviled by a mirage of problems ranging from over-population, change of teacher's role, lack of staff and equipment, inadequate skilled and competent professionals that can assist students in learning and acquiring skills that would make them proficient in their automobile career (Aloraini, 2005 and Osho, 2007).

An appropriate strategy for teaching automobile subject may foster interest and academic achievements of auto-mechanics students in technical colleges. Paden and Dereshiwsky (2007) and Omenka (2010) attributed the low achievement and interest rate in technical students to conventional teaching method mainly adopted by teachers. The conventional methods of teaching which are teachers centered that is persistently used for years is now gaining poorer results when compared with the modern and revolutionary teaching methods (Jackson, 2012). According to Mbah (2002), achievement is dependent upon several factors amongst which are instructional techniques, the learning environment, motivation as well as retention. Hence, the academic achievement of students in automobile also depends on the interest capability of the students in the subject. Agaba (2013) also confirmed that achievement in education is directly connected to knowledge retention.

Most automobile technology teachers in the technical colleges do constantly face the decision of how to design instruction, which will best meet the needs of the students. The decisions include selecting the best strategy that would be appropriate for teaching and learning (Amen, 2007). Agnew and Shinn (1990) are of the opinion that the selection process requires not only the teacher being aware of how to use various techniques, but that he or she knows which type of students learn best with various techniques. Due to the present advancement in technology and sophistication in automobile technology, the traditional teaching methods adopted by most teachers in teaching automobile in technical colleges do not allow teachers to adequately cater for the diverse learning styles of most students (Neekpoa, 2007). As technology is changing, the auto-technicians must change with the

technology so that the level of their thinking in dealings with various diagnoses, repairs, and maintenance of motor vehicles should be commensurate with maintenance need of today's automobile. In other words, students need to be equipped with higher order thinking skills for easy adaptability. Campbell and Campbell (1999) stated that traditional teaching methods do not adequately equip teachers with contemporary views of student intelligences and their vast learning capabilities. The consequence of this, according to Roegge, Wentling and Bragg (2000), is that students are unable to retain learning and to apply it to new situation.

The National Business and Technical Education Board (NABTEB) May/June Chief examiner's report (NABTEB, 2002) indicated that the shortcomings of the present teaching method partly accounted for the poor performance of students in auto-mechanics technology in the National Technical Certificate Examination in recent years. According to NABTEB (2006) the performance of students in National Technical Certificate (NTC) Examination was poor. The report showed that the level of achievement in auto-mechanics subjects was lower than expectation as most students scored less than 50 percent in this subject. This low achievement may be due to the traditional system of teaching adopted by automobile teachers in the technical colleges while teaching petrol engine in the classroom.

The vestiges of the traditional system of teaching and evaluation still prevail in schools (Sofolahan, 1991). He further maintained that when traditional method of teaching is employed, students' ability to grasp relevant concepts is made much more difficult than when students are exposed to lessons involving hands-on experience. Supporting Sofolahan, Haruna (1992) and Okebukola (1997) noted that in spite of the numerous teaching strategies propounded to cope with the recent trend in the various curriculum structures for schools, evidence had continued to show that most teachers still adopt the traditional talk chalk approach. The traditional instructional method of teaching has its advantages and disadvantages and the recurrent poor academic achievement in automobile technology subject may be related to the use of conventional/traditional method of teaching as observed by Ezech (2006).

However, the best way to make learning more concrete is to make use of real objects and in some situations, real object may either be too large or complex that hidden details are obscured. This situation arises in the study of some aspects of automobile. For example, how the crankshaft rotates in an engine, the jumping of sparks at the rear end of the spark plug resulting in igniting the mixture of fuel and air in the combustion chamber are hidden details that cannot be seen. Real object as well may be dangerous, and in such situations, the teaching and learning must be brought down to the learners' level using prototype or model so that the students would have a good mental picture of the topic being taught in the classroom. Learning with real objects may sometimes be too costly should any damage occur. Hence, it is better to start from the use of models for teaching/learning activities in the classroom before handling the real object in the workshop. Another commonly stated merit of the use of models is the learning safety as well as practicing new information or skills that may be tedious in real life. Lee (1979) describes safety as a factor to be considered when selecting a strategy.

Therefore, the need to find the best strategy that will assist students in auto-mechanics work and improve their retention and academic achievement has become most important to auto-mechanics teachers in North Eastern Nigeria.

Statement of the Problem

Many Technical College students find it difficult to study automobile technology because they see the engine as a complicated device. Those who eventually study auto-mechanics do not possess expected practical skills. This defeats the objective of self-reliant emphasize in National Policy on Education (FRN, 2013). The shortcoming in these conventional methods of teaching could be accountable for poor achievement of auto mechanics students in public examinations (NABTEB 2012) In the same vein, (Ogbuanya and Owodunni, 2013) opined that the persistent poor academic achievement as well as lack of interest in auto mechanics is as a result of the inappropriate and un-motivating approach and methods adopted by teachers in the classroom. Oluwatumbi (2015) asserted that it is appalling that many students graduate yearly from technical colleges without acquiring relevant practical skills. This situation became worrisome as most students have loss interest and are not willing to further their education in automobile at higher level.

Therefore, in order to address the issue of poor practical skills acquisition, and low performance of auto-students in National Technical Certificate (NTC) examination in Technical Colleges in Borno, a better method should be employ in imparting practical skills which is the use of model in the auto mechanic lesson to enable the students to have an insight of what the vehicle engine entails before the practical work in the workshop. This may likely arouse the students' interest as well as improving their retention and academic achievement. This study therefore, focused on finding out the effects of model on interest and academic achievement of auto mechanics students in technical colleges in Borno State, Nigeria.

Purpose of the Study

The purpose of this study was to determine the effect of models on interest and academic achievement of auto-mechanics students in technical colleges in Borno State Nigeria.

Specifically, this study sought to:

1. Determine the difference in the mean scores of motor vehicle mechanics interest inventory on motor vehicle mechanics students before and after treatment in technical colleges in Borno State
2. Determine the effect of constructed petrol engine model on academic achievement of motor vehicle mechanics students before and after treatment in technical colleges in Borno State.
3. Determine whether there is any interaction effect of sex and experiment on academic achievement of motor vehicle mechanics students in technical colleges in Borno State

Research Questions

The following research questions guide the study:

1. What is mean scores of motor vehicle mechanics interest inventory on motor vehicle mechanics students before and after treatment in technical colleges in Borno State?
2. What is the effect of constructed petrol engine model on academic achievement of motor vehicle mechanics students in technical colleges in Borno State?
3. Is there any interaction effect of gender and experiment on academic achievement of

motor vehicle mechanics students in technical colleges in Borno State

Hypotheses

The following null hypotheses at a level of significance of 0.05 will guide the study:

Ho1. There is no significant effect of constructed petrol engine model on academic achievement

of motor vehicle mechanics students in technical colleges in Borno State.

Ho2. There is no significant interaction effect of treatment and gender on the achievement of motor vehicle mechanics students in technical colleges in Borno State.

Significance of the Study

The findings of this study will sensitize the auto-mechanics teachers on the benefit of the use of models in teaching, since it has greater effect on the interest and academic achievement of the students. The research findings will as well form another dimension of innovations in teaching and learning of automobile.

The curriculum planners would also benefit from this study. The results of the research would assist in curriculum planning. For instance, information relating to the teaching and learning of automobile with the use of models will be utilized in the appropriate stages of curriculum planning, modification and revision.

The finding of this study will be of immense benefit to the students who have been sceptical in studying automobile since the study will be provided with pedagogical information that may improve their learning in petrol engine thereby the student will gain adequate knowledge in the course of training. The research findings will as well increase the interest of the students in auto-mechanics work.

The Ministry of education will also find this study useful. The findings of the study can be utilizing by the Education Ministry by organizing conferences, seminars, and workshops to sensitize and re-train auto-mechanics teachers on the use of models to improve their teaching.

Scope of the Study

Among the various types of models, the research is limited to the experimental construction type of model which is relevant to the study. The petrol engine is taught at National Technical Certificate (NTC) 1 in the first term of the academic year. **Methodology**

Research Design

The research design adopted for the study was the quasi-experimental non-randomize control group design. Quasi-experimental design can be use when it is not possible for the researcher to randomly sample the subject and assign them to treatment groups without disrupting the academic programmes of the schools involved in the study (Borg 2007). The type of quasi experimental design that is to be used is the non-equivalent control group which involves two groups.

The reason to adopt the quasi-experimental design is that intact classes are used by the researcher; quasi-experimental design did not involve randomization of participating units as applied in the true experimental designs. If random selection in true experimental design will be used, the school administration may not allow the splitting of classes, since it will likely disrupt normal school programmes. The quasi- experimental design thus can suit the use of intact classes which easily fit into the normal school programmes as it can smooth the conduct of the experiment.

Area of the Study

The study was conducted in Borno State, Nigeria. Borno State lies within latitude 11°-15°E and longitude 100 and 25°N and is located in the North-Eastern sub-region of Nigeria. The State shares border with Republic of Niger to the North, Chad to the North-East and Cameroon to the East. Within Nigeria, it is bounded by Yobe State to the West, Gombe State to the South-West and Adamawa State to the South. Borno State has 27 Local Government (Borno State Ministry of Information and Home Affairs, 2009).

Population for the Study

The population for the study comprised of 58 NTC 1 motor vehicle mechanics students in Technical College Damboa is the one functional while Technical College Bama has been displaced by insurgence, therefore the population for the study remained 58 NTC 1 motor vehicle mechanics students in Damboa, Borno State.

Sample and Sampling Technique

There was no sampling involved as the population was manageable. The sample size was 58 auto-mechanics students of technical college in Damboa, Borno State.

Instruments for Data Collection

The instruments that were developed by the researcher for the data collection in this study were motor vehicle mechanics achievement test (MVMAT) and motor vehicle mechanics interest inventory (MVMII). The interest inventory which was used to test the students' interest in motor vehicle mechanics test is a-30 multiple choice items and validated by the technical education experts in the Department of Technical Education Ramat Polytechnic Maiduguri to test the students' understanding in the subject and also the Auto-Mechanics Achievement Test (AMAT) is a-30 multiple choice items. Each has four options. The instrument covers the content areas of the topic selected for the study. To ensure the content validity, a table of specification on the instrument which ensured an appropriate distribution of the test items, with respect to the relevant content area chosen as well as the cognitive objective levels desired was applied based on the Bloom's Taxonomy of education objectives. A trial test was conducted on the MVMT for the purpose of determining the psychometric indices of the test. In the trial test, the AMAT was administered to 10 Year, NTC1 students in Technical College Damaturu, Borno State.

A trial test was also conducted on the AMII instrument. The purpose of the trial test was to try out the instrument and receive feedback on the reactions and effects based on the application.

The items will be based on five point Likert scale of strongly Agree (SA), Agree (A), Undecided (UD), Disagree (D) and strongly Disagree (SD). The motor vehicle mechanics work lesson notes that will be used for the study will be developed by the researcher.

Validation of the Instruments

The validation of the instruments takes the form of face and content validation. Two experts carry out the validation of the instruments. In the course of face validation, the experts subjected the items to criticism and vetting with respect to relevance, suitability, repetition, set objectives, use of language and ambiguity as demanded by the researcher. The items were reorganized at the end of the face validation. The Motor Vehicle Mechanics Lesson Note and Motor Vehicle Mechanics Interest inventory will be subjected to face validation by the two

experts from Department of Technical Education Ramat Polytechnic Maiduguri. To ensure the content validity, a table of specification on the instrument which ensured an appropriate distribution of the test items, with respect to the relevant content area chosen as well as the cognitive objective levels desire were applied based on the Bloom's Taxonomy of education objectives. A table of specification was built for the test. Based on the table of specification, items for the Motor Vehicle Mechanics Achievement Test will be developed.

Reliability of the Instruments.

A trial test of the Motor Vehicle Mechanics Achievement Test and Motor Vehicle Mechanics Interest Inventory was carried out using test-retest reliability technique. The instrument was administered on 10 motor mechanic students of Government Technical College, Damaturu, Yobe State. Cronbach Alpha will be used. The Cronbach Alpha was used to establish the reliability. A reliability coefficient of 0.831. The instrument was considered positive and stable.

Experimental Conditions

In order to avoid experimental bias, regular class teachers in the participating technical colleges taught the students. However, the researcher did not be involve directly in the administration of the instrument.

The classroom teachers were involved in administering the instruments and were properly trained by the researcher for the experimental construction petrol engine model before and after treatment in order to ensure the homogeneity of instruction across the groups and detailed explanation was given to the teachers by the researcher prior to the treatment.

The lesson notes were used, the researcher prepared the model and each teacher participated in administering the instrument using the lesson notes prior to the experiment and were supervised by the researcher. All these are aimed at arriving at a standardized mode of presentation among the teachers that were involved in administering the instruments and this assisted in eliminating the teacher variability factor extraneous to the study. The students in the experimental construction petrol engine model before and after treatment were not informed that they were involved in any research process.

Experimental Procedure

The experimental group before treatment was taught without model but used traditional method while experimental group after treatment used model. Interest inventory on motor vehicle mechanics work were administered as well the experimental construction petrol engine model. The same questions were used for experimental group before and after treatment but the questions were re-arranged. The reason for the re-arrangement of the questions so that the students would not be able to discover that the same questions is used to the group before treatment.

Method of Data Collection

The scores that were generated from Motor Vehicle Mechanics Achievement Test (MVMAT) and Motor Vehicle Interest Inventory (MVMII) were used as the data collection for the research work. The researcher and motor vehicle mechanics teachers were involved in the administration and collection of the Motor Vehicle Mechanics Achievement Test and Motor Vehicle Mechanics Interest Inventory.

Method of Data Analysis

Mean and standard deviation was used to answer the research questions while the analysis of covariance (ANCOVA) was used for testing the hypotheses at a significance level of 0.05. Since the research involved two group before and after treatment of intact classes, the statistical technique adopted for analyzing the hypotheses (ANCOVA) enabled the researcher to adjust initial group differences (Non-equivalence). Using ANCOVA helped to compare the mean of the two groups.

Decision Rule

Any Group before or after treatment with higher mean value irrespective of the closeness in the mean value of the other group would be taken to have performed better in achievement test or showing much interest in petrol engine. If the significance of F is less than 0.05, the null hypothesis is rejected. If the significance of F is greater than 0.05, the null hypothesis is accepted.

Analysis of Demographic Data

The demographic data for the study were analyzed in Tables 1 and 2 as follows:

Table 1: Percentages distribution of students according to the grouping

Group	Frequency	Percentage (%)
Experimental group one	30	51.7
Control group	28	48.3
Total	58	100.0

Source: Field experiment, 2021

The data presented in Table 1 revealed that there are 30 students representing 51.7% in experimental group (Petrol engine model group), and 28 students representing 48.3% in control group. This implied that there are more students in experimental group than students in control group.

Table 2: Percentages distribution of students by gender

Gender	Frequency	Percentage (%)
Male	27	46.6
Female	31	53.4
Total	58	100.0

Source: Field experiment, 2021

Table 2 revealed that there are 27 male students representing 46.6% and 31 female students representing 53.4% used for the experimental study. This indicated that female students used for the experimental study are more in number than male students used for the study.

Analysis of Quantitative Data on motor vehicle mechanics interest inventory

Table 3: Mean and standard deviation of responses on motor vehicle mechanics interest inventory before treatment

S/N	Item Statements	\bar{X}	SD	Remark
1.	Motor vehicle mechanics subjects are simple to understand.	4.44	0.75	Agreed
2.	Auto-mechanics class is very interesting.	4.48	0.58	Agreed
3.	Auto-mechanics period is always not interesting.	3.11	1.67	Undecided
4.	I enjoy participating in Auto-mechanics lesson.	4.33	0.78	Agreed
5.	I attended Auto-mechanics class regularly.	4.48	0.58	Agreed
6.	It is better to use auto-mechanics periods for other subjects.	3.26	1.38	Undecided
7.	I dislike auto-mechanics class period because there is no practical activities.	2.78	1.28	Disagreed
8.	I don't use to ask questions during auto-mechanics class.	2.74	1.48	Disagreed
9.	I pay more attention in the auto-mechanics class.	4.22	1.09	Agreed
10.	I don't like discussing about auto-mechanics subjects.	2.56	1.45	Disagreed
11.	I don't like doing assignments on auto-mechanics subjects.	2.30	1.44	Disagreed
12.	I always feel sleepy during auto-mechanics lesson.	1.93	1.00	Strongly Disagreed
13.	If auto-mechanics teacher/instructor fails to come to the class on time, I can go to his office to call him/her.	3.37	1.78	Undecided
14.	If auto-mechanics teacher/instructor misses his auto mechanics class, I always feel happy.	1.56	0.93	Strongly Disagreed
15.	I prefer auto-mechanics option to any other option in vocational trade.	3.59	1.12	Agreed
16.	I take interest in studying engine parts	4.37	0.84	Agreed
17.	Auto-mechanics practical class increases my interest in auto-mechanics trade.	4.59	0.57	Agreed
18.	Auto-mechanics practical lessons involves students in series of activities so that	3.89	1.48	Agreed
19.	I prefer auto-mechanics syllabus that does not require much drawings.	3.89	0.93	Agreed
20.	I prefer auto-mechanics syllabus that does not require much practical work.	2.48	1.37	Disagreed
21.	I take interest in handling automotive faults during practical class.	3.89	1.12	Agreed
22.	I pay much interest in auto-mechanics lessons more than in any other general subjects.	3.44	1.12	Undecided
23.	I don't take interest in anything involving automotive system.	2.26	1.35	Disagreed
24.	Automotive systems increase my interest in auto-mechanics trade.	4.00	1.18	Agreed
25.	I encourage my friends to develop interest in auto-mechanics.	3.81	1.08	Agreed
26.	The strategies adopted in teaching auto-mechanics subjects by the teachers negatively affect my interest in auto-mechanics.	2.74	1.48	Disagreed
27.	I engage myself with other assignments during the auto mechanics lessons.	2.22	1.67	Disagreed
28.	I don't do any extra studies on auto-mechanics apart from the normal lessons.	2.37	1.67	Disagreed
29.	I dislike auto-mechanics trade because my peer group does not show any interest in it.	2.15	1.41	Disagreed
30.	Auto-mechanics students are not neat in dressing; therefore, I don't like the trade.	2.26	1.48	Disagreed
Weighted average		3.25	1.20	Undecided

Source: Field Survey, 2021

Analysis of data in table 3 shows the mean and standard deviation of responses on motor vehicle mechanics interest inventory before treatment was given to the respondents. The table reveals that the respondents agreed to item 1, 2, 4, 5, 9, 15 to 19, 21, 24 and 25 with mean scores of 4.44, 4.48, 4.33, 4.48, 4.22, 3.59, 4.37, 4.59, 3.89, 3.89, 3.89, 4.00 and 3.81 respectively. The respondents disagreed with item 7, 8, 10, 11, 20, 23, and 26 to 30 with mean scores of 2.78, 2.74, 2.56, 2.30, 2.48, 2.26, 2.74, 2.22, 2.37, 2.15 and 2.26 respectively. In addition, the respondents were undecided for items 3, 6, 13, and 22, with mean scores of 3.11, 3.26, 3.37 and 3.44 respectively. All the 30 item constructs have standard deviation ranging from 0.57 to 1.78 which shows the responses are not widespread as they are close to the mean. The table has a grand calculated weighted average mean and standard deviation of 3.25 and 1.20 respectively. This means that the responses of the respondents indicated they were undecided. This implied that motor vehicle mechanics interest inventory before treatment were undecided.

Table 4: Mean and standard deviation of responses on motor vehicle mechanics interest inventory after treatment

S/N	Item Statements	\bar{X}	SD	Remark
1.	Motor vehicle mechanics subjects are simple to understand.	5.00	0.00	Strongly Agreed
2.	Auto-mechanics class is very interesting.	5.00	0.00	Strongly Agreed
3.	Auto-mechanics period is always not interesting.	1.00	0.00	Strongly disagreed
4.	I enjoy participating in Auto-mechanics lesson.	5.00	0.00	Strongly Agreed
5.	I attended Auto-mechanics class regularly.	4.04	0.19	Agreed
6.	It is better to use auto-mechanics periods for other subjects.	1.33	0.68	Strongly disagreed
7.	I dislike auto-mechanics class period because there is no practical activities.	4.37	1.36	Agreed
8.	I don't use to ask questions during auto-mechanics class.	4.56	0.85	Strongly Agreed
9.	I pay more attention in the auto-mechanics class.	4.96	0.19	Strongly Agreed
10.	I don't like discussing about auto-mechanics subjects.	3.00	0.68	Undecided
11.	I don't like doing assignments on auto-mechanics subjects.	2.96	0.71	Disagreed
12.	I always feel sleepy during auto-mechanics lesson.	1.26	0.45	Strongly disagreed
13.	If auto-mechanics teacher/instructor fails to come to the class on time, I can go to his office to call him/her.	4.81	0.79	Strongly Agreed
14.	If auto-mechanics teacher/instructor misses his auto mechanics class, I always feel happy.	1.15	0.77	Strongly disagreed
15.	I prefer auto-mechanics option to any other option in vocational trade.	2.33	1.12	Disagreed
16.	I take interest in studying engine parts	4.93	0.27	Strongly Agreed
17.	Auto-mechanics practical class increases my interest in auto-mechanics trade.	4.93	0.27	Strongly Agreed
18.	Auto-mechanics practical lessons involves students in series of	4.93	0.27	Strongly

19.	activities so that I prefer auto-mechanics syllabus that does not require much drawings.	4.93	0.27	Agreed Strongly
20.	I prefer auto-mechanics syllabus that does not require much practical work.	1.30	1.07	Agreed Strongly disagreed
21.	I take interest in handling automotive faults during practical class.	4.93	0.27	Strongly Agreed
22.	I pay much interest in auto-mechanics lessons more than in any other general subjects.	3.15	1.85	Undecided
23.	I don't take interest in anything involving automotive system.	1.26	0.94	Strongly disagreed
24.	Automotive systems increase my interest in auto-mechanics trade.	4.93	0.27	Strongly Agreed
25.	I encourage my friends to develop interest in auto-mechanics.	4.93	0.27	Strongly Agreed
26.	The strategies adopted in teaching auto-mechanics subjects by the teachers negatively affect my interest in auto-mechanics.	4.93	0.27	Strongly Agreed
27.	I engage myself with other assignments during the auto mechanics lessons.	3.78	1.45	Agreed
28.	I don't do any extra studies on auto-mechanics apart from the normal lessons.	4.70	0.47	Strongly Agreed
29.	I dislike auto-mechanics trade because my peer group does not show any interest in it.	4.33	0.92	Agreed
30.	Auto-mechanics students are not neat in dressing; therefore, I don't like the trade.	1.78	1.12	Strongly disagreed
Weighted average		3.68	0.62	Agreed

Source: Field Survey, 2021

Analysis of data in table 4 shows the mean and standard deviation of responses on motor vehicle mechanics interest inventory after treatment was given to the respondents. The table reveals that the respondents strongly agreed to items 1, 2, 4, 8, 9, 13, 16 to 19, 21, 24 to 26 and 28 with mean scores of ranging from 4.56 to 5.00. The same way the respondents agreed with item 5, 27 and 29 with mean scores of 4.04, 3.78 and 4.33 respectively. Also, the respondents disagreed with item construct 15 with mean score of 2.33 and strongly disagreed with item 3, 6, 12, 13, 14, 20, 23 and 30 with mean scores of 1.00, 1.33, 1.26, 1.15, 1.30, 1.26, and 1.78 respectively. In addition, the respondents indicated undecided for items 10 and 22 with mean 3.00 and 3.15. All the 30 item constructs have standard deviation ranging from 0.00 to 1.45 which shows the responses are not widespread as they are close to the mean. The table has a grand calculated weighted average mean and standard deviation of 3.68 and 0.62 respectively. This means that the responses of the respondents indicated they agreed to the constructs in table 4. This implied that motor vehicle mechanics interest inventory after treatment was high.

Research question: What is the effect of constructed petrol engine model on academic achievement of motor vehicle mechanics students in technical colleges in Borno State?

Table 5: Mean and standard deviation of the effect of constructed petrol engine model on academic achievement of motor vehicle mechanics students

GROUP	Experimental Group (Petrol engine model)			Control Group		
	N	\bar{X}	SD	N	\bar{X}	SD
PRE-TEST	30	18.50	7.37	28	17.07	4.47
POST-TEST	30	69.47	14.7	28	48.00	5.11
MEAN & SD DIFFERENCE		50.97	7.33		30.93	0.64

Source: Field experiment, 2021

The data presented in Table 5 revealed that the experimental group (constructed petrol engine model group) had a mean score of 18.50 in the pretest and a mean score of 69.47 in the post-test with standard deviation of 7.37 and 14.7 for the pre-test and post-test respectively, pre-test ($\bar{x} = 18.50$; SD = 7.37), post-test ($\bar{x} = 69.47$; SD = 14.7). The result gave a pre-test, post-test mean gain of the experimental group (constructed petrol engine model) to be 50.97. The low standard deviation difference (7.33) showed that the scores of students in both the pre-test and post-test are clustered around their respective mean scores. The control group had a mean score of 17.07 and standard deviation of 4.47 ($\bar{x} = 17.07$; SD = 4.47) in the pretest and mean score of 48.00 and standard deviation of 5.11 ($\bar{x} = 48.00$; SD = 5.11) in the post-test, giving a pre-test post-test mean gain in the control group to be 30.93. With this result, it is clear that constructed petrol engine model is effective in improving academic achievement of motor vehicle mechanics students in technical colleges.

Test of Hypotheses

The null hypotheses for the study were tested using Analysis of Covariance (ANCOVA). The null hypotheses were tested at 0.05 level of significance.

H₀₁: There is no significant effect of constructed petrol engine model on achievement of motor vehicle mechanics students in technical colleges in Borno State.

Table 6: Summary of Analysis of Covariance (ANCOVA) for Test of Significance of effect of constructed petrol engine model on achievement of motor vehicle mechanics students in technical colleges

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	6968.870a	3	399.142	18.738	.000
Intercept	193175.869	1	120861.166	1.558E3	.000
Gender	52.745	1	4624.393	.425	.517
Treatment	6513.766	1	89.578	52.542	.000
Treatment * Gender	229.049	1	178.979	1.848	.180
Error	6694.510	54	40.446		
Total	216270.000	58	74.533		
Corrected Total	13663.379	57			

a. R Squared = .510 (Adjusted R Squared = .483)

Source: Field experiment, 2021

The data presented in Table 6 showed F-calculated values for effects of constructed petrol engine model on achievement of motor vehicle mechanics students in technical. The Table showed that there was significant main effect of constructed petrol engine model on achievement of motor

vehicle mechanics students in technical colleges ($F = 52.542$; $P = .000$). Hence, the null hypothesis that stated that there is no significant effect of constructed petrol engine model on achievement of motor vehicle mechanics students in technical colleges in Borno State was therefore rejected. This implied that constructed petrol engine model has positive effect on the achievement of motor vehicle mechanics students in technical colleges. This means that the effect observed are due to the main treatment given to students.

H₀₂: There is no significant interaction effect of treatment and gender on the achievement of motor vehicle mechanics students in technical colleges in Borno State.

Table 7: Summary of Analysis of Covariance (ANCOVA) for Test of Significance of effect of treatment and gender on achievement of motor vehicle mechanics students in technical colleges

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	6968.870a	3	399.142	18.738	.000
Intercept	193175.869	1	120861.166	1.558E3	.000
Gender	52.745	1	4624.393	.425	.517
Treatment	6513.766	1	89.578	52.542	.000
Treatment * Gender	229.049	1	178.979	1.848	.180
Error	6694.510	54	40.446		
Total	216270.000	58	74.533		
Corrected Total	13663.379	57			

a. R Squared = .510 (Adjusted R Squared = .483)

Source: Field experiment, 2021

The data presented in Table 7 showed F-calculated value for interaction effect of treatment and gender on achievement of motor vehicle mechanics students in technical colleges. The Table showed that there was no significant interaction effect of treatments and gender on the achievement of motor vehicle mechanics students in technical colleges ($F = 2.923$; $P = 1.848$). Hence, the null hypothesis that stated that there is no significant interaction effect of treatments and gender on the achievement of motor vehicle mechanics students was therefore not rejected. This implied that interaction of treatment and gender has no effect on the achievement of motor vehicle mechanics students in technical colleges. This means that the effects observed are due to the main treatment given to students.

Summary of Major Findings of the Study

1. Motor vehicle mechanics interest inventory before treatment were undecided (Mean 3.25, SD 1.20)
2. Motor vehicle mechanics interest inventory after treatment was high (mean 3.68, SD 0.62)
3. Constructed petrol engine model has positive effect on the achievement of motor vehicle mechanics students in technical colleges ($F = 52.542$; $P = .000$).
4. Interaction of treatment and gender has no effect on the achievement of motor vehicle mechanics students in technical colleges ($F = 2.923$; $P = 1.848$).

Discussion of the Result

The study revealed that motor vehicle mechanics interest inventory of the students of technical college in Borno State did not signify whether the students have interest in motor

vehicle mechanics. The weighted average mean score was mean 3.25 which was below mean score of 3.50 which was the decision rule to whether consider an item as a factor or not. This implies that the students had no interest in motor vehicle mechanics before the treatment (experiment). This is likely attributed inappropriate method of teaching as observed by Paden and Dereshiwsky (2007) and Omenka (2010) attributed the low achievement and interest rate in technical students to conventional teaching method mainly adopted by teachers. The conventional methods of teaching which are teachers centered that is persistently used for years is now gaining poorer results when compared with the modern and revolutionary teaching methods (Jackson, 2012).

The study also revealed that motor vehicle mechanics interest inventory after treatment was high (mean 3.68). This implies that motor vehicle mechanics interest inventory was influenced by the treatment. Therefore, experimentation (constructed motor vehicle engine model) had significant effect on interest of the students. The findings of this study is in line with the opinions of Ogwo and Oranu (2006) who laid emphasis on the need for teachers to use stimulating strategies which lead to better retention of subject matter without which students' achievement will be minimal. Interest is a persisting tendency to pay attention and enjoy some activities (Jimoh, 2010).

The study also discovered that constructed petrol engine model has positive effect on the achievement of motor vehicle mechanics students in technical college. To support this finding is Neekpoa (2007) who opined that as technology is changing, the auto-technicians must change with the technology so that the level of their thinking in dealings with various diagnoses, repairs, and maintenance of motor vehicles should be commensurate with maintenance need of today's automobile. In other words, students need to be equipped with higher order thinking skills for easy adaptability. The best way to make learning more concrete is to make use of real objects and in some situations, real object may either be too large or complex that hidden details are obscured. This situation arises in the study of some aspects of automobile. The study also revealed that interaction of treatment and gender has no effect on the achievement of motor vehicle mechanics students in technical colleges. This finding is in contradiction with the opinion of Jimoh (2010) who affirmed that it is pertinent that auto-mechanics teachers should use teaching strategy which ensures gender active involvement in learning.

Conclusion

The study concluded that experiment (constructed motor vehicle engine model) has significant effect on motor vehicle mechanics students interest. Constructed petrol engine model has positive effect on the achievement of motor vehicle mechanics students in technical colleges; interaction of treatment and gender has no effect on the achievement of motor vehicle mechanics students in technical colleges. Therefore, teachers should make use of real objects.

Recommendations

Based on the findings of the study, the followings are the recommendations:

1. The constructed petrol engine model should be used in teaching and learning of petrol engine lesson in technical colleges in Borno State

2. Government should encourage the funding of construction of petrol model for the purpose of enhancing teaching and learning of motor vehicle mechanic course in technical colleges across the State.

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Design of Electrical Distribution Network for 500 Housing Units

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Abstract: *This work deals with the design of electrical distribution network for 500 housing units. The distribution system is designed to be overhead line, because it is cheap and tapping can be conveniently made at any time. A load estimation method was used for estimating an adequate transformer capacity with consideration of future expansion in load demand in the nearest future while the same transformer and other substation equipment will still be considered relevant and reliable. The overhead line accessories such as the pole, conductors, insulators, cross arms stay insulators and stay wives are also designed to suit the area. The transformer ratings are design to be four number of 500 KVA (11/415V). The system is also designed to carry the load imposed upon it without damage to the conductors. The system can also meet the load variations which are likely to arise in near future and provide continuity of supply.*

Key words: *load estimation, transformer rating and overhead line accessories*

1.0 INTRODUCTION

Electricity is the most convenient and useful form of energy. Without it the present social infrastructure cannot be feasible. The increasing per capital consumption of electricity throughout the world reflects a growing standard of living of people (Pablo, 2000) and the optimum utilization by society of this form of energy can be ensured by effective supply and distribution system. Distribution system differs from transmission system in several ways. Apart from voltage magnitude, the number of branches and source is much higher in distribution system and the general structure topology is different. Transmission is normality implied, the bulk transfers of power by high voltage between main load centers. Distribution on the other hand is mainly concerned with the conveyance of power of consumer by means of lower voltage network.

Due to expansion in the use of electricity, the demand on the distribution become greater and more complex. Therefore, the distribution network are designed to be able to carry the load imposed upon it without causing excessive heating in the consumers conductor and consequent damages to the insulator. The voltage drop through the network must be kept to minimum so as to maintain the voltage at the customer terminal within specified units (i.e 6% of the nominal value) whatever the loading conditions [NKPA

electricity distribution manual 1977]. Electrical wiring is one of the major parts of building construction. Electrical wiring is the connection of electrical accessories such as: sockets, lamp holder, distribution boards, fuses or cutouts, ceiling rose, etc. with electrical wire or cable of the appropriate rating. According to Electrical Engineering Portal (EEP), wires used in electrical wiring are normally coded with colour codes for easy identification. In electrical wiring, current entered a circuit through the hot (live) wire (usually red color) and returned along neutral wire (Uguru, and Obukoeroro, 2020). An electrical circuit is a continuous loop, which carries electricity from the mains (e.g. distribution line), throughout the house, then returns it back to the mains. Switches and other electrical appliances are usually connected to a single electrical circuit (EEP, 2020). Electrical wiring are done by trained professionals, but in some countries like Nigeria, due to lack of skill workforce, people with informal education, commonly called “engineers” within the locality, are mainly employed to carry out the electrical wiring of buildings. The utilization of substandard electrical materials or wrong connection of the circuit is very dangerous, as it can lead to electrical fires or breakdown of the system. Electrical fires are fires comprising the potential energization of electrical appliances and accessories. Electrical fires are mainly caused by either over-loading of the circuit or short-circuiting the system (Fair, 2014). Safety of human lives and materials in residential, administrative or commercial buildings is of high priority to every country. Electrical fire has become a serious threat to the life and materials in residential and commercial buildings (Madueme, 1997).

The paper is aimed at designing an electrical distribution network for the newly completed 500 housing estate. Toward the development of the area, power demand is necessary. Consideration is given to the future expansion of the area, also the maximum load demand of the Varian load centers and the effective maximum demand (i.e the total maximum load demands required by the consumers) are conserved for successful.

2.0 Methodology

This chapter deals with how the electrical distribution network for 500 housing unit was designed, the distribution network was also designed to be overhead type which technically suit the area. The type of line support and their accessories are also designed to the technical standard. Distribution substation is also designed to receive energy from a higher voltage system, convert into a form suitable for local distribution.

2.1 LINE SUPPORTS

For the purpose of this project, a steel reinforced concrete pole was designed, the poles were designed to be 8.5m length for the low voltages and 10m length for the high voltage line.

The span length for the low voltage lines was designed to be 40m while that of high voltage line was designed to be 50m, this is to avoid the difficulties of terrains, urban development and natural hazards.

The reinforced concrete pole have the advantage of longer life, shattering tendency when hit by vehicles and can be used in areas that have high humidity

2.2 ACCESSORIES OF OVERHEAD LINES DESIGNED FOR THESE PROJECT ARE:

i. CROSS-ARM

A hot dip galvanized cross - arms are designed for the project, the length of the cross - arm should be 1.63m long and, the bolts and nuts of 5mc and 8mc respectively should be used.

The hot dip galvanized has the following advantages:

- a. It has longer life.
- b. They cannot be attack by termites
- c. They are stronger than the wood types.

ii. INSULATORS

For the insulation of the distribution lines, use shall be made of porcelain insulators as specified in B.S. 137.

The Disc type insulator of approximately 254mm in diameter, 6.3kg In weight and mechanical failing load of 10.6KN should be used for the high voltage lines.

Also for the low - voltages a single groove type shackle insulator of 76mm in diameter, 0.4kg in weight with a mechanical failing land of 19KIM should be used.

iii. CONDUCTORS

Conductors used are aluminum conductors (AAC), conductors shall be 50mm² and 100mm² in size for the high voltage and the low voltage respectively. Base conductors shall be used in normal conditions, conductors shall be hard-drawn aluminum twisted wires made of aluminum for electric purposes. However, it major advantage is that it is cheaper than copper.

2.3 Design of Electrical Installation for Buildings

The total load was used to determine the actual size of the transformer required for the area.

According to IEE Regulation A30 - 36, that the cables supplying lighting load need only be rated for 50% of the full load current.

The diversity factor is taken into consideration due to the fact that the likely-hood of all the domestic installation been ON at the same time is remote, hence it reduces imbalance in the lighting loads. (George G. 1975).

Finally, the diversity factors suggested in the I.E.E regulations A27 & A28 are:

1. Lighting circuit is 65%
2. 13A socket outlet is 65%
3. 15A socket outlet is 80%

4. Electric Cooker is 65%

The breakdowns of the load demand are as follows:-

The total lumens is given by

$$\theta = E \times A / n \times p \quad (1)$$

Where E = is the illumination in lm/m²

A = is the Area of working plane to be illuminated in m²

p = Maintenance factor

n = utilization factor.

Using the standard table of installation (T. G. Francis 5th edition).

P = 0.8 for bedrooms and living room.

n = 0.5 for bed rooms and living room.

E = 40lm/m² for Bedrooms and living room. Lumen/watt for (4 x 4)m² size = 10lm/w.

Now, for Bedrooms;

a) Two Bedrooms Flat: There are 350 two bedroom flats, the load demand of single 2-bedroom was calculated and multiplied by 350 to give the total load demand of the flats.

i. For the bedroom with size (3.5 x 3.5)m², the following standard were obtained using electrical installation IEE standard table (M. A. Laughton, 2003). As stated in (A) above.

P = 0.7

n = 0.5

E = 40lm/m²

$$\theta = \frac{E \times A}{n \times p} = \frac{40 \times (3.5 \times 3.5)}{0.5 \times 0.7} = 1400lm$$

The total watt required = 1400lm/12lm/w = 116.7w

Therefore, 116.7/60 = 1.9 = 2 lamps of 60w for each bedroom

ii. For the living room with size (4.5 x 4.5)m², it has the following data.
Lumen/watt = 13lm/w, n = 0.5, E = 40lm/m², p=0.7

$$\theta = \frac{E \times A}{n \times p} = \frac{40 \times (4.5 \times 4.5)}{0.5 \times 0.8} = 2314lm$$

The total wattage required = 2314.3lm/13lm/w = 178w

Therefore, $178/60 = 3$ lamps of 60w.

- iii. For the kitchen, toilet, Veranda and security light, eight numbers of lamps was designed. That is, totaling to 15 lamps.
- iv. Six number of 13A socket, each of 100w was designed.
- v. Two number of ISA socket, each of 1500w was designed.
- vi. Three number of ceiling fan, each of 80w was designed.
- vii. One number of electric cooker with 1200w rating.
- viii. One number of water heaters with 8000w rating.

b) **One Bedroom Flat:** there are 150 one bedroom flats, the load demand of single one bedroom was calculated and multiplied by 150 to give the total load demand of the all flats.

- i. For the bedroom with size $(3.5 \times 3.5)m^2$, the total number of wattage required was the same with that of two bedroom, since they have same size, hence the same illumination was required.

- ii. Therefore, two lamps of 60w each was designed.

- ii. For the living room; with size $(4.2 \times 4.2)m^2$, the following data's were extracted from the standard installation table.

Lumen/watt = 17lm/w, $n = 0.5$, $E = 40lm/m^2$, $P = 0.8$,

$A = (4.2 \times 4.2)m^2$.

From:

$$\theta = \frac{E \times A}{n \times p} = \frac{40 \times (4.2 \times 4.2)}{0.8 \times 0.5} = 1764lm$$

The total wattage required = $1764lm/17lm/w = 103.76w$

Therefore, $103.76w/60 = 3$ lamps.

Hence, the living room was designed with two lamps of 60w each for it illumination.

- iii. For the kitchen, toilet, veranda and security lights, the number of lamps designed was 8 lamps of 60w each.
- iv. Five number of 13A socket outlet, each of 100w was designed.
- v. One number of 15A socket outlets, each of 1500w was designed.
- vi. Two number of ceiling fan, each of 80w was designed.
- vii. One number of electric cooker, rating 8000w was designed.

viii. One number of water heater ratings.

2.4 Design of Distribution Transformer

The distribution transformer were design based on the load demand of the area and the breakdown of the load demand are presented below.

Table 1: Maximum required for single two bedrooms.

Load	Wattage (W)	Total (Kw)	Diversity factors (%)	Maximum load Demand (KW)
Lightings	15 x 60	0.9	65	0,59
13A socket outlets	6 x 100	0.6	65	0.3
15A socket outlets	2 x 1500	3.0	80	2.4
Ceiling Fan	3 x 80	0.24	-	0.24
Cooker	1 x 8000	8.0	65	5.2
Water heater	1 x 1200	1.2	-	1.2

Maximum load = 9.9kw

Therefore, the total maximum load demand for the 350 two bedroom flats will be; $9.9 \times 626 = 3465\text{kw}$.

Sub-total (1): 3465kw

Table 2: Maximum required for single one bedrooms.

Load	Wattage (W)	Total (Kw)	Diversity factors (%)	Maximum load demand (KW)
Lightings	13 x 60	0.78	65	0.51
13A socket outlets	5 x 100	0.5	65	0.325

ISA socket outlets	1 x 1500	1.5	80	1.2
Ceiling Fan	2 x 80	0.16	-	0.16
Cooker	1 x 8000	8.0	65	5.2
Water heater	1 x 1200	1.2	-	1.2

Maximum demand = 8.595kw.

Therefore, the total maximum load demand for the 150 one bedroom flats will be;

$$8.595 \times 150 = 1288.5\text{kW}$$

Sub-total (2) = 1288.5kW

c) Load Requirement of the Other Building

v. For the primary school, the required maximum load is 7.5kw i.e **subtotal (3) = 7.5kw.**

vi. For the Boreholes, the required maximum load is 180kw. i.e **subtotal (4) = 180kw.**

vii. For the street light the required maximum load is 15kw. i.e **sub-total (5) = 15kw.**

viii. For the fire-service office, the required maximum demand is 2.5kw. **sub-total (6) = 2.5kw**

Therefore, the total maximum demand of the whole units will be total maximum demand of all load centres, i.e Total maximum demand of sub (1) + sub (2) + Sub (3) + Sub (4) + Sub (5) + Sub (6) = **3465kw + 1288.5kw + 7.5kw + 180kw + 15kw + 2.5kw = 11220.47kw.**

Grand total = 4958.5kw.

Now, power = $3VI \cos \theta$ where θ is the power factor and is taken as 0.85.

$$\text{Therefore, } IV = \frac{\text{Total Power in kw}}{3 \cos \theta} \quad (2)$$

$$VI = \frac{4958.5}{3 \times 0.85} = 1944.51\text{kw}$$

Where VI, is the KVA which determines the sizes of transformers to be used.

The total KVA = 1944.51kw. Now, it is designed to use **4 x 500KVA** transformers.

2.5 TRANSFORMER LOCATION AND ITS LOADING CONDITION.

Distribution transformers are output rated, then can deliver their rated KVA without exceeding temperature rise limits when following condition are applied (ABB, 1995).

- a. The secondary voltage should not exceed 105% of rating.
- b. The load factor should be $> 80\%$.
- c. The frequency should not be $> 95\%$ of rating. Transformers are to be located at the centre of load so as to minimize the losses and maintain quality supply to a consumer.

Each transformer is designed to carry 440.0184 KVA, therefore it should be placed at the load centre even though the loads are not evenly distributed.

2.6 SUBSTATION

i. TRANSFORMER

A step-down transformers of ground mounted outdoor type was designed. The high voltage sides and low voltage side of the transformers shall be fitted with cable boxes in accordance to B.S 2562 part equipment.

They shall allow connection of 50mm² paper insulated copper cables on high voltage side and 150mm² PVC insulated copper cables on low voltage side.

The Cable size was designed considering the rating of the transformer. According to IEE regulation 7M, 50mm² copper cables should be connected on the high voltage side and 150mm² copper cables should be connected on the low voltage side.

ii. LIGHTING ARRESTERS

For each transformer, there lighting arresters shall be installed in order to protect the system from high voltage surge due to lightning.

They should be attached to the high voltage side of this transformer and these arrangement will send any over voltage which falls on the system due to lightning to the ground directly.

iii. DROPOUT FUSES

The dropout fuses shall be of cross arm mounted type with such construction as shall allow opening and closing operation of the contact safely by an operating rod. Its construction shall be such that after this operation of the fuses shall construct as shall allow opening and closing operating of the contract safely by an operating after the operation of the fuses, the primary and secondary will be disconnected from each other and complete insulation will be maintained. Fuse intended for the dropout fuse switch shall be mounted on the switch and shall meet the rating capacity of 100MVA in the case of short circuit failing on the transformer side.

iv. EARTHING:

According to (Anthony J., 2006), the neutral conductors of low voltage shall be earthed at the supply point and each and every terminal as well as at interval of 250m along the distribution line route. The earthing shall be covered copper conductor and its cross-section shall be less than 25mm. Earthing rods shall be used to serve as earthing electrode, each earthing rod 2.5cm in diameter and 1.8m in length.

v. FEEDER PILLAR REQUIRED FOR THE LOW VOLTAGE LINE

Four feeders shall be provided for the four low voltage line. The feeder pillars should be water proofed and installed. Each pillar should contain:

- i. 3-fuse set, 3-phases and a neutral for overhead line feeders,
- ii. 1-fuse set, 3-phases and a neutral for input cable from transformer.

According to (Fringsby L. L. 2001), the incoming and outgoing cable should allow connection to 150mm copper cables on the transformer side and 70mm copper cable on the side feeder side. Therefore, each transformer shall be provided with its feeder pillar.

2.7 CONSTRUCTION OF SUBSTATION

According to (NEPA Manual, 1977), the foundation which the transformer is to be installed shall be composed of an upper concrete base 20 to 25cm in thickness and wider than the transformer bottom by 10cm, reinforced by the steel wire 10mm in diameter placed cross-wise at a depth of 5mm below the surface.

A lower concrete base wider than the upper one by 10cm shall be constructed, there under a layer of stones of 150 to 200mm in diameter, 30cm thickness shall also be placed. Substation shall be constructed away from any such places;

- i. Along heavy traffic road where motor cars are likely to collide.
- ii. Where the soil is soft,
- iii. Where people are frequent,
- iv. As is likely to be flooded.

2.8 PROTECTION REQUIREMENTS

(i) According to I.E.E Regulation A8-A10, every consumer's installation supplied from an external source shall be adequately controlled by protection equipment accessible to consumer, the protection equipment should incorporate:

- i. Means of Isolation
- ii. Means of excess current protection.

Circuit breakers were designed for the protection of excess current every conductor in the installation is to be protected by a circuit breaker fitted at the origin of the circuit.

The current rating of the circuit breaker should not exceed the current rating of the lowest rated conductor in the protected circuit.

- (ii) Earthing: According to IEE Regulation D1, every conductor shall be prevented from giving rise to earth leakage current by earthing of exposed metal parts. For this purpose of this project, it was designed that all conductor are earth to ground using earth electrode.

3.0 Results and discussion

Based on the design of this project, the following results were obtained.

Table 2: Results for overhead line Design

S/N	ITEM	TYPE	SPECIFICATION
1	Line Support	Concrete Poles	10m long -H.T 8.5m long - LT.
2	Cross-Arm	Hot-Dip Galvanized Cross-arm	1.63m Long
3	Insulator	Disc Insulator Shackle insulator	254mm diam. 76mm diam.
4	Conductor	AAC	50mm ² - H. T. 100mm ² - L. T.

From table 2 above, it can be seen that concrete poles were designed for the project, wooden poles are rather short in service life because they are inapplicable in place that have higher humidity and liable to be affected by insects or animals. It can be concluded that concrete poles have advantage over wooden poles.

Although pin type insulators are also available but because of it low level of insulation, disc type was used as specified by B.S 137.

All aluminium conductors of 50mm² were designed for the high voltage line while 100mm² was designed for the low voltage line. Aluminium was used because of it cheapness and easy to machine handle.

Standard cross-arms shall have a size of either 1.63 or 2.24m. for places that require span length size cross-arm will be used, but for the purpose of this project which the span length is not more 80m, 1.63 size was designed.

Table 3: Maximum load demand for whole unit.

S/N	BEDROOM FLAT/OTHER	TOTAL LOAD DEMAND (KW)
3.	Two Bedrooms	3465
4.	One Bedrooms	2388.5

5.	Primary school	7.5
6.	Boreholes	180
7.	Street light	1.5
8.	Fire services	2.5
9.	Transformer Designed	4 x 500KVA

The total load demand for each unit was calculated in table 1.6 above. This load demand was added to have maximum load demand for the whole unit. The transformers designed for the whole unit was obtained by considering this maximum load demand of the area. It can be concluded that ten number of 500KVA transformers was designed for the purpose of this project.

CONCLUSION

The objective of the design is to provide electrical power supply to 500 housing units, because the optimum utilization by society of electrical energy can be ensured by effective supply and distribution systems. Also, electricity is the most convenient and useful form of energy, without it the present social infrastructure cannot be feasible, hence there is a need to electrify the area.

The designed network of the area can carry the load imposed upon it without excessive heating in the conductor and consequently damages to the insulation. The voltage at the consumer terminal is kept within the specified limit (i.e 6% of the nominal value). (NEPA Manual, 1975)

The system as designed can meet the load variations which are likely to arise in near future and provide continuity of supply and should a fault occur on the system, interruption in the supply to the consumers should last for a shortest possible time. The system is very simple to maintain and operate and routine maintenance should be carried out with minimum interruption to power supply.

From the above results, it can be concluded that the system is quite reliable. Since the reliability of any good designed system depends on efficient control equipment such as circuit breakers, lighting arresters, fuses etc., hence it becomes necessary to incorporate in this design to obtain reliable system. The overhead lines distribution and the electrical installation designed for this project will suite the area, because it is cheaper and easy to maintain.

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Effect of Treatment on Mechanical Properties of *Irvengia gabonensis* Shell Fiber Reinforced Polypropylene Composite

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Abstract: *The problems associated with the use of synthetic fibers cannot be over emphasized; they are costly and non-environmentally friendly. Hence, there is need to explore other alternatives. An Irvengia gabonensis fiber and shell particles reinforced polypropylene composite was produced and its mechanical properties were studied. Effect of treatment of the fiber and the shell particles on the mechanical properties of the composite has also been studied. The study revealed that the treatment of the fiber and shell particles can influence the mechanical properties of the composite.*

Key words: Polypropylene, *Irvengia gabonensis*, Shell, Particles

Introduction

Fiber is a class of material that is a continuous filament or discrete elongated pieces, similar to the lengths of thread. They can be spun into filaments, rope or string. The two main sources of natural fibers are plants and animals. The main component of animal-based fibers is protein (Shubhra *et al.*, 2010): examples include; wool, silk, alpaca, angora, and so on. The major components of plant fibers are cellulose microfibrils, lignin and hemicelluloses: examples include; cotton, jute, flax, ramie, sisal, hemp, and so on. Fiber reinforced composite materials are classified as important engineering materials. This class of materials offers outstanding mechanical properties and their composite are easy to fabricate. The plant fiber has been in used as reinforcement in composite materials since 3,000 years ago; the Egyptians used straw to reinforced clay to build walls. However, the current application of plant fiber in composites is mainly non-structural components with a random fiber orientation used by the automotive and building industry (Broge 2000; Clemons 2000). Composites made from synthetic fibers such as glass, graphite and aramid are commonly used in wide range of applications ranging from aerospace structure to automotive parts and from building materials to sporting goods (Arib *et al.*, 2006). FRPCs find applications in construction industries, decking, window and door frames, sports

equipment such as bicycle frames, baseball bats, exercise equipment, and so on sports equipment such as bicycle frames, baseball bats, exercise equipment, and so on. They are also suited for many automotive applications (Bledzki and Gassan 1999). For construction purposes jute PP composite can play an important role all over the world. Jute polypropylene composite can be used for interior design, particle board, ceiling, and construction purposes. Instead of importing particle board and cement we can use jute Polypropylene composite (Siddika *et al.*, 2014). However, the development of natural fiber reinforced composites becomes an attractive research area and a possible substitute for synthetic fiber composites due to the non-recyclability; high density and health hazards associated with composites reinforced with synthetic fibers such as glass, carbon and aramid fibers (Corrales *et al.*, 2007). Natural fiber is a long filament which can be obtained from plant, mineral or animal sources. Among the above three classification, plant fiber represent more than 95% of the total volume of natural fibers worldwide. As a result, the term “natural fiber” usually refers to the natural fibers from plant origin. The performance of fiber reinforced polymer composite (FRPCs) depends on the constituent materials. The length of reinforcing fiber and fiber content are the two important factors affecting the mechanical properties of a fiber-reinforced composite. A lot of research has been done on plant fibers (such as flax, hemp, jute, bamboo, coir, etc.) as reinforcement for composite materials due to their renewable nature and good mechanical properties. These properties depend to larger extent on the structure and chemical composition of the fiber. However, environmental conditions and age are factors that affect the structure and composition of plant fiber and their mechanical properties. The performances of Short-Carbon-Fiber-Reinforced Polypropylene Composite for Car Bonnet composites were compared to the standard steel material applied and were found to be a viable replacement option. Nadir *et al.* (2011) found in their study that the optimal composite panel formulation for automotive interior applications was obtained from a mixture of 60 wt % the coir fiber, 37 wt % the PP powder, and 3 wt % the MAPP. Doan *et al.* (2006) investigated the effect of maleic anhydride grafted PP (MAPP) coupling agents on the properties of jute fiber/PP composites. They observed that addition of 2wt% MAPP to PP matrices improved the adhesion strength with jute fibers and the mechanical properties of composites. Girone's *et al.* (2007) studied the PP-based composites, reinforced with surface modified pine fibers. Tensile modulus increased only by 12% after incorporation of untreated fibers to PP matrix. Despite the fact that a lot has been done on natural fiber reinforced polymer composites, there remains a wide gap to be filled in that area. This is owing to fact that there are abundant natural fibers that are not exploited as reinforcement for polymer composite. Among the natural fiber that are not exploited or less exploited is *Irvengia gabonensis* shell fiber. This plant can be found abundantly in every part Nigeria and in fact other countries in Africa but use of the waste from the fruit of this plant is scanty. Therefore, there is need to further device way of using this agricultural waste in way that is beneficial to the human kind.

Methodology

Materials/Equipment

Materials

- *Irvengia gabonensis* fruit remnants collected from various gardens in Maiduguri and Jere local government areas of Borno state
- Polypropylene
- Sodium hydroxide (NaOH) solution
- Distilled water

Equipments

- Universal Testing Machine
- pressure compression molding machine of 30tonn capacity
- Two roll mill
- An impact testing machine
- Digital weighing balance
- Thermometers
- Specimen mould
- Razor blade

Methodology

Method used involved the extraction of the fiber and shell from *Irvengia gabonensis* fruit. This was followed by washing the fiber and shell with water and then dried them. The fibers and the shell prepared thus were further treated with NaoH. The fiber, shell and the Polypropylene formulations was done in such a way that the proportion of fiber and shell particles loading to Polypropylene was continuously varied by 10wt% up to 40wt%/60wt fiber/shell and Polypropylene. The formulation was mixed using two roll mill one after the other, at 40 rpm processing speed and 190°C. The blends were then used to make test sample plates through compression molding. The specimens were produced according to ASTM standards, as this determines the dimensions of the specimens.

Result and discussion

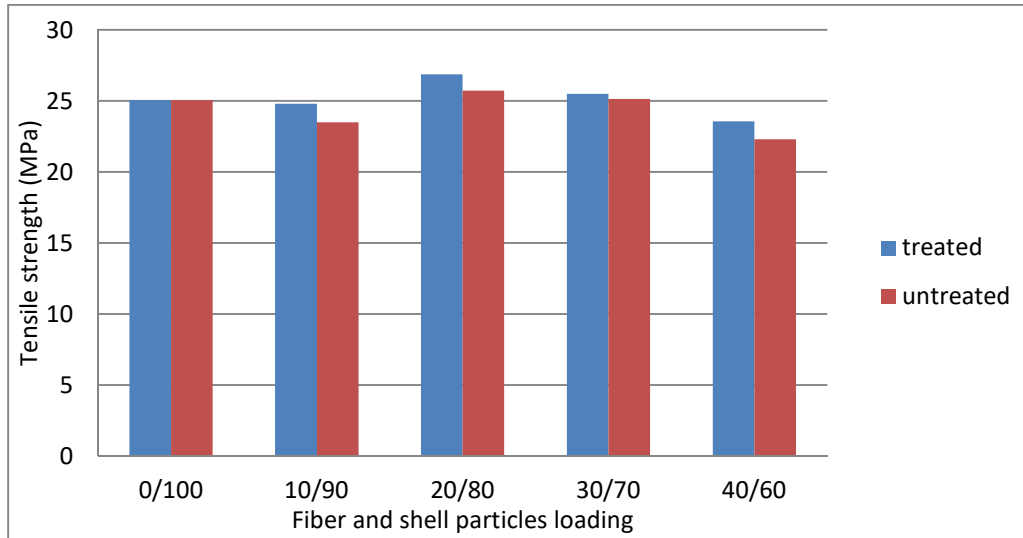


Figure1: Tensile strengths of treated and untreated Bush-mango fiber and shell particles reinforced Polypropylene composites at different fiber and shell particles loading

Figure1 shows the tensile strengths of treated and untreated *Irvengia gabonensis* fiber and shell particles reinforced polypropylene composites at four different fiber and shell particles loadings. At 10wt% fiber and shell particles loading, there was drop in tensile strengths. This is due to poor concentration of the fiber and shell particles in the composite but as the loading increased to 20wt%, increase in the tensile strength was observed in both composites. However, the tensile strength of the composite made from treated fiber and shell particles were higher than those made from the untreated fiber and shell particles.

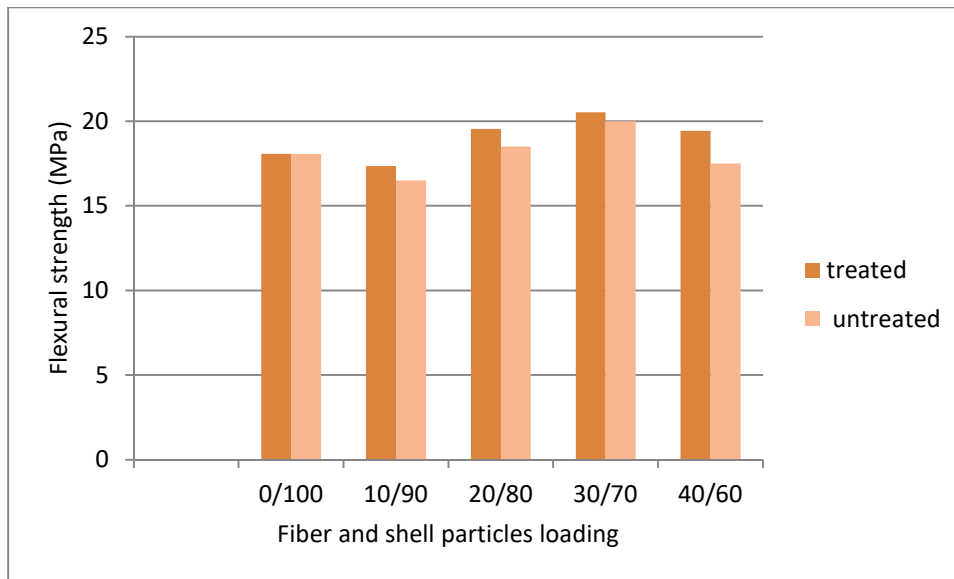


Figure 2: flexural strengths of treated and untreated Bush-mango fiber and shell particles reinforced Polypropylene composites

It can be seen from figure 2 that the maximum flexural strength was recorded at 30wt % fiber and shell particles loading in both cases. Increase in flexural strength was also observed at 20wt % but is not as high as that of 30wt % fiber and shell particles loading. It can also be seen that the flexural strength of the treated fiber and shell particles reinforced composite in all the four different loadings were higher than those of the untreated fiber and shell particles reinforced composite.

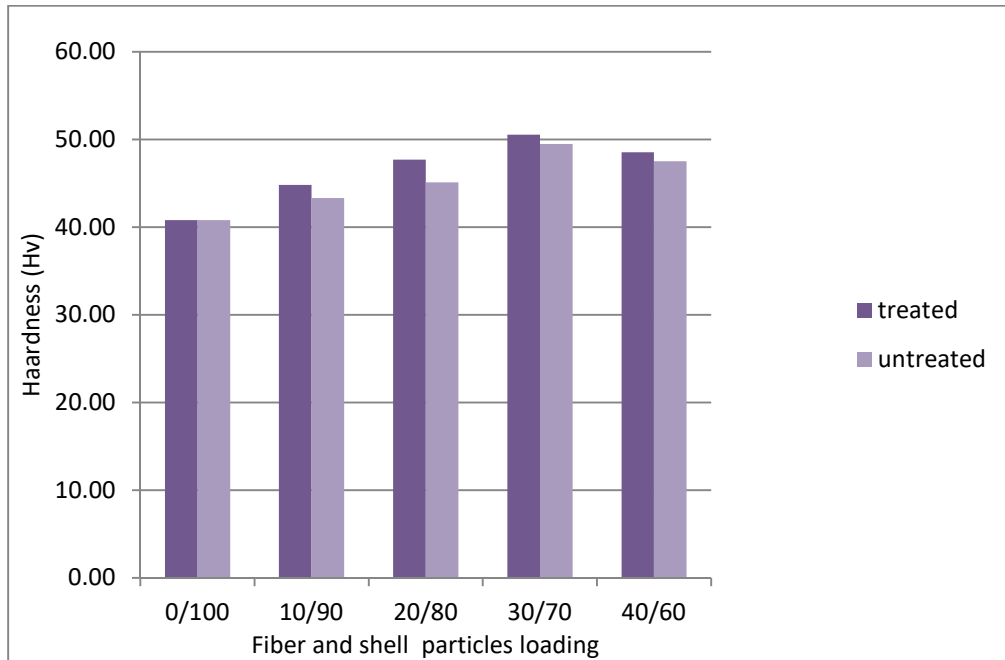


Figure 3: Vickers's hardness of treated and untreated Bush-mango fiber and shell particles reinforced Polypropylene composites

Figure 3 shows hardness of the two composites, the hardness increases as the fiber and shell particles loading increases up to 30wt % loading beyond which the property declined. It can be observed that the incorporation of fiber and the shell particles led to increase in the hardness of the composites in all the formulations. The effect of treatment of the *Irvengia gabonensis* fiber and shell particles has also been seen.

Conclusion

The fiber and shell particles of *Irvengia gabonensis* can be used as reinforcement for polypropylene matrix to produce natural fiber reinforced composite. It was also found that the NaOH treatment and varying the proportion of fiber and shell particles to Polypropylene can influence the mechanical properties of the composite. The composite produced can be used for interior applications such as partition wall.

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Design and Performance Evaluation of Pico Hydropower Generation

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Abstract: *The study carried out design and performance evaluation of Pico Hydropower generation. A Pico hydro power plant is a green energy that consumes small streams to generate electricity without depends on any source of non-renewable energy. To accomplish the design and evaluation of the system, water was harvested from rooftops during rainfall and channeled into a tank on a stand at the side of the story building the tank discharges water through a pipe to the nozzle which then narrows the flow of water to the Pelton turbine as the water jet from the nozzle hits the Pelton turbine, it produces power to the shaft connected to the electric generator which then produces electrical power. The Pico size hydropower system directly connected to a small variable speed an electric generator which is capable of supplying the power needed for minimal but very essential like phone charging, however, the position of water being storage tank is mainly at the uppermost in the building, storage water potential energy is connected into kinetic energy. The Pico scale power systems performance was investigated using excel spreadsheet where all the mathematical expressions were programmed and the efficiency was varied to obtain the efficiency. The operating efficiency was found to be within the range of 50% and 80% while the Pico hydro generator produces power between 300W and 1000W with the generator running at about 70 r.p.m by estimation.*

Key words: *Efficiency, Generation, Hydropower & Pico*

BACKGROUND OF THE STUDY

A Pico hydro power plant is a green energy that consumes small streams to generate electricity without depends on any source of non-renewable energy. It is used for hydroelectric power generation of under (5KW) these generators have proven to be useful in small, remote communities that require only a small amount of electricity and also fore front of these option because it is considered as the most cost-effective to provide electricity for rural areas, and to enable energy to be derived from extremely low head and how streams of IL/s respectively.

Pico hydro is a term used to distinguish very small scale hydropower with a maximum electrical output of five kilowatts (5 KW) it is good technique of providing electricity to the off-grid remote and isolated regions that suffer energy deficit. Typical Pico hydro generator is designed and supported by electrical converting system, battery and safety equipment so that it can be installed at the at the

residential water pipeline. In Pico hydropower generation, the environment impact is negligible since large dams are not involved, and the schemes can be managed and maintained by the consumer

STATEMENT OF PROBLEM

1. Pico hydropower plant, these are biomass and traditional source of energy used mostly in rural areas and also renewable energy which develop in capital intensive and take time to develop (financial cost however, despite its high upfront costs it is sustainable and reliable. in line with grid connection, it can supply power to hundreds.
2. Financial constrain and time to develop the maintenance of pico hydropower plant.
3. Pico hydro power plant, the output is limited by local condition of height and amount of water available

MATERIAL AND METHOD

The water flowing area was figured out and the average power consumption of the place. the head and the flow rate of the water were also ascertained. Head was considered as the difference in elevation between the headwater surface of the storage tank above and the tail-water surface below the hydro-power plant. The flow rate of the water depends on the nozzle diameter, total length, number and type of fittings, the elevation head of the water tank and the difference in pressure head. Pelton wheel turbine was selected based on the available head and flow rate.

A Pico is the unit use of measurement in a metric system denoting of 10-12 Pico is a memories used to describe the four element of a good clinical fore ground such as P stand for population/patient, and problem, I stand for intervention, C stand for control/comparison, and O stand for output or outcome.

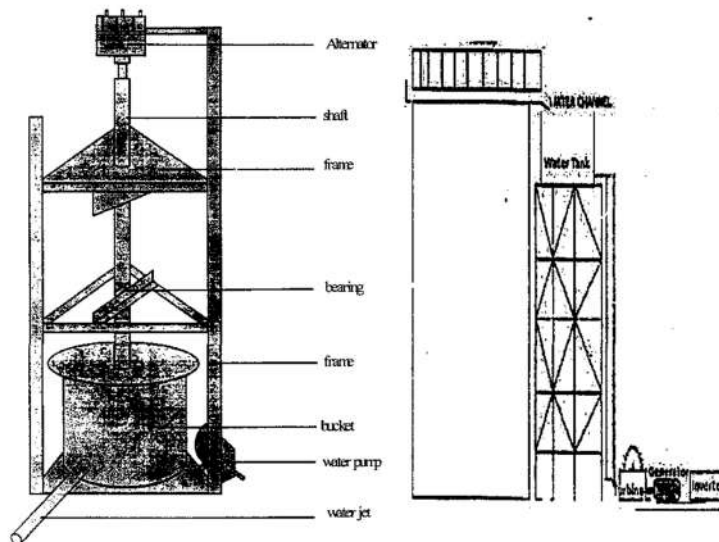


Figure 1: Schematic Diagram of Pico Hydropower System

THE MODEL PICO HYDROPOWER SYSTEM

Water was harvested from rooftops during rainfall and channeled into a tank on a stand at the side of the story building the tank discharges water through a pipe to the nozzle which then narrows the flow of water to the Pelton turbine as the water jet from the nozzle hits the Pelton turbine, it produces power to the shaft connected to the electric generator which then produces electrical power.

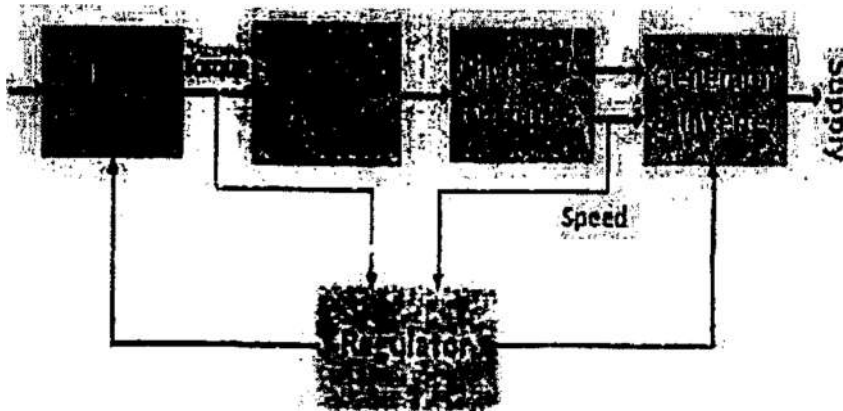


Figure 2: Block Diagram of Pico Hydropower System

SPECIFICATION OF THE MODEL PELTON WHEEL TURBINES COMPONENTS

The water falls from a head (H) at a flow rate (Q), the Pelton wheel run at a certain specific speed (N_s) to transfer torque (T) to the electric generator to produce power (P) the expected output produced by the system is power = 1000W. The distance from the base of the collecting tank to the jet nozzle was considered to be a head of 12m. Performance depends on hydraulic pressure and flow. The head is the energy per unit weight of water. The static head is proportional to the height difference of the falls. The dynamic height depends on the speed of the moving water. Each unit of water can do a lot of work, which corresponds to its weight multiplied by the head. The methodology used in this section is as adopted from earlier models of small hydro turbine power system

CALCULATION OF DIAMETER OF PELTON RUNNER

The power available from the waterfall energy was calculated from the flow and density of the water, the height of fall and the local acceleration due to gravity. In SI units, the performance in terms of Power expressed as:

$$P_{tj} = \text{density} \times \text{acceleration due to gravity} \times C^2 \times H \times Q$$

$$Q = \frac{1000}{(1000 \times 10 \times 0.982 \times 10)} = 0.0104 \text{ m}^3/\text{s}$$

Specific Speed, N_s of the turbine

$$N_2 = 25.49 \times n$$

$$(1000 \times 10 \times 0.982 \times 10) = 0.0104 \text{ m}^3/\text{s}$$

While; n_j = number of turbine nozzle = 1

$$N_3 = 65.3$$

N = Speed of the turbine

$$= N_s \times H^s / 4 / P_{ti}$$

$$= 65.3 \times 10^5 / 4 P_{ti}$$

$$= 36.72 \text{ rpm}$$

$$F(x) = N_3 + \sum (n_f)$$

$$n=1$$

$$N_2 = 85.49 \times n_j$$

$$H 0.234$$

Given Q = flow rate of the water from the head = $0.0104 \text{ m}^3/\text{s}$

D_r = diameter of pelton runner = $300 \text{ mm} = 0.3 \text{ m}$

And the diameter of jet D_j = $20 \text{ mm} = 0.02 \text{ m}$

CALCULATION OF WATER JET VELOCITY THROUGH THE NOZZLE

The expression for water jet through the nozzle with a velocity V_j in m/s is given as:

$$V^1 = C_{xx} \times 2 \times g \times H$$

$$= 13.86 \text{ m/s}$$

CALCULATING THE BUCKET DIMENSION

The expression for calculating bucket axial width is given as

$$B_w = 3.4 \times D_j$$

$$= 0.068 \text{ m}$$

The expression for calculating bucket radial length is given as

$$B_1 = 3 \times D_j$$

$$= 0.06 \text{ m}$$

CALCULATING THE BUCKET DEPTH

The expression for bucket depth is given as:

$$B_d = 1.2 \times D_j = 0.024\text{m}$$

CALCULATING THE NUMBER OF BUCKET

The expression of number of bucket is given as:

$$N_b = \frac{D_r}{2D_j} + 15 = 22.5$$

Here it is clear the use 22 buckets will make the Pico hydropower efficient for the proposed power generation of 1kw.

CALCULATING THE NOZZLE DIMENSIONS

The expression for water flow rate through the nozzle is given as:

The expression for nozzle area A_j is given as:

$$Q_n = V_1 \times A_1$$

The expression of nozzle area A_j is given as

$$\begin{aligned} A_j &= n \times D^2 \\ &= 1.257 \times 10^{-2} \text{ m}^2 \\ Q_n &= 13.86 \times 1.257 \times 10^{-2} \\ &= 0.0174 \text{ m}^3/\text{s} \end{aligned}$$

Given;

D_{pn} = diameter of penstock = 25mm diameter pipe.

D_j = diameter of water jet = 20mm = 0.02m

β = nozzle tapper at angle = 15

The expression for calculating nozzle length, L_n is given as:

$$L_n = \frac{D_{pn} - D_1}{\tan \beta}$$

CALCULATING OF BUCKETS DISTANCE BETWEEN THE RADIUS CENTER OF MASS TO THE CENTER OF THE RUNNER

The radius of bucket centre of mass to the centre of runner is given as:

$$\begin{aligned} R_{hn} &= 0.47 \times D_i \\ &= 0.141\text{m} \end{aligned}$$

CALCULATION OF THE FORCE ON EACH BUCKET

$$F_d = \rho w \times Q_n \times V^2$$

$$= 3342.53 \text{ J/V}$$

The required force in each bucket is:

$$F_{dy} = F_s \times \text{Safety factor}$$

$$= 3342.53 \times 3.5$$

$$= 11698.87 \text{ N}$$

CALCULATING THE MAXIMUM TURBINE EFFICIENCY

The expression for calculating input power to the turbines:

$$P_{ti} = \frac{\rho w \times Q_1 \times V^2}{2}$$

$$= 998.89 \text{ W}$$

And the power output generated by the turbine as:

$$P_{to} = \rho w \times Q_1 \times V_{ty} \times \{(V_1 + V_{ty}) (1 + \lambda \times \cos \beta_3)\}$$

Runner tangential velocity $V_{ty} = \frac{ND_y}{60}$

$$= 23.56 \text{ m/s}$$

RECALL, λ roughness coefficient of the bucket (0.98)

θ = Angle of Depletion between jet and bucket $180^\circ - \theta$

$$\theta = (160^\circ \text{ to } 170^\circ)$$

$$\theta = 180^\circ - 160^\circ = 20^\circ$$

$$P_{to} = 1000 \times 0.0104 \times 6.3756 \times (13.86 - 6.3756)(1 + 0.98 \times \cos 20^\circ)$$

$$= 457 \text{ W}$$

SHAFT

The overall efficiency η is assumed to be 70%, which is within the specification range.

Radial shaft velocity; $w = \frac{2\pi N}{60}$

$$= 60$$

$$= 157.08 \text{ rad/s}$$

Power = torque radial shaft velocity

i.e $P = T w$

$T = P/w$

$T = 1000/157.08 = 6.366 \text{ N/m}$

The working shear stress, $\theta = N/d^3$

Where d = diameter of the shaft,

Allowable working shear stress, θ Ultimate shear stress

Factor of safety

$M_1 = (M_1 \text{ is the maximum allowable torque})$

The specified ultimate shear stress for the mild steel shaft is 220mpa and the selected factor of safety is 15

$\theta = \frac{200 \times 10^6}{15} = 14667.67 \text{ N/m}^2$

15

$D = \frac{16 N_s}{\theta d} = \frac{16 \times 15}{14667.67}$

$D = 0.1733 \text{ m}$

Shaft diameter, $d = 173 \text{ mm}$

Therefore, $d = 200 \text{ mm}$ is used for design purposes

PARAMETER IN SUMMARY

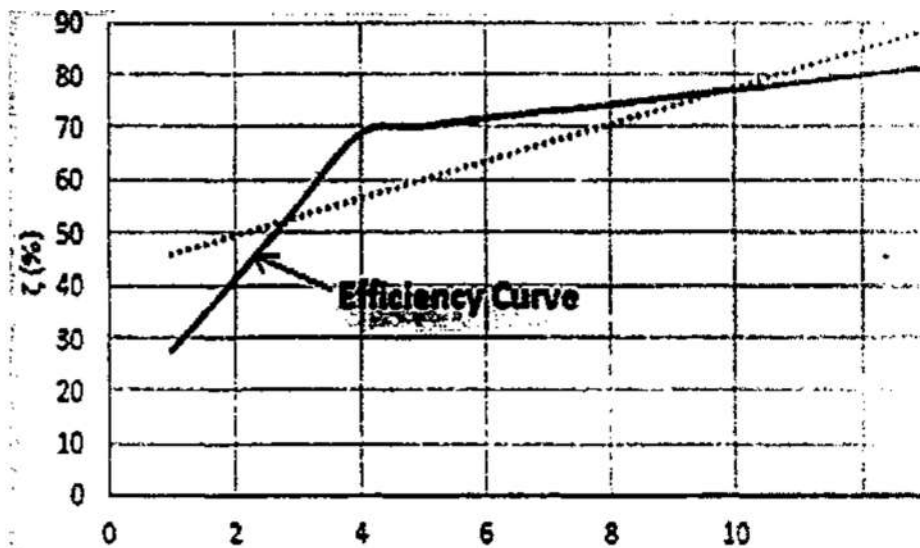
The summary of the calculated design parameters is as represented in table 1 below.

Table 1 parameters of the model Pelton wheel turbine as obtained from design calculation

Se/N	Parameters	calculated
1	Flow rate, Q	0.01403 m ³ /s
2	The velocity of the water jet through the nozzle	13.86m/s
3	The diameter of Pelton runner, Dr	0.3m
4	Bucket axial width	0.68m
5	Bucket radial length	0.06m
6	Bucket depth	0.024m
7	Number of bucket	22
8	The radius: centre of the bucket to the centre of the runner	0.141m
9	Runner tangential velocity	23.566m/s
10	Force on each bucket	11698.87N
11	Bucket roughness coefficient,	0.98
12 -N	Deflection angle between bucket and jet,	160 to 170
13	The torque produced by the shaft	6.366N/m

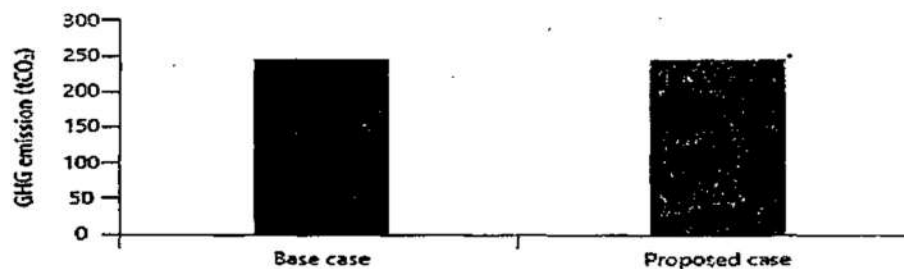
PERFORMANCE ANALYSIS

The Pico scale power systems performance was investigated using excel spreadsheet where all the mathematical expressions were programmed and the efficiency was varied to obtain the efficiency curve of the designed Pelton wheel assuming linearity and neglecting external forces that may be exerted on the system during operation. The operating efficiency was found to be within the range of 50% and 80% while the Pico hydro generator produce s power between 300W and 1000W with the generator running at about 70 r.p.m by estimation.



emission analysis

Base case electricity system (Baseline)		GHG emission factor (excl. T&D)	T&D losses
Country - region	Fuel type	kg CO ₂ /kWh	%
Nigeria	All types	0.433	7.0%
GHG emission			GHG emission factor
Base case	tCO ₂	245.5	kg CO ₂ /kWh
Proposed case	tCO ₂	198.9	0.465
Gross annual GHG emission reduction		46.6	



Gross annual GHG emission reduction (19%)

Estimate reduction in green emission for the design system

CHAPTER FIVE

CONCLUSION

A research work has been carried out on the construction of Pico hydropower generation plant the study has been successfully achieved. A Pico hydropower is a source that utilizes the mechanical energy of water strolling down from an elevated head an electric generator thus producing electricity, small hydropower turbines are rotated by a relatively low pressure head and usually generate low energy outputs therefore by design the run water from the building rooflines are collected and passed through down point into an elevated tank and then the height of the bottom of the tank gives the required head to spin the micro fund and then to generate a Pico level energy. The Pico size hydropower system directly connected to a small variable speed an electric generator which is capable of supplying the power needed for minimal but very essential like handset charging, however, the position of water being storage tank is mainly at the uppermost in the building, storage water potential energy is connected into kinetic energy.

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Assessment of Local Blacksmithing Industry in Maiduguri, Borno State Nigeria

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Abstract: *The study look at the necessity of finding out the challenges faces by the blacksmith industry in Maiduguri and suggest a possible ways of integrating/updating them. The blacksmithing industry popularly called ka'almari or Makera by its locals has been in existence over for long. The industry plays a vital role in providing job opportunity and the socio-economic development of the nation through the servicing of vehicles spare parts, carpentry tools, household utensils, and agricultural implements. This study assesses the performance of the blacksmithing industry of Maiduguri in Borno State, Nigeria. An interview and observation was considered best for this study because most of the respondents could not read and write. The study considered the standardized interview technique where questionnaire designed and asked verbally in a face-to-face to gather the needed information. Training, capacity building and education on the safety related issues is highly recommended, as such, safety engineers, safety officer and fire fighting officers need to visit the industry from time to time. The study strongly recommends a permanent site should be provided to all Small, Medium, and Micro-Enterprise and the blacksmithing industry.*

Key words: *Blacksmithing, safety, production, capacity building, raw materials*

1.0 Introduction

Blacksmith is an ancient indigenous technology which is the progenitor of various metals forging operation in use today and can be found virtually in all major culture of the world(Oke & Aderoba, 2000).Blacksmith are those individuals who manufacture certain product in metal and steel by forging. The blacksmith creates objects from wrought iron or steel by forging the metal, using tools to hammer, bend, cut, and shape it into useful product; blacksmith produce objects such as cooking utensils, tools, agricultural implements and local weapon. Blacksmith works primarily with wrought iron and steel. The "black" in "blacksmith" refers to the black fire scale, a layer of oxides that forms on the surface of the metal during heating. The word "smith" was also derived from an old word, "smite" (to hit): Thus, a blacksmith is a person who hits black metal (Bealer, 1996). Blacksmith is someone who uses fire to transform unprocessed object into object of utility and beauty, giving life to inert metal, to be specific iron. Blacksmith make metal objects by using tool such as hammer. They do this by heating metal in a fire (forge) until it is hot enough to bend and shape. When the metal is removed from the forge, it is hit with a

hammer until it takes on the shape the Blacksmith wants. The metal may need to be reheated several times during this process. Blacksmith produce functional products such as pot, racks and tools. They also produce architectural pieces such as gates and railings. Today blacksmith are creating artwork and sculptures. Most modern-day Blacksmith considers them to be artists rather than toolmakers.

Blacksmith products have been recognized in the country from time immemorial and its importance, as an enterprise cannot be contested as one of the local skill necessary for sustainable development. The skill was extremely important to early Arkansan, to make and repairs tools, automobile spare parts, household implements and weapons (Oyenenye, 1984). The potential of blacksmiths for serious application sometimes demonstrated under unusual circumstances is beginning to find commercial application in satellite town of Nigeria's urban centers where they serve as an adjunct to roadside mechanics (Aboh, et al 1995). Although the advent of the imported farm implements and machineries spare parts distorted the activities of local producers, the increasing scarcity of foreign exchange is now necessitating a change of direction to abandoned indigenous products (Obikwelu, 1999). Presently in Borno state the use of blacksmiths forge is minimal as in some local government area the use of smith forge is in existent: Therefore, the need to develop a smith forges to facilitate the blacksmith operation, off the entire requirement this study focus on the development of fuel-efficient blacksmith forge.

Blacksmith processes still remain primitive and rudimentary that it is hardly employed as a viable means of commercial production of metal wares in Nigeria (Thomas-Ogubuji, 1989). During a visit to some blacksmithing industries in Maiduguri Metropolitan Council, it was observed that the industries are lagging behind as well missing some basic requirements to produce qualitative products: These include; lack of safety, raw materials and lack of blacksmith forge this study focus on the development of fuel-efficient blacksmith forge.

This work aims to assess the performance of the blacksmith industries in Maiduguri, Borno state.

Blacksmith shops were considered as the hardware store, factory and repair shop: However, today's blacksmith faces some challenges, the created data bank would assist future researchers, the development of fuel efficient blacksmith forge should significantly improve the fuel economy and improve the production process.

1.1 Study area

This proposed study is expected to cover blacksmithing industries in Maiduguri Local Government council. Maiduguri also called yerwa by its locals is the capital and the largest city of Borno state in the northeast Nigeria. The city sits along the seasonal NgaddaBul River which disappears into the firki swamps in the area around Lake Chad. Maiduguri is a city found in Borno, Nigeria. It is located 11.85^olatitude and 13.16^olongitudes and it is situated at elevation 325 meters above sea level. Maiduguri has a population of about 1,112,449 making it the biggest city in Borno.(www.worldatlas.com/where-is-maiduguri). The data seek from government agencies such as cooperate appears commission (CAC), Raw Materials Research and Development Council (RMRDC), Federal Bureau of Statistics and Borno State Agric Mechanization. There are no data available to know more about their existing work and the government policies or roll on technological advancement of indigenous technology employed by the Blacksmith. During the field survey to the

Gamboru market, a total number of 430 members of Blacksmith were found out of which only one hundred and seventy agreed to be interviewed, that was obtained through a well structured questionnaire where some members of the Blacksmith choose to answer face-to-face and responded directly. The experimental data were obtained in a Blacksmith workstation during production of hoe, cutlass, knife and rake.

2.0 Data Collection Instruments

An interview and observation was considered best for this study because most of the respondents could not read and write. The study considered the standardized interview technique where questionnaire designed and asked verbally in a face-to-face to gather the needed information. (Catherine Adu, 2014)

3.0 Methodology

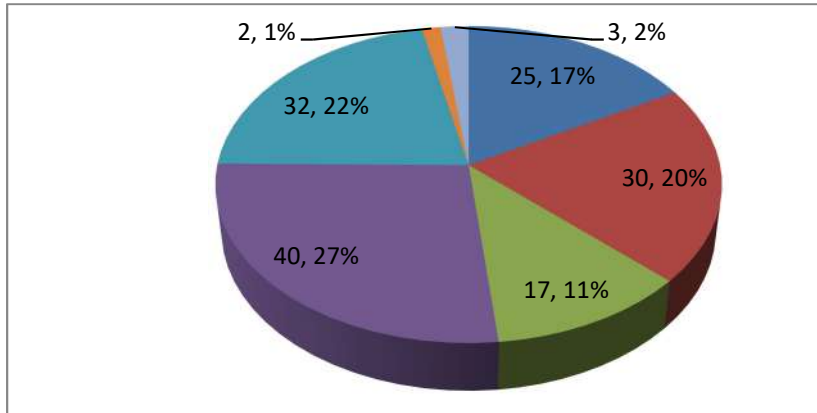
Empirical evidence shows that the validity and reliability of easy information depends largely on the strategies used in collecting data gathered (Cooper, 1985). There are two basic methods of research designs that one can use to carry out a study, these are quantitative which relies on numbers to describe data and the qualitative which resort to the use of words, interviews, recordings, videotapes, personal comments etc. in describing a phenomenon. For the purpose of this research study the descriptive method under the qualitative research method was used. The strategy included the use of a formal interview (structured interview) which helped the researchers to obtain first-hand information from the respondents (Best, 1981)

Design of questionnaire was carried out to facilitate the development of a data bank of the existing blacksmith industries in Maiduguri Local Governments Areas in Borno state. The designed questionnaire were used as the instrument for research, these questionnaires were administered to local blacksmiths shops in Maiduguri Metropolitan council area in Maiduguri, Borno State. Visitations were made to some blacksmith shops in order to carryout physical assessment of their manufacturing processes. The level of developments of theses blacksmith shops were also ascertained. One hundred and seventy copies of the questionnaire were distributed to various blacksmith shops in the study area. One hundred and fifty four of the copies were duly completed by the respondents. It was on these figures our findings were based on. The statistical methods used for description of the response contained in the administered questionnaire were simple percentage bar chart and pie chart.

4.0 Results and discussion

The data in plate 1 indicate that all the blacksmith interviewed were 100% males. This mean that females were not allowed into the industry probably because of the nature of the work and on religion background so as not to mingle with males. The data in Plate 2 indicate that one hundred and forty nine responded. Out of which twenty five (25) 17% of them are school dropout at various level for differences reason ranging financial issue, dead of parent and lack of motivation. Thirty (30) 20% of the blacksmith were ordinary level certificate holders, seventeen (17) 11% of them were advance level school certificate holders, while forty junior secondary school certificate holders, senior secondary school certificate holders were recorded to be thirty two, two (2) 1% technical school certificate

holders, three (3) 2% polytechnic graduate and zero (0) university graduate were recorded.



The data in plate 3 shows one hundred and fifty four responded to years spend in blacksmith work, from zero to four years were sixty eight (68) 44% blacksmith these; include apprentice and semi skill, from four years to eight old were recorded to be seventy nine (79) 51% who are both semi skill and skill blacksmith and from eight and above were recorded to be only seven (7) 5% in number, this is because of age related issues, fatigue, stress at work and muscular skeleton disorder due poor work station design(poor ergonomics). The data in Plate 4 shows one hundred and fifty four (154) responded by saying source of raw materials are from scrap, Auction or market. The breakdowns of their responses are as follows; one hundred and twenty one (121) 79% says raw materials are from scrap, twenty seven (27) 18% says their sources of raw materials are from auction and the other four 3% blacksmith says they obtain their material from the market. The data in Plate 5 shows that one hundred and two responded to the question related to finances out which fifty three (53) 52% agree to have gotten support from the family, none responded to saving and forty nine (49) 48% responded to have gotten support from relatives. The data in Plata 6 indicate that total number of one hundred and fifty four (154) interviewed about safety awareness and forty four (44) which is 29% refused to respond possibly, they have not gotten any safety related matter, while eighty (80) which indicate 52% of the blacksmith agrees that safety exist but in adequate, these indicate that some of the them were aware of safety and thirty (30) which is 19% of the blacksmith goes with adequate safety, but from the discussion we had with them shows the knowledge of safety is minimal though their responses are positive. The issue related ergonomics, anthropometry, global warming and carbon emission were not adequately discussed with them before now. The data in Plate 7 shows one hundred and fifty four (154) responded to challenges encountered by blacksmith, forty six (46) 30% responded to high income tax and multiple taxation from government, thirty two (32) 21% answers to lack of market as a result of the product computing with cheap imported product, thirty three (33) 21% of the blacksmith responded to lack of credit facility from government and forty three (43) 28% said low and irregular income were their major challenges.

4.1 Conclusion

In line with the government's policy of entrepreneurial, vocational training and poverty alleviation in the country, assessing the performance of the blacksmithing industry has

become necessary because of the role blacksmith plays providing services to the agricultural sector (implement), household utensils, vehicles spare parts and carpentry, to mention but a few, which contribute immensely to the socio-economic livelihood and development of the nation.

However, blacksmith's industries impact to national development has not been greatly felt because the industry has not been given its rightful position in national development policies. None inclusion of blacksmith industry to the national development policies has poses a great challenge to the industry in terms of the quality of the products, their utility as well as costing and pricing of the products due to the inferior finishing of the final product. Therefore, assessing the performance of the industry is a step in the right direction, since it can address some of the problems faced by the industry if given opportunity, so that they could offer better services to the general public and the nations as a whole.

4.2 Recommendations

Based research carried out, the following recommendations have been suggested to enhance the effective running and performance of the industry;

There is the need from time to time organize training for the industry and resource persons with the requisite knowledge and skills in blacksmithing invited to educate the blacksmiths. This will help to upgrade and update the skills and techniques of the industry. Training and capacity building cannot be overemphasized, so educate the blacksmith on the safety related issues is paramount, as such, safety engineers, safety officer and fire fighting officers need to visit the industry from time to time as well.

Lastly, a permanent site should be provided to all Small, Medium, and Micro-Enterprise and the blacksmithing industry. This will give sense of belonging and drive away any fear of an impromptu ejection by land owners.

Plate 1 Sex of blacksmith

Sex	frequencies
Male	100
Female	0
Total	100

Plate 2 educational status

Level	frequencies
Drop out	25
'O' level school leaver	30
'A' level school leaver	17
JSS school leaver	40

SSS school leaver	32
Technical school leaver	02
Polytechnic graduates	03
University graduates	00
Total	149

Plate 3 number of years spend in blacksmith work

Years	frequencies
0.....4	68
4.....8	79
8 and above	07
Total	154

Plate 4 source of blacksmith raw material

Raw material	frequencies
Scrap	121
Auction	27
Market	04
Total	152

Plate 5 Source of finance

Status	frequency
Support from family	53
Saving	00
Loan from relative	49
Total	102

Plate 6 blacksmith safety awareness

Safety	frequency
No response	44
In adequate	80
Adequate	30
Total	154

Plate 7 blacksmith challenges

Challenge	frequency
Low and irregular income	43
Lack of capital and credit facility	33
Lack of market as a result of the product-computing with cheap imported product	32
High income tax	46
Total	154

Plate 8 capacity building

Training	frequency
Yes	00
No	143
Total	143

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Investigating the Effects of Weather on the Performance of Mono-crystalline and Polycrystalline Photovoltaic Systems in Maiduguri

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Abstract: Various developing countries in the world view renewable energy sources as an inevitable necessity to reduce greenhouse gas emissions and dependence on fossil fuel energy. The main source of energy for electricity generation in Nigeria comes from fossil fuels, which greatly constrains the fossil fuel supply and contributes to adverse effects on the environment. For these reasons, the Nigerian government is working toward attaining energy independence and promoting efficient use of renewable energy resources. One of the main sources of renewable energy in a tropical climate such as Borno is solar photovoltaic energy. The photovoltaic systems have received a tremendous attention due to the role it played in sustainable energy production and energy saving in the past two decades. Photovoltaic (PV) module and array performance is difficult to predict due to variations in weather, air mass (AM), and non-linear performance characteristics of various module technologies. Photovoltaic (PV) technology harvests abundant, free sunlight to produce electricity via photonic effect. In effect, this solar Pv, performance were hindered by the weather. In view of this, the Researchers try to investigate the performance of the system in Maiduguri which was known for its harsh weather and characterize it according to the two types of Pv used. This research explores other influential factors such as ambient temperature, light intensity, wind cooling, and humidity that could contribute to the sudden drop in PV energy generation. These factors are especially important to the conditions in tropical weather locations. The researchers intend to implore the NI LabVIEW and CompactRIO soft wares which are proved to be the best approach for analyzing the tropical environmental impact of solar photovoltaic performance. The ruggedness and modularity of CompactRIO made it the most suitable platform for our application." A host program using LabVIEW will be designed to monitor data in real time and analyze the data in offline mode. The program will capture three main features of thermocouple data, environmental data, and PV generation data in real-time mode. These parameters are so much essential when it comes to the production of PV modules so as to derive the maximum efficiency from the finished goods.

Key words: Photovoltaic, solar power, weather effect, standalone pv system, renewable energy

INTRODUCTION

Nowadays, energy-related aspects are becoming extremely important. They involve, for instance, a rational use of resources, the environmental impact related to the pollutants emission and the consumption of non-renewable resources. For these reasons there is an increasing worldwide interest in sustainable energy production and energy saving. Among the technologies that could play a role in the generation of sustainable and widespread energy, interesting solutions are represented by photovoltaic (PV) cells, wind generators,

biomass plants and fuel cells. In particular, photovoltaic systems can be considered one of the most widespread solutions with significant margins of improvement while ensuring the generation of energy with low environmental impact(Rajput & Sudhakar, 2013).

Photovoltaic (PV) module and array performance is difficult to predict due to variations in weather, air mass (AM), and non-linear performance characteristics of various module technologies. The International Electro technical Commission (IEC) has proposed PV rating standards (IEC 61853) that include characterizing module performance based on a matrix of various weather conditions, including high temperature conditions (HTC), STC, nominal operating cell temperature (NOCT), low temperature conditions (LTC) and low irradiance conditions (LIC)(Micheal, 2011). Temperature affects how electricity flows through an electrical circuit by changing the speed at which the electrons travel. This is due to an increase in resistance of the circuit that results from an increase in temperature. Likewise, resistance is decreased with decreasing temperatures.

Solar panels work best in certain weather conditions, but since the weather is always changing and as engineers are installing solar panels all over the world in different climate regions, most panels do not operate under ideal conditions. That is why it is important for researchers to understand how panels react to different weather conditions. With this knowledge, it can be designed in such a way as to improve the efficiency of solar panels that operate in non-optimal conditions.

Amongst the various renewable energy sources, photovoltaic (PV) technologies that convert sunlight directly to electricity have been gaining ground and popularity, especially in countries with high solar irradiation. The power generation of a photovoltaic (PV) system may be documented by a capacity test that quantifies the power output of the system at set conditions, such as an irradiance of 1000 W/m^2 , an ambient temperature of 20°C , and a wind speed of 1 m/s . A longer test must be used to verify the system performance under a range of conditions. A year-long test sample weather and shading associated with all seasons. Temperature affects how electricity flows through an electrical circuit by changing the speed at which the electrons travel. This is due to an increase in resistance of the circuit that results from an increase in temperature as in the case of Maiduguri where temperature will raise to about 50°C . Hence, there is the need to investigate the performance and effects of the two PV systems and keep a document on the effect of temperature on the photovoltaic power system in such a harsh and dusty city of Maiduguri.

Wilton (2011), carried out a joint effort research between the University of Hong Kong (HKU) and CLP, the electricity power generation and distribution service provider in Hong Kong with the objective of identifying and verifying the potential relationships between performance of the standalone PV power system, such as the state of charge of the battery and power output, and other environmental factors such as solar radiation, wind speed, and ambient temperature.

(George M.,2014) provide an overview of different PV technologies ranging from crystalline silicon (c-Si) to thin-film and concentrators by outlining a summary of the main outdoor evaluation performance parameters used to describe PV operation and performance and also an overview of the effects of different environmental and operational factors such as

solar irradiance, temperature, spectrum and degradation is also provided along with the results of previously published research efforts in this field. Finally, the installed PV and data acquisition infrastructure of a testing facility in Cyprus is presented and a thorough analysis of the climatic conditions and the performance of different grid-connected PV technologies that have been installed side-by-side and exposed to warm climatic conditions, typical of the Mediterranean region are given. The main environmental factors affecting PV performance considered in his research include solar irradiance, ambient temperature and solar spectrum.

In addition to the review of several factors affecting PV performance, the main results of the outdoor investigation carried out in Cyprus over a four-year period have been presented. In particular, useful information on the performance of different PV technologies installed side-by-side was obtained by investigating their seasonal performance and the effects of temperature, soiling and power rating. The outcome of the outdoor performance assessment also showed that these technologies have enormous potential in countries with high solar resource.

And to the best knowledge of the researcher, there is no any record with this regard in Maiduguri and the results could help academia and industry to enhance the knowledge on the performance of such standalone PV supply system under real operating conditions and help to improve similar designs in the future.

Many module failures and performance losses are the result of gradual accumulated damage resulting from long-term outdoor exposure in harsh environments, referred to as “weathering” (Dumbleton, 2012). Similarly, most PV modules were designed to operate at a certain temperature. The dusty weather of Maiduguri will reach about 50°C. Thus, the two can affect the performance of the PV System.

The main aim of this research proposal is to find out the characteristic/ effects of Weather on the Performance of Photovoltaic (PV) Systems in Maiduguri, Borno State.

This aim can be achieved through the following objectives: Investigate the performance of the different types of solar panels/modules; Identify and verify potential relationships between performance of the standalone PV power system and other environmental factors such as solar radiation and ambient temperature; Identify and verify potential relationships between Solar Radiation , ambient temperature and Time characteristics; Identify and verify potential relationships between Panel efficiency and Time analysis with and without dust.

METHODOLOGY

Basically there are three types of research methods; namely: qualitative, quantitative and mixed methodology.

Qualitative research is a unique method that comprises micro and macro analysis of knowledge based on observation, comparism and interaction. It has a multiple approach to a problem and its data were non numerical and obtained from either structured or unstructured approach. Qualitative data which are in the form of words, pictures or words provide meaning to a research because it is subjective, process oriented, holistic and

interpretative and also tends to provide full description of the research ((Bryman, 2004)) by giving detailed explanations and generation of theory at all levels of analysis.

Qualitative research has the advantages of being subjective; providing complete description; good for early research; and it provide the researcher with first-hand information for he is the instrument for data gathering. Disadvantages include consuming a lot of time; and the data collected cannot be generalized.

Quantitative research on the other hand, is objective and involves measuring facts. Quantitative data are numerical and presented in either percentage or graphs. It has the advantages of being hard, objective, strong, and its data are generalised at a significant level. Similarly, (Rank, 2004) outlined the following disadvantages: it seldom captures the overall context; biasness may exist in respondents' response; validity of data may be questionable.

Mixed methodology is a hybrid of qualitative and quantitative research. According to (Rank, 2004), it has the advantages of providing additional insight; increased validity; further pushing of research; and it mutually supports each other's lacks. And has the disadvantages of higher cost and more time consuming.

In this research, "**NI LabVIEW** and **CompactRIO** proved to be the best approach for analysing the tropical environmental impact of solar photovoltaic performance. The ruggedness and modularity of CompactRIO made it the most suitable platform for our application" (M. Ya'acob Effendy, Universiti Putra)(Ya'acob, Hizam, & Mustaffa).

The researcher will set up 2-250W each of mono- and poly- PV pilot plant at the Power Laboratory of Ramat Polytechnic Maiduguri, Nigeria. The pilot plant will be made up of two units of concentrating PV (CPV) generator systems; one unit of tracking-flat PV (TF) generator systems; a thermometer with clock and; 1KVA inverter.

This research explores other influential factors such as ambient temperature, light intensity/visibility, wind cooling/heating, and humidity whose data will be obtain from the DAQ system as shown in fig 1 below that could contribute to the sudden drop in PV energy generation. These factors are especially important to the conditions in tropical weather locations.

DAQ and Monitoring System Setup

Similarly, DAQ and Monitoring Systems set up used in (Ya'acob, Hizam, & Mustaffa) for the solar PV monitoring system will be adopted in this research work with little modifications. The researcher will capture the power generated from the PV panels and the surface temperature of the PV and synchronize it with the environment data.

The CompactRIO module will be programmed in such a way as to automatically measure and log data in real time, normally from 6:00 a.m. until 6:00 p.m. every day. The system operates in a stand-alone mode and can constantly stream data to a PC connected to the CompactRIO module.

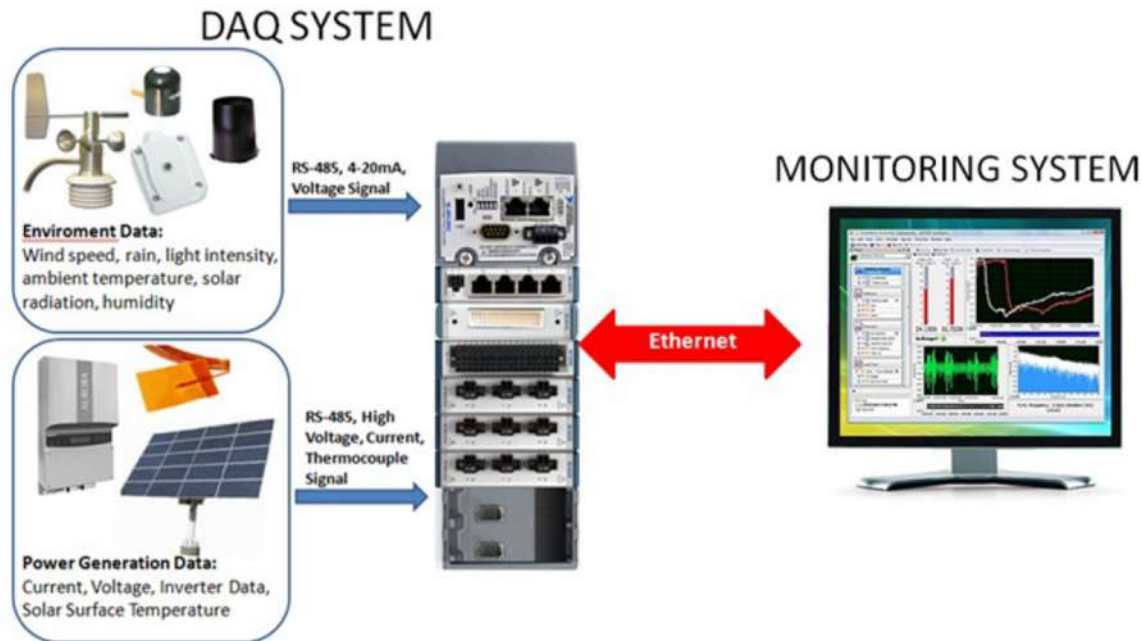


Figure 1. Solar Monitoring Station System Setup

SUMMARY OF THE FINDINGS

The study so far revealed that, for the two types of modules used, both exhibit a good and efficient outcome base on the parameters involved. However, the poly-crystalline panel shows a slightly better output especially when there is haze/dust. For the period under review, the temperature, relative humidity and output voltage was measured three times a day. That is, 10am, 2pm and 4pm.

The relationship between ambient temperature and the state of charge of the battery was very weak. In case of high temperature, the output of the PV will significantly decrease as temperature of the PV module was very high. Therefore, the temperature factor is not the dominating factor that influences the PV output in the typical environment of Maiduguri.

The wind speed in Maiduguri is quite strong and the exposed solar panel may be exposed to the wind chilling effect, a study on the relationship between wind speed and state of charge was also very weak, even weaker than that of ambient temperature. Hence, the wind speed was also not a dominating factor that affects the output of the PV system installed in Maiduguri.

The relationship between solar radiation and state of charge of the battery indicate that there is increment of the battery state of charge. State of charge was just one way to measure the PV output. However, it also depends on other factors such as the solar radiation, initial state of charge and loading demand.

The relationship between the inverter output and solar radiation recorded was very intelligible. When the battery was fully charged, the increment of the inverter was significant even when solar radiation was increasing. The peak of the solar radiation was

also the peak of the inverter output. The solar radiation was the dominating factor to the inverter output.

CONCLUSION

The collected data from the photo voltaic system in the electronics and Telecommunication Laboratory and the weather data from NAMA Maiduguri were used to investigate the relationship amongst various environmental factors such as solar radiation, wind speed, ambient temperature etc. The PV output of the system in terms of SOC and inverter output was the dominating factor that correlated to solar radiation. The direct solar radiation also plays a key role in the system output and efficiency of the system. The ambient temperature and wind speed were the less significant factors. It was discovered that, the major localised environmental effect affecting the system was the solar radiation. When the battery capacity was fully charged, one way to improve the system efficiency was to increase the battery capacity.

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Assessment of Environmental Noise Pollution in Selected Areas in Offa, Nigeria

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Abstract: Many people do not understand noise as a form of physical pollution. As a result, it is critical to examine the environment where noise levels have increased using appropriate measuring and analytical tools to identify whether or not a genuine nuisance exists. The goal of this research is to uncover the rising levels of noise pollution in Offa, Kwara State, Nigeria. A sound level meter was used to monitor noise levels in nine different places. The investigation shows that the noise pollution levels measured at some areas in Offa exceeded the standard and set limit by the World Health Organisation (WHO) and Federal Environment Protection Agency (FEPA). The investigation shows that there was a significant increase in noise pollution in Owode market and Oja Ale as a result of high vehicular movement occasioned by congestion of road within the metropolis.

Key words: Noise, Decibel, Sound pressure, Noise level, Noise limit, Pollution

1.0 Introduction

Noise is defined as an unwelcome and unpleasant sound. Sound is a rapidly varying pressure wave that travels through a medium. When sound travels through air, the atmospheric pressure changes on a regular basis. The frequency of sound is defined as the number of pressure variations per second and is measured in Hertz (Hz), which is defined as cycles per second. The intensity of noise is measured in decibels (Dai et al., 2005).

The decibel scale is logarithmic, meaning that a 10-decibel increase in noise intensity corresponds to a tenfold increase in noise intensity. The human perception of loudness follows a logarithmic scale as well; a 10-decibel increase is seen as nearly twice the volume. Thus, 30 decibels is ten times more intense than 20 decibels and sounds twice as loud; 40 decibels is one hundred times more powerful than 20 and sounds four times as loud; and 80 decibels is one million times more intense than 20 and sounds 64 times louder (Ighoroje et al., 2004). Hearing is a complex process that involves many parts of the ear working together to convert sound waves into information that the brain understands and interprets as sound.

1.1 Noise Pollution

Noise pollution is defined as any sound that is unwelcome or interferes with one's quality of life. Noise pollution occurs when there is a lot of noise in the environment. Sound

becomes unappealing when it interferes with normal activities such as working, sleeping, or conversing.

It is an underrated environmental problem because of the fact that we can't see, smell, or taste it. World Health Organization stated that "Noise must be recognized as a major threat to human well-being"

1.2 Source of Noise Pollution

1. Transportation systems are the main source of noise pollution in urban areas due to increase in number of vehicles.
2. Industrial noise – this is mainly caused by heavy industrial machines. Examples are Generators, Pneumatic equipment, Air conditioners, Pump, Fans, Turbines and Mills.
3. Neighborhood noise – this are noise form gadgets and household equipment. Examples are musical instruments or loudspeakers.

1.3 Effects of Noise Pollution

This following are the effect of noise pollution to human being (Garcia and Garrigues 1998);

1. Hearing loss, productivity loss
2. High Blood Pressure/Hypertension
3. Stress related illness, Insomnia
4. Labored breathing, altered brain chemistry
5. Permanent damage in voice
6. Sleep Disturbances, Color Blindness
7. It can also cause memory loss/Forgetfulness
8. Severe depression and Panic attacks
9. Damage Physiological and Psychological health.
10. Annoyance and Aggression, Tinnitus
11. Miscarriages and abortions in women

1.4 Effect on Non-Living Thing

1. It causes cracks in Structure
2. Loud noise is very dangerous to buildings, bridges, Stones, Earth, Land and monuments.
 3. It creates waves which struck the walls and put the building in danger condition.
 4. It breaks of Glass, China clay, mud vessels due to sudden loud noise
 5. It causes damage to furniture – ages faster
 6. It cause damage to paintings and antique pieces

Noise levels below 85 dBA (decibels) are generally regarded safe, whereas noise levels exceeding 85 dBA induce hearing damage. The level (dBA) and time of exposure to the sound will inform you how hazardous the noise is, according to the Center for Hearing and Communication (Anomohanran et al., 2008). The louder the noise, the shorter the time it takes for hearing loss to occur. For comparison, the quietest sound a human can hear with normal hearing is 0 decibels, whereas regular breathing is 10 dBA. Rainfall has a decibel

level of 50, while an average discussion has a decibel level of 60. Something like shouting in someone's ear or thunder at 120 decibels would be above the level of safety at 110.

Many surveys have been conducted in many cities around the world to address the problem of noise pollution (Singh & Daver 2004, Li et al. 2002, Morillas et al. 2002, Zannin et al. 2002, Alberola et al. 2005, Lebedowska 2005, Pucher et al. 2005, Tansatcha et al. 2005), and (Ali & Tamura 2003; Marius et al. 2005) have demonstrated the level of annoyance caused by noise in people's lives

Existing evidence that noise pollution has a harmful influence on human health has prompted research to better understand and address noise pollution issues (Georgiadou et al. 2004).

The effects of noise on human health and comfort are divided into four categories based on its duration and volume: physical effects, such as hearing loss; physiological effects, such as increased blood pressure, irregular heart rhythms, and ulcers; psychological effects, such as sleeplessness and going to bed late, irritability, and stress; and finally effects on work performance, such as decreased productivity and misunderstanding what is heard.

Noise levels in cities can be studied in three ways: traffic and transportation; industrial operations; and sport, marketing, and entertainment facilities (Dursun et al. 2006).

In compared to other pollutants, the control of ambient noise has been impeded by a lack of established standards and limited information of its impacts on humans. In many rapidly urbanizing locations, noise pollution is a significant environmental issue.

Noise has long been recognized as a potential threat to one's health, communication, and pleasure of social life. It's turning into an unacceptable intrusion into people's comfort, health, and quality of life. Noise pollution is a widespread concern in Nigeria. Several studies have found that noise levels in major cities surpass established standards. In a research conducted in Makurdi, Nigeria, Ugwuanyi et al. (2004) discovered that noise pollution levels in the city were about 3 dB(A) to 10 dB(A) above the recommended upper limit of 82 dB(A) (A).

Anomohanran et al. (2008) also discovered a peak noise level of 100 dB at a road junction in Abraka, Nigeria (A).

This noise level is higher than the recommended level for commercial and residential areas, which is 60 decibels (A). Ighoroje et al. (2004) looked at the amount of noise pollution in a few industrial areas in Benin, Nigeria. The average ambient noise level at sawmills, electro-acoustic markets, and food processing industrial zones was found to be greater than 90 decibels (A). This noise level is significantly higher than the safe noise level of 60 decibels (A).

2.0 Material and Methods

This research is based on the results of outdoor sound level measurements carried out in July 2021 at 10 different locations (2 commercial centers, 3 road junctions & busy roads, 1 passengers loading parks, 2 high density areas and 2 low density areas) in Offa metropolis, Kwara State. Table 1 shows the locations selected for the noise level measurements in Offa metropolis. Figure 1 shows an overview of Offa metropolis showing the locations of noise measurements for this study.

Table 1: Location selected for the noise level measurement in Offa metropolis.

S/NO	DESIGNATION	DESIGNATION NUMBER
1	OSUNTE AREA	001
2	ATAN OBA AREA	002
3	OLOHUNKUSHE AREA	003
4	OWODE MARKET	004
5	IDI AGBON AREA	005
6	AMUYO AREA	006
7	ANILELERIN AREA	007
8	OMO OWO AREA	008
9	OJA ALE AREA	009
10	RONDO AREA	010

Sound Level Meter was used to carry out this research. The sound level meter was incorporated with a softwares designed by SplendApp. The measurements were taken at street level (road junctions, parks, market and residential areas). The instrument was carefully held with the microphone pointing towards the suspected noise source at a distance not less than 1 meter away from the source of the noise. L_{Ai} (A-weighted instantaneous sound pressure level) measurements were taken at interval of 15 seconds for a period of 15 minutes, having 60 meter readings. Morning readings were taken between 8:00am and 8:15am while evening readings were taken between 5:00pm and 5:15pm for each location. Commonly used community noise assessment quantities like the exceedence percentiles (L_{10} and L_{90}), the A-weighted equivalent sound pressure level L_{Aeq} , daytime average sound level (L_D), the noise pollution level (L_{NP}) and the traffic noise index(TNI) were computed.

The data are computed as follows (Saadu et al., 1998):

$$L_{Aeq} = 10 \log_{10} \left[\frac{1}{N} \sum_{i=1}^N \left(\text{antilog} \frac{L_{Ai}}{10} \right) n_i \right] \quad (1)$$

$$L_D = 10 \log_{10} \left[\frac{1}{2} \left[\text{antilog} \frac{L_{AeqM}}{10} + \text{antilog} \frac{L_{AeqE}}{10} \right] \right] \quad (2)$$

$$L_{NP} = L_{Aeq} + (L_{10} - L_{90}) \quad (3)$$

$$TNI = 4(L_{10} - L_{90}) + (L_{90} - 30)$$

Where L_{Ai} is the i th A-weighted sound pressure level reading dB, N is the total number of readings, L_{Aeq} is the A-weighted equivalent sound pressure level (dB (A)), L_{AeqM} is the equivalent sound pressure for the morning measurement (dB (A)), L_{AeqE} is the equivalent sound pressure level for the evening measurement, L_D is day time noise level, L_{10} is the noise level exceeded 10% of the time, L_{90} is the noise level exceeded 90% of the time, L_{NP} is noise pollution level, L_{DN} is day-night noise level, TNI is the traffic noise index.

3.0 Results and Discussion

The measurements were made when the impacts of variable elements on the noise sources were minimal (e.g., wind speed, rainfall, etc.). All of the data was collected on weekdays and under ideal weather conditions, i.e., no rain. For a period of 15 minutes, measurements were taken every 15 seconds, yielding 60 meter readings in the morning and 60 meter readings in the afternoon each location. The information was utilized to assess noise descriptors such as L_{Aeq} , L_{10} , L_{90} , TNI, L_{NP} , and L_D .

The average noise descriptors were determined per location. Table 2 shows the daily average values of noise descriptors for all the sites surveyed. The sites are designated with numbers 001 to 010.

Table 2: Average Noise Descriptors at Study Locations

LOCATIONS	LOCATION NUMBERS	L_{10} (dB (A))		L_{90} (dB (A))		L_{Aeq} (dB (A))		TNI(dB (A))		LNP(dB (A))		L_D (dB (A))
		M	E	M	E	M	E	M	E	M	E	
OSUNTE	001	80	80	68	65	75.89	75.98	86	95	87.89	90.98	75.94
ATAN OBA	002	73	77	54	61	67.3	72.51	100	95	86.30	88.51	70.64
OLOHUNKUSHE	003	79	81	65	65	76.74	77.32	91	99	90.74	93.32	77.04
OWODE MARKET	004	83	85	63	73	75.73	81.65	113	91	95.73	93.65	79.63
IDIAGBON	005	78	81	60	72	74.19	77.89	102	78	92.19	86.89	76.42
AMUYO	006	80	80	65	67	75.55	76.54	95	89	90.55	89.54	76.07
ANILELERIN	007	71	75	60	68	72.67	76.44	74	66	83.67	83.44	74.95
OMOOWO	008	78	78	65	66	75.01	74.71	87	84	88.01	86.71	74.86
OJA ALE	009	80	81	62	65	75.51	76.87	104	99	93.51	92.87	76.24
RONDO	010	66	73	52	60	64.65	67.64	78	82	78.65	80.64	66.40

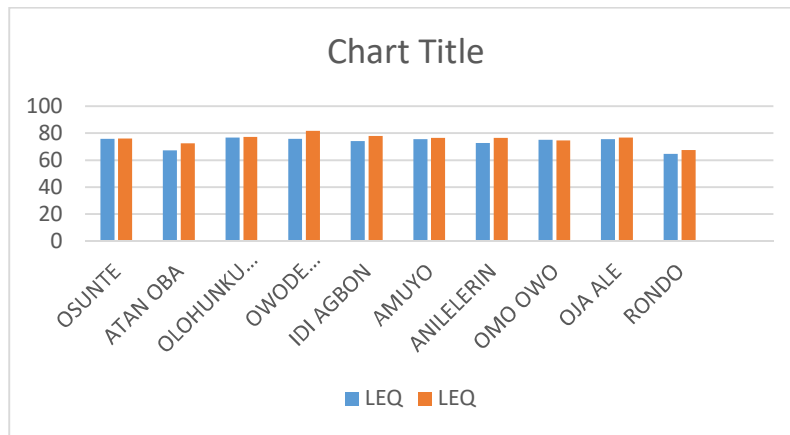


Fig 1: Graph showing the morning and evening equivalent sound pressures

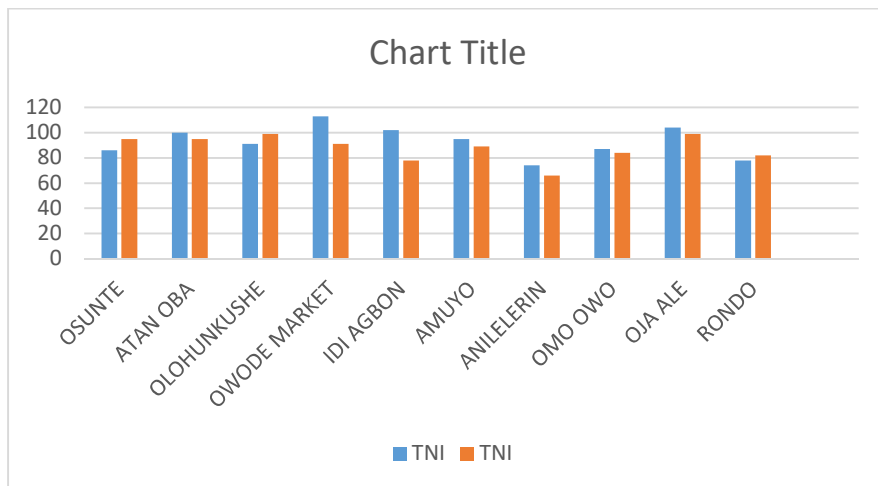


Fig 2: Graph showing the morning and evening Traffic Noise Index Values

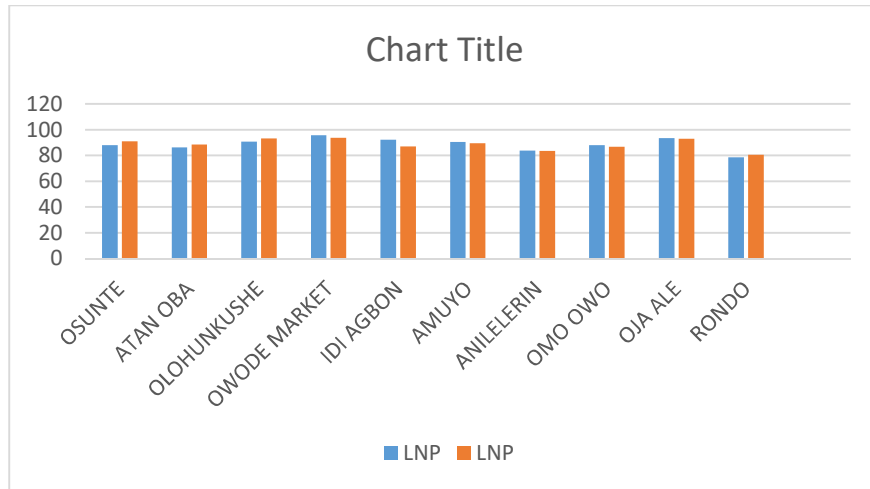


Fig 3: Graph showing the morning and evening Noise Pollution Level

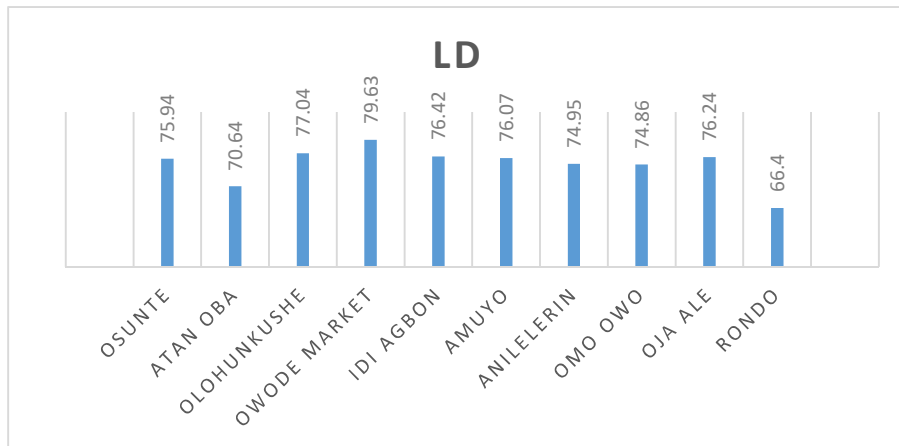


Fig 4: Graph showing the Daylight Average Sound Level

From Table 2, location 003 has the highest morning Leq (76.74dB (A)) and highest TNI in the evening (99dB (A)). This is so because most of the residents in the area are car owners and move to and from their various workplaces within the period the measurements are taken, thereby creating more traffic. Location 004 has the highest evening Leq (81.65dB (A)), highest morning LNP (113dB (A)) and second highest evening LNP (91dB (A)) because it is a market square where there is always high noise level. Location 009 has the second highest morning TNI (104dB (A)), highest evening TNI (99dB (A)), the second highest morning and evening LNP (95.51dB (A) and 92.87dB (A) respectively) because it is also a market that is situated near an expressway. Of all the locations considered for this research work, location 010 has the least morning and evening Leq (64.65dB (A) and 67.64dB (A) respectively) and second least morning and evening TNI (78dB (A) and 82dB (A) respectively) and the least LNP both in the morning and evening (78.64dB (A) and 80.64dB (A)). Among the factors responsible for differences in noise levels in the centers surveyed include location site, presence of intrusive noise, traffic volume, commercial activities etc.

In conclusion, location 004 is found to be the noisiest in the town because of the presence of market and Load Park and commercial centers. In these locations, apart from traffic noise, other intrusive noise sources include noise from record players, loud speakers, hawking and human conversation which contribute majorly to the environmental noise pollution.

Most of the countries have come up with permissible noise standards keeping in view the alarming increase in environmental noise pollution, Table 3 shows Table 4 shows the official gazette by National Environmental (Noise Standard) Regulation where 55dB (A) is the maximum permissible noise level for mixed residential areas. The World Health Organization (WHO) has also suggested a standard guideline value for average outdoor noise levels of 55 dB (A), applied during normal daytime (16 hours) in order to prevent significant interference with the normal activities of local communities, and is considered as serious annoyance, while a value of 50 dB as moderate annoyance. Table 5 shows the WHO Guidelines values for community noise listing also critical health effects ranging from annoyance to hearing impairment.

Table 3: FHWA noised standards (Oyedepo, 2012)

S/No	Land use	Noise Level L_{10}	Description of land use category
1	A	60dB (A) (Exterior limit)	For parts and open places
2	B	70dB (A) (Exterior limit)	Residential area, Hotels, Schools, Libraries, Hospitals etc.
3	C	75dB (A)	Developed areas
4	D	55dB (A) (Interior limit)	Residential areas, Hotels, Libraries etc.

The U.S. Department of Housing and Urban Development (HUD) recommends the following noise levels for residential areas, measured outdoors:

$$L_{Aeq} \leq 49 \text{ dB (A)} \text{— clearly acceptable}$$

$$49 < L_{Aeq} \leq 62 \text{ dB (A) (or } L_{DN} \leq 65 \text{ dB (A)) — normally acceptable}$$

$$62 < L_{Aeq} \leq 76 \text{ dB (A) (or } 65 < L_{DN} \leq 75 \text{ dB (A)) — normally unacceptable}$$

$$L_{Aeq} \leq 76 \text{ dB (A) (or } 75 \text{ dB (A) } < L_{DN} \text{) — clearly unacceptable (Dhananjay and Prashant, 2007)}$$

The result of this study shows that noise levels (L_{10}) in all the locations surveyed (ranges from 66–80 dB (A)) are higher than the recommended values by FHWA (i.e., 60 dB (A)). Out of 10 locations surveyed, only 3 locations have noise level higher than 75 dB (A),
 Table 4: Maximum Permissible Noise Levels for General Environments [FGN GAZETTE] (Oyedepo and Saadu 2010)

	Column 1	Column 2	
	Facility	Maximum permissible noise limit L_{eq} (dB (A))	
		DAY	NIGHT
A	Any building used as hospital, convalescence home, home for the aged, sanatorium, home for higher learning, conference room, public library, environmental or recreational centres	45	35
B	Residential buildings	50	35
C	Mixed residential (with some commercial and entertainment)	55	45
D	Residential + Industry or small scale production + commerce	60	50
E	Industrial (outside perimeter fence)	70	60

Above noise levels are weighed average in the facility over the hours defined for night and day below,

Time frame: used duration

Day -6:00am-10:00pm

Night -10:00pm-6:00am

Table 5: WHO guideline for community noise (Mansouri et al. 2006)

Environment	Critical health effect	Sound level (dB (A))	Time (hours)
Outdoor living areas	Annoyance	50-55	16

Indoor dwellings	Speech intelligibility	35	16
Bedrooms	Sleep disturbance	30	8
School classrooms	Disturbance of communication	35	During class
Industrial, commercial and traffic areas	Hearing impairment	70	24
Music through earphones	Hearing impairment	85	1
Ceremonies and entertainment	Hearing impairment	100	4

4.0 Recommendation

In this work, transport infra-structures have been recognized as major sources of noise in Offa town. Hence, technical actions on the transport systems can produce interesting results. Possible technical controls include:

- (i) Changes in road profiles,
- (ii) Low noise pavements (porous or porous elastic) type,
- (iii) Effective repairs to the silencers and vehicle suspensions restrictions on
- (iv) Traffic (types of vehicles, speed, hours of access etc.)
- (v) Building of acoustic barriers along the sides of heavily travelled highways running through residential areas.

Noise generated as a result of citizen's behaviour (driver, music player, hawker etc.) can be controlled by regular education of the drivers. Another step that can be taken to minimize noise pollution is preparation of noise map. The noise map that has baseline data for town planners, engineers and other professionals and researchers for the planning and execution of their projects. Most of the cities in Nigeria have not presented noise pollution maps.

5.0 Conclusion

In this study, comprehensive assessment of environmental noise levels has been carried out in Offa town. Ten (10) selected areas were surveyed for noise pollution levels. The result of this study shows that at locations near the busy roads/ road junctions, commercial centers and passengers loading parks, the equivalent noise level, background noise level and peak noise level are higher compared to station near low density residential areas. This investigation reveals that noise levels at all the locations surveyed exceeded the recommended limit of 60dB (A) by values of 6–25 dB (A). Hence, the present status of noise pollution in Offa town poses a severe health risk to the residents. Furthermore, productivity can be affected by the discomfort and irritation being caused by the pollution, both in public service and private sectors. In addition, the research shows that some areas tend to reach the threshold of pains and lead to permanent loss of hearing and death.

Attention has to be given to the challenges noise pollution pose on human health by full implementation of general and statutory policies.

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Blockchain Technology Application and Supply Chain Collaboration of Energy Companies in Rivers State of Nigeria

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Abstract: *This study examined the impact of block chain technology application on supply chain collaboration of energy companies in Rivers State of Nigeria. The population of the study consisted of 295 registered energy companies operating in Rivers State of Nigeria. To obtain the sample size, the Krejcie and Morgan's formula was used to determine a sample size of 169 Energy companies. The simple random sampling technique was used to obtain two (2) executives from each of the 169 companies under study, to turn up 338 management staff for the whole sample. A 4-point likert-scale structured questionnaire was distributed to the respondents, of which out of the 338 copies of structured questionnaire distributed, 246 copies accounting for 73% were retrieved from the respondents, and after data cleaning, 202 (82%) of the questionnaire were found useful for analysis. The analysis was carried out using the simple regression technique to test the hypotheses at 0.05 level of significance. The findings revealed that, BTC-enabled visibility strongly, positively and significantly influences supply chain collaboration. It was also, found that BTC-enabled traceability moderately, positively and significantly influences supply chain collaboration. The study therefore, concludes that blockchain technology application positively and significantly influences supply chain collaboration of energy companies in Rivers State and recommends that, Energy companies have to prioritize blockchain activities such as BTC-enabled visibility and BTC-enabled traceability to manage and strengthen their supply chain collaboration activities and improve their performance.*

Key words: *Blockchain technology application, BTC-enabled traceability, BTC-enabled visibility, supply chain collaboration*

INTRODUCTION

A growing number of products are delivered to the customers by means of supply chains that consist of independent firms (Christopher & Peck, 2012; Wang, Jie & Abareshi, 2018). Manifold supply chain partners have to work as one collaboratively to put together and distribute products and services to the consumer. Porter (2019) noted that supply chain management concept essentially transforms the nature of a company as control has ceased to anchor on straight direction of the internal business procedures, but somewhat anchored on integration crosswise affiliate organizations in the supply chain. Supply chains constitute a nucleus area for companies and carries out four indispensable functions: sales, distribution, production, and procurement (Arshinder, Kanda & Deshmukh, 2008). Companies encounter amplified uncertainty, confrontations, and constrictions, owing to globalization, elevated customer expectation, market competition, supply chain complexity and uncertainty, these constraints straightforwardly influence companies performance and frequently result in challenges and constrictions, such as soaring operation costs or capacity deficiency, which possibly will be determined by the Blockchain rising (Tapscott & Tapscott, 2016). This calls for harmonization and collaboration crosswise the supply chains and the necessity for information technology (Huddiniyah & Er, 2019). This implies that, a crisis in this area can hamper good organization and postponements in the delivery of goods to consumers and a loss of revenue. Companies have therefore, automated their processes, and by this means have contributed to a boost in the quantity of digitized data equally emanating from inside the organization and from outside the organization by means of distributors, freight and transportation sources such as Blockchain, which is a distributed data configuration that is simulated and shared in the midst of the affiliates of a network (Greenspan, 2015).

The block chain technology which was launched with Bitcoin, as a trendy form of digital crypto currency developed by Satoshi Nakamoto in 2008, is a central distributed sheltered technology in the existing Industry 4.0 epoch in recent times and has fascinated immense interest from both academia and industry (Dobrovnik, Herold, Fürst & Kummer, 2018; Swan, 2017). Blockchain is identified as distributed ledger technology (Tschorsch & Scheuermann, 2016), which allows partakers to secure the settlement of business deals, document the business deal, and transmit assets economically (Tschorsch & Scheuermann, 2016). Block chain technology is an innovative brand of internet infrastructure anchored on distributed applications as well an innovative brand of supply chain network, which possibly will offer a new prototype for future business (Hackius & Petersen, 2017; Mansfield-Devine, 2017; Swan, 2015).

Sourcing of raw materials, product manufacturing and delivery of products to end consumers have led to data surfacing and becoming an aspect of daily human activity. This lift up in data has presented opportunity for novel advances and techniques to generate, store, analyze and get hold of constructive imminence from the supply chain. The emergence of blockchain technology has therefore conveyed innovative possibilities extended from financial services to supply chain management, intelligent manufacturing and Internet of things. The materialization of the Internet of things signifies a boost in connectivity and information sharing and hence a need for increasing trust and efficiency in dealings which may affect the supply chain and its resilience to pull through from all categories of disruptions (Mondragon, Mondragon & Coronado, 2018).

The tracking of all categories of business deals more visibly and firmly by means of Blockchain technology motivates an investigation on the opportunities Blockchain technology tenders crosswise the supply chain. However, there have been very few studies conducted on the nexus between block chain technology application and supply chain collaboration (Bai & Sarkis, 2020; Chang & Chen, 2020; Vos, 2018; Petersson & Baur, 2018). Therefore, this paper tries to fill this research gap by investigating the impact of Block chain technology application (BTC) using BTC-enabled visibility and BTC-enabled traceability as dimensions on supply chain collaboration of energy companies in Rivers State.

Research Objectives

The main objective of this study is to ascertain the influence of blockchain technology application on supply chain collaboration of energy companies in Rivers State. The specific objectives are:

- 1: To examine the influence of BTC-enabled visibility on supply chain collaboration of energy companies in Rivers State.
- 2: To examine the influence of BTC-enabled traceability on supply chain collaboration of energy companies in Rivers State.
- 3: To identify and highlight key attributes of blockchain technology applicable to supply chain collaboration of energy companies in Rivers State?

Research Questions

RQ1: To what extent does Btc-enabled visibility of blockchain technology influence supply chain collaboration of oil and gas companies in Rivers State.?

RQ2: To what extent does BTC-enabled traceability of blockchain technology influence supply chain collaboration of oil and gas companies

RQ3: What are the key attributes of blockchain technology applicable to supply chain collaboration of energy companies in Rivers State?

LITERATURE REVIEW AND HYPOTHESES

Technological Determinism

This study is anchored on technological determinism. Technological determinism was derived from Thorstein Veblen (1987-1929), and centered on the affiliation amid technology and society. Technological modernism modifies how society functions. Simply put, technological determinism stem from the conviction that technology is the principal energy in a society (Smith & Marx, 1994). Technological determinism is the foundation for influencing society and any vital occurrence in society is as a result of a quantity of innovation. The theory is envisaged on the principle that

technology more than any other significant dynamic play and does settle on social change (Bimber, 1990). The whole society's life and several facet of human communication have systematically changed owing to the spreading out of computers, networks and the internet (Hauer, 2017). This theory is relevant to this present study because recent blockchain technological progression has affirmed itself in the way human produce, dispense and appraise knowledge, skills and information in the present day. The hall mark of the above declaration epitomizes the standard used to communicate as influencer of the intellect of the receiver.

Block Chain Technology Application

The technology underlying Bitcoin is named Blockchain which acts as the payments layer for Internet (Sultan & Lakhani, 2018). Blockchain is a decentralized database enclosing chronological, cryptographically connected blocks of digitally indicated asset deals, presided over by a consensus model (Sultan & Lakhani, 2018). It is a mechanism for bringing up to date exactness of states in distributed computer networks (Swan, 2016). Blockchain, also branded as the consensus protocol, doles out as a public or private ledger for any transactions, enabling every user to hook up to the network and send transactions to the Blockchain, confirm transactions and generate new Blocks (Herlihy & Moir, 2016). Blockchain, in short, is a record-keeping system that stores information about transaction records shared peer-to-peer crosswise all computers contained by its network, and allows diverse organizations to collaborate and validate entries in the Blockchain hence giving stakeholders visibility of the overall activities taking place.

Key Attributes of Blockchain

In this subsection, based on previous studies we identified the key attributes of the blockchain technology. Blockchain technologies have the following key attributes: Jawaji *et al.* (2020) point out that Blockchain implements transparency, security, authenticity, and auditability. Yang *et al.* (2019) assert that the attributes of blockchain consist of decentralization, security, visibility and Zhenget *al.* (2018) affirm that the key distinctiveness of a blockchain embrace decentralization, persistency, anonymity, and auditability. Sultan and Lakhani (2018) emphasize four nucleus attributes of blockchain: immutable, decentralized, consensus driven, and transparent. Chen *et al.* (2018) categorize four features: decentralization, traceability, immutability, and currency properties. This study, based on the above, investigates decentralization, immutability: Transparency, Security, Authenticity, Traceability and Visibility as the key attributes of blockchain applicable to supply chain collaboration in Energy Companies in Rivers State.

There are many factors, which would influence the blockchain applications in supply chain collaboration; however, each industry may have dissimilar focal points or main concerns. As a result, it is wise to evocatively evaluate the use of blockchain in terms of the definite necessities in a meticulous business area spotlighted on three significant realistic insinuations: information sharing, traceability and automation within digital transformation (Chang & Chen, 2020; Frank, Dalenogare & Ayala, 2019; Wollschlaeger, Sauter & Jasperneite, 2017). Since blockchain, which is a trusted, auditable and decentralized system can be employed to handle personal data (Zyskind, Nathan & Pentland, 2015), these three globally accepted situations express the application of blockchain in supply chain collaboration. This present study investigates two attributes of blockchain technology (visibility and traceability), renamed them as BTC-enabled visibility and BTC-enabled traceability and adopts them as the dimensions of blockchain technology application.

BTC-Enabled Visibility

Visibility guarantees self-assurance into the supply chain and puts off overreactions, pointless involvements and unproductive decisions in a risk event state of affairs (Soni, Jain & Kumar, 2014). Information sharing is the ability of the firm in sharing knowledge with supply chain partners in an effective and efficient approach. The unavailability or absence of the information essential to decision making can damage the competence of a company (Ouabouch & Paché 2014). In supply chain processes, bulky number of communications and documentations necessitate plenty of exertions and time to pull through. These embrace legal documents and contracts which companies will sustain costs to make available and convey. Blockchain could present an answer, as every document or paper can be uploaded and shared to departments or business, thus appreciably dropping the endeavors for communications or transporting papers and improving the information sharing in a supply chain (Benton *et al.*, 2018; Wollschlaeger *et al.*, 2017).

BTC-Enabled Traceability

BTC-enabled traceability can be used to offer identification and trace the raw materials and final products in supply chains. In a supply chain arrangement, partners can employ this attribute of blockchain to trace and keep an eye on blocks in the network. The block may enclose vital information, products, process history, shipments, components, etc. Traceability facilitates information sharing, which advances the visibility and transparency of supply chains, making it easier for partners to speedily access information exclusive of permissions (Apte & Petrovsky, 2016; Hackius & Petersen, 2017; Swan, 2017). BTC-enabled traceability can also be applied to numerous functions of a Supply Chain Management (SCM) schemes, such as logistics, quality assurance, inventory management (Ju, Jongwook & Taeho Park, 2019). Owing to the blueprint of blockchain, each and every one user can without difficulty trace the block in the network, because transactions or records are stocked up correspondingly in dissimilar blocks and connected by the cryptographic hash function, making available a significant trait to trace the blocks.

Supply Chain Collaboration

Supply chain collaboration is well thought-out as a significant factor to realize a win-win resolution for diverse shareholders in a supply chain (Ramanathan & Gunasekaran, 2014; Tsou, 2013). Besides, Soosay and Hyland (2015) stress that collaboration includes long-standing commitments to technology sharing and to directly incorporate planning and control systems. Different forms of supply chain collaborations exist, including collaborative planning, collaborative decision making and collaborative execution (Ramanathan & Gunasekaran, 2014). Supply chain collaboration involves a high level of commitment, trust, joint decisions and information sharing (Liao *et al.*, 2017; Pradabwong *et al.*, 2017; Soosay & Hyland, 2015; Zhang & Cao, 2018). A high level of supply chain collaboration show the way to advanced levels of supply chain performance (Chen *et al.*, 2017; Wiengarten *et al.*, 2016). Supply chain collaboration is thus, a firm's capability to sense, work in partnership, synchronize and reconfigure the elements in a supply chain as well as internal cross-functional integration and external integration with suppliers and customers.

Empirical Review

Chen *et al.* (2020) considered a block chain-driven platform for supply chain finance and to establish a reliable and efficient financing platform for the auto retail industry in China. The

findings of the study show that, participants in supply chain (SC) networks in block chain built-in trust mechanism, work broadly and visibly to run a dependable, well-situated, and distinguishable business; similarly, the traditional supply chain finance (SCF), partial automation of SCF workflows in the midst of less human errors and interruptions was realized through smart contract in BCautoSCF. Such open and secure features suggest the feasibility of BCautoSCF in SCF.

Dinesh, Manoj and Anandh (2020) investigated blockchain technology in food supply chain security in India using the methods of information science, management science, system science and other theories and empirical research methods, chiefly by means of the PEST analysis, compare and exhibit studying the appliance of Blockchain in the food supply chain. It was established that, transactions are cryptographically secured by means of double SHA 256; Bit algorithm guarantee immutability, transparency, distributed and easy to uphold; blockchain transaction secured cryptographically by means of Hashing algorithm Double SHA 256; the blockchain can keep the information secured void of manipulation. The blockchain technologies realize multifaceted enterprise of the food supply is the government demand, through the system of food market transaction record.

Vos (2018) presented a blockchain-based decentralized system for freight declaration and aims to make simpler and automate the collaboration among the economic operators and the Customs agencies. By digitizing the shipment containers through the Internet of Things (IoT) technology, this system intends to improve the responsiveness of the Customs Authority concerning the shipped goods and their shipping conduit. These two systems target the international trading state of affairs, with contributors situated both within and outside the country. It revealed that the applicability of such solutions is limited, since the keenness of the contributors to link with the network is a major concern.

Petersson and Baur (2018) explored how blockchain technology could be put into practice in supply chains and focused on the predictable benefits on collaboration and add to the appreciation of the upcoming potentials of the technology. By means of a qualitative multiple case studies with eight firms operating in varied business fields as different as pharmaceutical, automobile and shipping industry, six semi-structured interviews were performed in cooperation with firms proffering blockchain solutions and firms involved in the technology. Extra secondary data from two firms including supporting material via the involvement at a blockchain seminar and webinar were composed. Mainly, secondary data emanating from whitepapers, company presentations and information from the websites were engaged to attain triangulation of the empirical data, and it was demonstrated that, the application of blockchain technology positively influences supply chain collaboration.

Based on the review of literature, the following research model was developed:

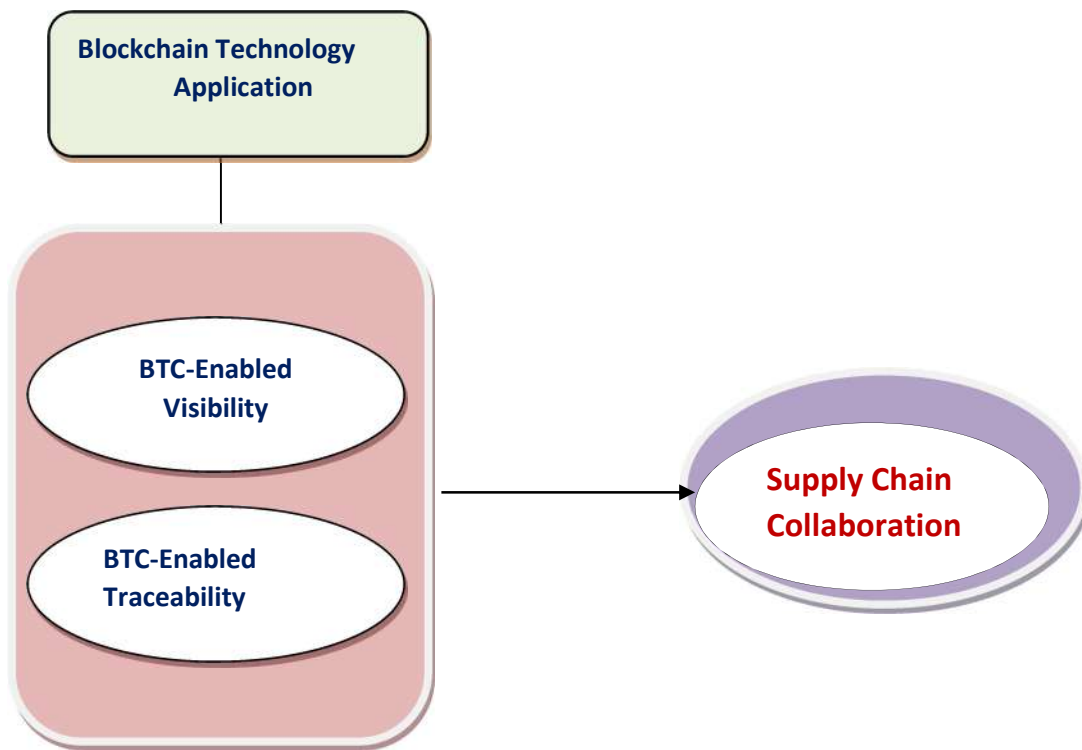


Figure 1: Conceptual Framework of Block Chain Technology Application and Supply Chain Collaboration.

Source: Designed by the Researcher, 2022.

Based on the conceptual framework of block chain technology application and supply chain collaboration, the following hypotheses were formulated:

- Ho₁:** There is no significant influence of BTC-enabled visibility on supply chain collaboration of oil and gas companies in Rivers State.
- Ho₂:** There is no significant influence of BTC-enabled traceability on supply chain collaboration of oil and gas companies in Rivers State.

METHODOLOGY

The population of the study consisted of 295 registered energy companies operating in Rivers State of Nigeria as at October, 2020 when the survey was conducted. To obtain the sample size, the Krejcie and Morgan (1970) formula was used to determine a sample size of 169 Energy companies. The simple random sampling technique was used to obtain two (2) executives from each of the 169 companies under study, to turn up 338 management staff for the whole sample. A 4-point likert-scale questionnaire was distributed to respondents, of which out of the 338 copies distributed, 246 copies accounting for 73% were retrieved from the respondents, and after data cleaning, 202

(82%) of the questionnaire were found useful for analysis, The analysis was carried out using the simple regression technique to test the hypotheses at 0.05 level of significance. The analysis was carried out using the simple regression technique to test the hypotheses at 0.05 level of significance.

RESULTS

Data and Reliability Indices

Prior to and after the survey had been completed, the reliability scales was further examined by computing their co-efficient alpha by means of Cronbach alpha to measure the reliability of the instruments used for the study.

Table 1: Reliability measure of Blockchain Technology Application and Supply Chain Collaboration

S/N	ITEM	NUMBER OF ITEMS	INDEX
1.	BTC-Enabled Visibility	3	0.817
2.	BTC-Enabled Traceability	3	0.846
3.	Supply Chain Collaboration	3	0.864

Source: Field survey data, 2022).

Table 1 summarizes the reliability result of the block chain technology (BTC-enabled visibility and BTC-enabled traceability) and supply chain collaboration). All items were found to be reliable and are used to study the impact of block chain technology on supply chain collaboration of energy companies in Rivers State of Nigeria.

Answers to Research Questions

RQ1:To what extent does BTC-enabled visibility influence supply chain collaboration of energy companies in Rivers State.?

Table 2: Mean and standard deviation of BCT-Enabled Visibility and Supply Chain Collaboration (n=202)

S/N	ITEMS	VLE	LE	HE	VHE	(\bar{x})	STD	Remark
1.	Using BTC-enabled visibility to simplify supply chain collaboration	9 (4.50)	7 (3.50)	74 (36.6)	112 (55.4)	3.14	.85	High Extent
2	Using BTC-enabled visibility that can positively affect the strategies used in the production/process of your company and her supply chain performance.	6 (3.0)	7 (3.5)	16 (7.9)	116 (57.4)	3.41	0.85	High Extent
3.	Using BTC-enabled visibility that can positively guarantee self-assurance into your company's supply chain and puts off unproductive decisions.	8 (4.00)	7 (3.50)	35 (17.3)	152 (75.2)	2.14	0.99	Low Extent

Source: SPSS Window Output on Research Data, 2022.

Table 2 shows that all the items were rated within 214 – 341, indicating that the respondents agreed to a high extent with the first and second items, but a low extent on the third item. Thus, the sampled companies used BTC-enabled visibility to simplify supply chain collaboration and positively affect the strategies used in the production/process of their company and her supply chain performance to a high extent, but use BTC-enabled visibility to positively guarantee self-assurance into their company's supply chain and puts off unproductive decisions to a low extent.

RQ2: To what extent does BTC-enabled traceability influence supply chain collaboration of energy companies in Rivers State?

Table 3: Mean and standard deviation of BTC-Enabled Traceability and Supply Chain Collaboration (n=202)

S/N	ITEMS	VHE	HE	LE	VLE	(\bar{x})	STD	Remark
1.	Using BTC-enabled traceability to offer identification and trace the raw materials and final products in supply chains.	10 (10)	5 (2.50)	109 (76.3)	78 (38.61)	3.10	0.86	High Extent
2.	Embarking on BTC-enabled traceability that would lead to efficient distribution of products.	- -	- -	75 (37.1)	127 (62.9)	2.15	0.99	Low Extent
3.	Embarking on BTC-enabled traceability to increase supply chain collaboration.	9 (4.50)	16 (7.90)	129 (63.9)	48 (23.0)	3.18	0.92	High Extent

Source: *Source: SPSS Window Output on Research Data, 2022.*

Table 3 demonstrate that all the items were rated within 2.15 – 3.18, indicating that the respondents agreed to a high extent with the first and third items, while the second item was rated low extent. Thus, the sampled companies use BTC-enabled traceability to offer identification, trace the raw materials and final products in supply chains and increase supply chain collaboration to a high extent. However, the sampled companies use BTC-enabled traceability to attain efficient distribution of products to a low extent.

RQ3:What are the key attributes of blockchain technology applicable to supply chain

Collaboration of energy companies in Rivers State?

In research question three, the researcher sought to ascertain the key attributes of blockchain technology applicable to supply chain collaboration of energy companies in Rivers State. The descriptive relationships between the attributes of blockchain technology applicable to supply chain collaboration were ascertained through the analysis the graphical representation of respondents' inputs as presented in Table 4.

Table 4: Blockchain Technology Attributes applicable to Supply Chain

Collaboration (n=200)			
SN	Blockchain Technology Attributes	Frequency	Percentage
1	Decentralization	29	14
2	Immutability	31	15
3	Authenticity	16	8
4	Transparency	70	35
5	Visibility	12	6
6	Traceability	44	22
Total		202	100.00

Source: SPSS Window Output, Version 22.0 (based on 2022 field survey data).

The participants in this study identified six categories of blockchain attributes that are applicable to supply chain collaboration in energy companies in Rivers State. Table 4 reveals that the six attributes of blockchain and the respondents there includes 29 for Decentralization (14%), 31 for Immutability (15%), 16 for Authenticity (8%), 70 for Transparency (35%), 12 for Visibility (6) and 44 for Traceability (22%). This is further illustrated in Figure 2.

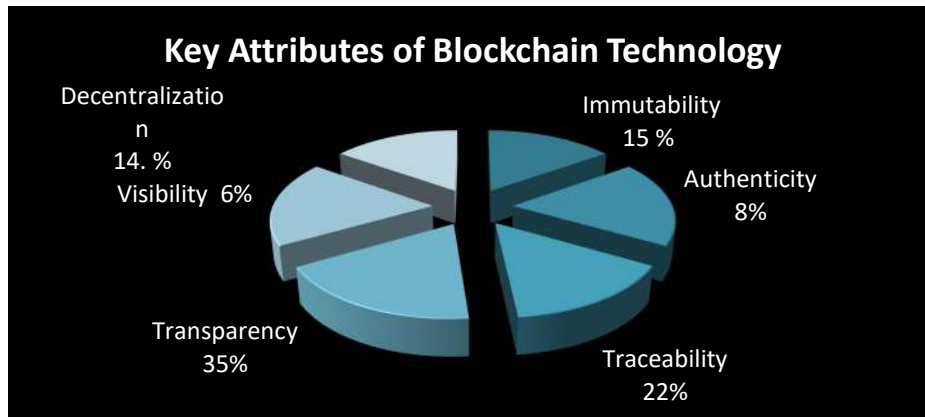


Figure 2: Graphical Presentation of Key Attributes of Blockchain Technology applicable to Supply Chain Collaboration of Energy Companies in Rivers State.

As can be seen from Figure 2, the option on the use of Transparency attribute had more respondents, followed by Traceability attribute. The attribute of Immutability produced the third highest response on the instrument, responses on attribute of Decentralization recorded fourth position, and the attribute of Authenticity attribute had the fifth position while, the least response rate came from the attribute of Visibility. Thus, the responses were composed of disparate options of block chain key attributes for supply chain collaboration.

Test of Hypotheses

Influence of BTC-Enabled Visibility on Supply Chain Collaboration

Table 5: Influence of BTC-Enabled Visibility on Supply Chain Collaboration (n=202).

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	.692	.481	.429	2.872

a. Predictors: (Constant) BTC-Enabled Visibility

b. Criterion: Supply Chain Collaboration

Source: SPSS Window Output, Version 22.0, 2022.

Table 5 shows the model summary, depicting how much of the variance in the dependent variable (supply chain collaboration) is explained by the independent variable (BTC-Enabled Visibility). The model portrays that with the R (Coefficient of Correlation) that there is 69.2% direct relationship between BTC-enabled visibility and supply chain collaboration, and R-Square value of .481, depicting that BTC-Enabled Visibility accounts for 48.1% of variances in supply chain collaboration. The remaining 51.9% is due to other variables that will affect supply chain collaboration but are not present in the model.

Table 6: ANOVA of the influence of BTC-Enabled Visibility on Supply Chain Collaboration (n=202).

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3201393	1	3201393	648433	.0000
Within Groups	1481137	201	199595		
Total	4682530	202			

a. criterion: Supply Chain Collaboration

b. Predictor: BTC-Enabled Visibility

Source: SPSS Window Output, Version 22.0, 2022.

Table 6 shows that between BTC-enabled visibility and supply chain collaboration, $F(dfB, dfw) = F(334, 1) = 648433$, $p < 0.05$. Significant value is 0.01, $r(1, 334)$. The results of the findings above revealed that the level of significance was 0.00 which is less than 0.05. This implies that the null hypothesis is rejected and the regression model is significant in predicting the effect of BTC-Enabled Visibility on Supply Chain Collaboration.

Influence of BTC-Enabled Traceability on Supply Chain Collaboration

Table 7: Influence of BTC-Enabled Traceability on Supply Chain Collaboration (N=202).

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	.442	.195	.191	3.576

a. Predictors: (Constant), BTC-Enabled Traceability

b. Criterion Variable: Supply Chain Collaboration

Source: SPSS Window Output, Version 22.0 (2022).

Table 7 shows the model summary, depicting how much of the variance in the dependent variable (supply chain collaboration) is explained by the independent variable (BTC-Enabled Traceability). The model portrays that with the R (Coefficient of Correlation) that there is 44.2% direct relationship between BTC-enabled traceability and supply chain collaboration, and R-square value of .195, depicting that BTC-enabled Traceability accounts for 19.5% of variances in supply chain collaboration. The remaining 80.5 % is due to other variables that will affect supply chain collaboration but are not present in the model

Table 8: ANOVA of the influence of BTC-Enabled Traceability and Supply Chain Collaboration (N=202).

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	77.074	1	77.074	374.879	.0000
Within Groups	23.849	201	206		
Total	100.94	202			

a. Criterion variable: Supply chain collaboration

b. Predictor: BTC-Enabled Traceability

Source: SPSS Window Output, Version 22.0 (2022).

Table 8 shows that between block chain technological application and BTC-enabled traceability $F(dfB, dfw) = F(334, 1) = 77.074$, $p < 0.05$. The results of the findings above revealed that the level of significance was 0.00 which is less than 0.05. This implies that the null hypothesis is rejected and the regression model is significant in predicting the effect of BTC-enabled traceability on supply chain collaboration.

DISCUSSIONS OF FINDINGS

The aim of this study was to investigate the connection between blockchain technology application and supply chain collaboration within energy companies in Rivers State. To achieve this aim, the study considered the influence on supply chain collaboration by two blockchain competitive attributes, namely BTC-enabled visibility and BTC-enabled traceability. The association between each set of constructs is discussed in terms of the results of the null hypothesis. The first null hypothesis (H_{01}) was rejected since BTC-enabled visibility had a considerable and statistically significant impact ($r=.692$; $p=.0000$) on supply chain collaboration. By inference, within energy firms, an increase in BTC-enabled visibility simplifies supply chain collaboration, positively affect the strategies used in the production/process of companies and her supply chain performance, and positively guarantee self-assurance into company's supply chain and puts off unproductive decisions to attain a physically powerful impact on supply chain collaboration. Likewise, the existence of BTC-enabled visibility in an energy company necessarily point to the entrenchment of more vigorous blockchain activities within the supply chain by that energy company. Our empirical findings showed that higher visibility lead to a higher level of supply chain collaboration. The current study corresponds to earlier results such as: Joon-Seok and Nina (2019) that blockchain technology characteristics (information transparency, information immutability, and smart contracts) have significant positive effects on partnership growth and marginal effects on partnership efficiency, and Chen (2020) whose findings show that, participants in supply chain (SC) networks in blockchain built-in trust mechanism, work broadly and visibly to run a dependable, well-situated, and distinguishable business.

The second null hypothesis (H_{02}) was rejected since there was a moderate positive and statistically significant association ($r=.442$; $p=.0000$) between BTC-enabled traceability and supply chain collaboration. This result demonstrates that supply chain collaboration is likely to improve as BTC-

enabled traceability increases within energy companies supply chains. Equally, it is commonsense to presume that energy companies that have established BTC-enabled traceability with their partners also exercise consequential supply chain collaboration. In other words, BTC-enabled traceability amongst energy companies predicts supply chain collaboration. Consistent with these results, a number of studies (Peterson & Baur, 2018; Vos, 2018; Dinesh *et al.*, 2020) concluded that, the application of blockchain technology positively influences supply chain collaboration.

CONCLUSION ANDRECOMMENDATION

This study investigated the impact of blockchain application on supply chain collaboration. The application of blockchain to supply chain collaboration of energy companies in Rivers State is functional because of blockchain attributes such as decentralization, immutability: Transparency, Security, Authenticity, Traceability and Visibility are applicable to supply chain collaboration in Energy Companies in Rivers State. With respect to this study, two attributes of blockchain application, namely BTC-enabled visibility and BTC-enabled traceability, were adopted as the dimensions of blockchain application. For supply chain collaboration, BCT-enabled visibility and BCT-enabled traceability attributes revealed positive effects. Interestingly, in the context of this study, the greatest impact on supply chain collaboration in energy companies in Rivers State originates from BTC-enabled visibility. The study therefore, concludes that, blockchain technology application significantly influences supply chain collaboration of energy companies in Rivers State, and recommends that, to remain competitive, Energy companies have to prioritize blockchain activities such as BTC-enabled visibility and BTC-enabled traceability to manage and strengthen their supply chain collaboration activities and improve their performance.

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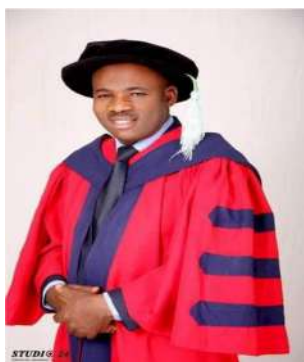
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Construction and Performance Evaluation of Poultry Feed Mixer

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Abstract: *The construction and performance evaluation of the poultry feed mixer was achieved using locally available materials. It was tested and affirmed that the machine can mix up to 361.44kg/hr of ingredients. It has an efficiency of 90.16% degree of mixing and requires less time for feeding, and it is not also difficult to operate. The cost of constructing the machine amounted to seventy thousand Naira only (₦70,000), which is affordable by the small and medium scale farmers, although this machine has been designed with a high standard in mind, there is however possibility of human error, therefore, any criticism regarding the enhancement of the outlook and general performance of the machine is accepted.*

Key words: *Construction, performance, evaluation, poultry, feed mixer*

1.0 INTRODUCTION

Mixing is one of the most important operations in the manufacturing of animal feeds and the mixer is considered to be the heart of feed milling operation. The need for uniformity in a complete feed is a must in order to satisfy the nutritional requirements of the animal to achieve growth, production, and good health as well as to meet regulatory guidelines of food and drug administration. Feed mixers are used in feed mills for the mixing of feed ingredients and premixes. The mixer plays a vital role in the feed production process, with efficient mixing being the key to good feed production. If the feed is not mixed properly, ingredients and nutrients will not be properly distributed when it comes to time to extrude and pelletize the feed, or if the feed is to be used as mash. This means that not only would the feed not have nutritional benefits, but it would also be bad for the animals that are eating it. The mixers produce a very homogeneous mix of different ingredients used in the feed industry.

As mills became multistoried structures, gravity spouting was used to direct the meal and grain from the top of the elevator legs. However, gravity spouting could neither reach the locations desired nor handle the various textures of grains selected by mill customers to meet their own individual needs. Horizontal devices were merely shaft with short pegs fastened in a spiral pattern which advanced the grain when the shaft rotated. All housed in long wooden boxes. With the invention of electric motor, sweeping changes in mill design took place. A specialized type of conveyor was developed called feeder. The construction was similar to the material handling conveyor, except it was shorter and by a motor and a speed reduction device called a gear box. This allowed for the achievement of variable speeds, which afforded mill operators added flexibility of operation (Culpin, 2000).

As the list of available ingredients increased, the mill operator was forced to reserve a bin or box for each ingredient. This process was accelerated as scientific research began to show the advantages of feeding balanced diets. The feeders were designed to empty into a large, slow-moving, collecting conveyor, which usually included a method to impede or separate part of the flow in an effort to improve blending. The storage of whole and ground grains has changed little since the construction of first mill bins. This was the key component of the first so called feeder line for the production of formula feeds on the American continents. Demand for higher production output led to the development of the feeder line plants. It has become obvious that acceptable weight control was difficult to achieve due to the variable densities of the individual ingredients that were being routinely used (George, 2009).

Each feeder was located under a single ingredient or premix bin which was put through the hopper and spouted to provide constant, uniform flows regardless of the rate demanded by the feeder. The inconsistencies of the volumetric feeder, resulting from variable ingredients, led to the development of the gravimetric feeder. This device allowed for continuous weight checks and provided automatic adjustment of the gate control mechanism. With the advent of drug and antibiotic use, it became obvious that the feeder line was incapable of accurately handling and mixing products with an inclusion rate of less than 1% of the mix. This led to the premixing of these micro-ingredients to a level above 1% with a diluent or carrier. This was usually accomplished at an alternative site with more sophisticated equipment than described above (George, 2009).

In the early days on the small family farm, the mixing of homegrown grains with supplements purchased from the local miller began with a smooth floor, shovel, and knowledge of quartering. Local village and commercial operators were more refined and had the advantage of both grinding and screening facilities to increase the efficacy of the formulas that were being prepared for animal feeds. In time, operators duplicated the action of the shovel by fashioning crude plows or paddles fastened to slowly rotating horizontal shafts contained in a wooden booth with a curved bottom (Culpin, 2000).

The mixing of feedstuffs to form a ration is a regular need on the large stock farms. There have been few official tests of the evenness of the mix of the various types of machines. Mixing is one of the most important operations in the manufacturing of animal feeds. And feed mixing machines are important in the feed pellet production line and are considered to be the heart of feed milling operations. A feed mixer is an efficient and versatile machine for mixing different kinds of powder and other materials. The feed

mixing machine can be made of stainless steel or alloy steel for your choice. It has the characteristics of high efficiency, reasonable structure, compact layout, reliable performance, and easy maintenance. And the finished powder after mixing makes the pellet production process much easier (Culpin, 2000).

Feed mixers are used in feed mills for the mixing of feed ingredients and premix. The mixer plays a vital role in the feed production process, with efficient mixing being the key to good production, if the feed is not mixed properly distributed it comes a time to extrude and pelletize the feed, or if the feed is to be used as a mesh. This has nutritional benefits, it would be bad for the poultry, animal, and shrimp that are eating it. The use of hand to mix the crushed poultry feeds by the traditional agricultural sector characterized by subsistence farming was perhaps the first form of poultry feed mixer. This method was subsequently developed by the use of manual machines after the advent of the industrial revolution in Great Britain. There is a universal demand for poultry feed mixers as machinery for food production. Our small and medium scale industries in the country are in dire need of high nutrition poultry feed for their birds to increase production output. The necessity to boost and sustain the economy which requires well-planned industrialization by increasing the level of our designing and manufacturing rather than mere assembling activities such an effort would reduce the importation of machines, spare parts, and components that can be produced locally.

Since the bulk of the economic activities in the rural part of the country is agricultural, it is general knowledge that those who are engaged in agriculture are poor in comparison with those who are engaged in agriculture are poor in comparison with those engaged in other sectors of the economy in Nigeria that is to say their standard of living is so low that shortage of funds to enable them purchase modern facilities has been a major difficulty in the development of agriculture. Feed production for livestock, poultry or aquatic life involves a range of activities, which include grinding, mixing, pelleting, and drying operations. New (1987) gave a summary of the different types of machinery needed for the production of various types of feeds and they include grinding, mixers, elevators, conveyors, extruders, dries, fat sprayers, and steam boilers. The mixing operation in particular is of great importance since it is the means through which two or more ingredients that form the feed are interspersed in space with one another for the purpose of achieving a homogeneous mixture capable of meeting the nutritional requirements of the target livestock, poultry life being raised. Unprofessional admixing of liquid components in the main mixer can cause insufficient homogeneity by the formation of agglomerates and deposits on the mixing tools. The deposits as sticks and crusts cause carry-over and contamination stochastically which cannot be compensated by rinsing batches. Mainly in cases of the mixing process by mixer, solid dispersed components have better suitability than liquid. Johnson (New Delhi, 2007). In most developing countries including Nigeria, a major common problem facing farmers' livestock, poultry, and or aquatic life is the lack of access of proper feed that can meet the nutritional requirements of their poultry at the right time in the right quantity and price. Dogo (2001) observed that the rate of poultry production in Nigeria is not commensurate with human population growth and demand. He, therefore, opined that the major constraint is the high cost of feed in the market.

2.0 PURPOSE OF THE WORK

The mixer plays a vital role in the feed production process, with efficient mixing being the key to good feed production. If feed is not mixed properly, ingredients and nutrients will not be properly distributed when it comes time to extrude and pelletize the feed, or if the feed is to be used as mash. The purpose of this work is to construct poultry feed mixer which is a type of mixer that consists of one or more vertical screws which elevate the ingredients to the top of the mixer where they fall by gravity to the bottom, to be mixed and re-elevated.

The primary purpose of the work is the provision of an improved feed mixer for cutting and mixing feed material such as hay. A further purpose of the work is the provision of a feed mixer having a plurality of claws for maintaining hay in the mixing chamber during the cutting and mixing process. Also, another purpose is the provision of a feed mixer having a plurality of claws to impede or prevent rotation of hay with the rotating auger, and also the provision of an improved vertical feed mixer which is economical to manufacture and durable and efficient in use.

3.0 PROCEDURE

The poultry feed mixer is constructed using locally available materials. A gauge 16mm metal sheet was cut to a size of 730mm x 1200mm and rolled, using a roller to form a semi-circular drum. Twelve (12) metal bars of 5mm x 250mm length were welded on a shaft of 750mm length x \varnothing 25mm which is passed through the drum. The mixing shaft is supported by bearings at the ends of the drum. A pulley is also attached to one end of the shaft.

A 50mm x 50mm angle iron was cut to size to form the frame which holds the drum; the two components were joined by electric arc welding to form the hopper, and the chute. The hopper was joined to the upper parts of the drum and the chute to the lower parts of the drum both using electric arc welding. A 5hp generator was fastened to the lower part of the frame using A-13 bolts to serves as a prime mover. Finally, a V-belt is fixed to the mixing shaft, via a pulley and the other end to the generator pulley.

4.0 INSTRUCTIONAL MATERIALS

The consists of a rectangular frame made of twelve (12) angle irons of 50 x 50mm, on top of the rectangular frame is a mixing drum of semi-circular shape. A mixing shaft with iron bars welded on as blades pass through the drum and aid the mixing. A hopper of truncated pyramid shape is welded at the top of the mixing drum. A chute at the bottom of the drum is provided for content delivery. A 5hp generator is fastened to the lower part of the frame giving drive to the mixing shaft via V-belt.

5.0 COST IMPLICATION

The table below shows the production cost of the poultry feed mixer:

S/NO	MATERIALS	SIZE	QUANTITY	AMOUNT
1.	Metal sheet	Gauge 16mm x 730 x 1200mm	1	
2.	Angle iron	50mm x 50mm	2	
3.	Bearing	Ø 26mm	2	
4.	Iron bar	5mm x 250mm	1	
5.	Shaft	Ø 25mm	1	
6.	Pulley	Ø 70mm & Ø 180mm	2	
7.	Belt	A55mm	1	
8.	Electrode	Gauge 16mm	1 packet	
9.	Bolt/Nut	A 13mm	16	
10.	Feeds	-	-	
11.	Labour	-	-	

6.0 MERITS AND DEMERITS

- Merits

- i. Poultry feed mixer does not make the material segregation when mixing materials. Feed materials will not occur grading phenomena, which can better achieve mixed accuracy.
- ii. The poultry feed mixer is suitable for small batch animal feed production and has low residual materials.
- iii. As one of the most popular small poultry feed machines, the poultry feed mixer adopts the helical structure mandatory, and the total power required for mixing feed materials is low, and the sealing performance is relatively good.
- iv. Mixing reduces waste of chicken feed, water soiling, and selective eating behavior in chickens.
- v. Reduces *Salmonella*, *E. coli*, molds, and more, and destroys growth inhibitors, like trypsin inhibitors and gossypol during processing.

- Demerits

- i. **Noisy:** The sound of the mixer is often very loud and irritating. This is because the people using it are unable to hear the voice of the other persons in the area.
- ii. **Sharp Blades:** Often while taking out the ground food materials from the mixer, if you are not very cautious, your finger might be wounded. The blades of the mixer are extremely sharp since they are used to cut through food substances. So the slightest carelessness can hurt your fingers resulting in a deep cut and heavy bleeding.

7.0 CONCLUSION

The construction and performance evaluation of the poultry feed mixer was achieved using locally available materials. It was tested and affirmed that the machine can mix up to 361.44kg/hr of ingredients. It has an efficiency of 90.16% degree of mixing and

requires less time for feeding, and it is not also difficult to operate. The cost of constructing the machine amounted to seventy thousand nairas only (₦70,000), which is affordable by the small and medium scale farmers, although this machine has been designed with a high standard in mind, there is however the possibility of human error, therefore, any criticism regarding the enhancement of the outlook and general performance of the machine is accepted.

8.0 SUMMARY

The developed machine reduced the labour cost of mixing by 40% and the time involved by 60% for compounding 250kg of feed. Different types of feed formulation and the production cost were stated above to enable farmers to produce feed at a cheaper rate. Poultry feed mixers can be fabricated vertically or horizontally, but the horizontal type requires more power than the vertical type. The fabricated machine s batch process of mixing and continuous mixing type can be fabricated using the same principle. The efficiency of the machine will reduce if the calculated power is not used for its operation. It will also delay the rate of mixing and lead to poor quality of feed.

9.0 SUGGESTIONS/RECOMMENDATIONS

- ❑ The machine should be modified to increase its efficiency in terms of capacity.
- ❑ The machine is recommended for use by small and medium scale poultry farmers
- ❑ To avoid vibration, the machine should be installed
- ❑ A cover should be provided for the hopper to avoid spillage of ingredients.

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Adsorption Potentials of Rice Husk for Treatment of Tannery Effluent in Zaria, Nigeria

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Abstract: Chromium rich tannery effluent is a serious threat to environment that need urgent and low cost Agro-based adsorbents for removal of heavy metals. The prepared adsorbent was characterized based on the moisture content, bulk density, surface area, point of zero charge, zeta potential, fourier transform infrared (FTIR) spectroscopy, surface morphology using scanning electron microscopy (SEM), electron dispersive spectrum (EDS), and thermos-gravimetric analysis (TGA). The experiment was conducted at room temperature and adsorbent particle size of 0.15 mm to investigate the adsorption capacities of rice husk powder on removal of Cr, Cd and Cu from tannery wastewater. The experiments were conducted to evaluate the influence of variables on removal of the heavy metals by optimizing adsorbents dosage of 5, 10, 15g and contact time of 60, 120, 180 min. The results obtained from the characterization of the adsorbents indicated that the prepared bio-sorbents have good adsorptive properties with as much as $973\text{m}^2/\text{g}$ for rice husk surface area respectively. The bulk density; $0.386\text{g}/\text{cm}^3$, moisture content; 1%, point of zero charge; 5.92, Surface area; $973\text{m}^2/\text{g}$ and surface morphology properties showed them to be good adsorbents. The use of rice husk mixture in the treatment of tannery effluent, indicated that rice husk is more effective in removing chromium from tannery effluent with a success of 88.6 %. Optimum operating conditions are concluded to be a contact time of 60 minutes at an adsorbent dosage of 5 g at ambient room temperature. Experimental data has well fitted into Freundlich isotherm model with R^2 value of 0.9573 and second-order kinetic model suggesting second-order nature of the process with R^2 value of 0.988, clearly indicating that one metal ion is absorbed onto two sorption sites on the adsorbent surface.

Key words: Adsorbent, Heavy metals, Leather, Wastewater

Introduction

Tanning is the chemical process that converts animal hides and skin into leather and related products. The transformation of hides into leather is usually done by means of tanning agents and the process generates highly turbid, colored and foul smell wastewater.

The tanning industry plays an important role with respect to environmental pollution due to disposal of large volume of solutions of tanning baths. More than one hundred different chemicals and nearly 350,000 tones/year of inorganic and heavy metal salts, soaps, oils, waxes, solvents, and dyes, used in tanning processes are found in process wastes and wastewater (Fabianil *et al.*, 1996). The major components of the effluent include sulfide, chromium, volatile organic compounds, large quantities of solid waste, suspended solids like animal hair and trimmings. The discharge of chromium rich tannery effluent is a serious threat for environment with high concentrations of organic and inorganic component that they create risk to human health and environmental aspects (Cetin *et al.*, 2013).

Many investigators have examined a wide variety of absorbents like fly-ash, peat, sawdust, brown coal, bagasse, activated carbon to remove chromium from tannery industry wastewater. Recently, numerous approaches have been studied for the development of cheaper and more effective technologies, both to decrease the amount of wastewater produced and to improve the quality of the treated effluent. Adsorption has become one of the alternative treatments, in recent years; the search for low-cost adsorbents that have metal-binding capacities has intensified (Leung *et al.*, 2000). The adsorbents may be of mineral, organic or biological origin, zeolites, industrial byproducts, agricultural wastes, biomass, and polymeric materials (Kurniawan *et al.*, 2005). Rice husk is one of the main agricultural wastes in milling processes that is abundantly available in Nigeria. Rice husk is an agro-waste which is produced in about 100 million of tons. About 10^8 tons of rice husks are generated annually in the world. In Nigeria about 2.0 million tons of rice is produced annually (Oyetola and Abdullahi, 2006). Approximately, 20 kg of rice husk are obtained from 100 kg of rice by burning so as to generate rice husk powder which is rich in silica and can be an economically valuable raw material for production of natural silica (Kalapathy *et al.* 2000). Industrial importance of rice husk (RH) is due to the presence of silica in hydrated amorphous form. The rice husk contains 80 per cent organic volatile materials and remaining 20 per cent silica (James and Subbarao, 1996).

In recent years, attention has been focused on the utilization of unmodified or modified rice husk as an adsorbent for the removal of pollutants. Batch studies using tartaric acid modified rice husk as adsorbent have been carried out for the removal of lead and copper and have reported the effects of various parameters such as pH, initial concentration of adsorbent, particle size and temperature. It was reported that modified rice husk is a potentially useful material for the removal of Cu and Pb from aqueous solutions (Wong *et al.*, 2003). Thus, it becomes essential to remove Cr (VI) from industrial waste water before discharging it into water body or on to land (Macchi *et al.*, 1991). The Nigerian Institute of Leather Technology carries out tanning process as part of its learning teaching processes and discharges the effluent into the river without proper treatment. The receiving water body either surface or groundwater get contaminated as most of the residences uses shallow wells as source of domestic water supply. In recent years, the need for safe and economical methods for the elimination of heavy metals from contaminated waters has necessitated research interest towards the production of low cost alternatives to commercially available activated carbon. Therefore, there is an urgent need that all possible sources of agro-based inexpensive adsorbents should be explored and their

feasibility for the removal of heavy metals should be studied in detail. Conservative technologies for metal control have an increasing interest, as they are able to remove pollutants and reuse valuable by-products resulting from the wastes and or side streams from manufacturing processes. The objective of this study is to evaluate the adsorption kinetics and equilibrium sorption of Chromium, Cadmium and Copper to rice husk powder as adsorbents.

Materials and Method

Study area

The Nigerian Institute of Leather technology is located in Samaru Zaria, which lies within latitudes 11° 06' N and 11° 12' N of the equator and longitude 7° 39' E and 7° 45' E of the Greenwich meridian. The mean daily temperature ranged from 26.7°C to 28.9°C. The average duration of sunshine in August varies from 3 to 6 hours. The Galma river is the only perennial river in the area, the others are either completely dried up during the dry season along their channels. River Galma, which is also among the major tributaries of River Kaduna is the main drainage system in Zaria, supplied with run-off and seepage from drainage basin about 5.0km² in area (Folorunsho and Brinemigha, 2011). The estimated population of Samaru was 124,582 people (NPC, 2009). The residence of Samaru mainly depend on shallow wells (Folorunsho and Brinemigha, 2011). On the Normality of Monthly Rainfall Series of Samaru, Zaria (1979-2009). The annual average rainfall of Zaria is 1050 mm according to Köppen-Geiger system.

Preparation of the adsorbents

The preparation of the adsorbents started with the collection of Rice husk from local rice milling centre in Zaria city and mixed to form homogeneous mixture. Then, homogeneous mixture of rice husk was thoroughly washed with distilled water to clean dirt and mud and heated to the temperature of 104 °C for 3 hours. The rice husk was grinded into fine powder using kitchen grinder and sieved to particle size fraction of 100 mesh size (0.150mm).

Characterization of the adsorbents

The prepared adsorbents were characterized based on the moisture content, bulk density, surface area, point of zero charge, zeta potential, fourier transform infrared (FTIR) spectroscopy, surface morphology using scanning electron microscopy (SEM), electron dispersive spectrum (EDS), and thermos-gravimetric analysis (TGA). The determination of the adsorbent pH was carried out by using a pH meter (model ATPH-6).

Specific surface area

Saers method was used for the determination of the surface area, the volume V required to raise the pH from 4.0 to 9.0 was noted and the surface area was computed from the Equation 1:

$$s \left(\frac{m^2}{g} \right) = 32v - 25 \quad (1)$$

Where: s = surface area

v= volume required to raise the pH

m= mass of the adsorbent (g)

g= acceleration due to gravity

Moisture content

The moisture content of the adsorbents was determined by the difference in the mass constitutes of the amount of moisture content of the adsorbent, Equation 2.

$$\% \text{ moisture content} = \frac{w_2 - w_3}{w_2 - w_1} \quad (2)$$

Where: W1 = Weight of crucible

W2 = Initial weight of crucible with sample

W3 = Final weight of crucible with sample

Bulk density

The bulk density of each of the adsorbents was determined using Archimedes principle using Equation 3:

$$\text{bulk density} = \frac{w_2 - w_1}{v} \quad (3)$$

Where: W1 = Weight of empty measuring cylinder

W2 = Weight of cylinder filled with sample

V = Volume of cylinder

Point of zero charge

pH drift method was used to determine the point of zero (PZC) charge of the adsorbents (pH pzc), a plot of final pH against initial pH gives the point of zero charge pH

Scanning electron microscopy (SEM)

The microstructures of the adsorbents (rice husk) were obtained using FE- SEM Integrated system. The samples were prepared in stub holders with double face carbon tape, placed on an aluminum sheet and covered with gold, using a Balzers SCD 050 evaporator. The same SEM samples were scanned at 100 um magnification and 20kV and the results of percentage of C, O and other metals are showed in the spectra.

Zeta potential

Zeta potential measures the electrical charges of particles that are in suspension. The zeta potential of the adsorbents (rice husk and banana peel) were obtained using a Malvern

Zetersizer Nano-ZS (Malvern, USA). The zeta potential of the samples was then determined from their mobility based on Smoluchowski equation.

Energy-dispersive-X- ray spectrum (EDS)

The surface morphologies of the samples were characterized by scanning electron micrographs using JSM-6460LV. (Jeol) SEM. The analysis of samples was performed at various magnification sizes (50 μm , 10 μm , 200 nm and 500 nm) at 5-20 kV. The same SEM sample was scanned at 100 μm magnification and 20kV and the results of percentage of C, O and other metals are showed in the spectra.

Fourier transform infrared (FTIR) spectroscopy

The Fourier transform analysis of the samples was performed using Thermo scientific Nicolet attenuated total reflection (ATR) instrument (6700). The samples were scanned at resolution of 4cm (32 scans) from wavelength 500 to 4000 wavelength. The software shows the spectra of sample containing peaks of different functional groups which will be used for the identification of functionalities of sample surface.

Thermo-gravimetric analysis (TGA)

The thermal behavior and decomposition pattern via thermos-grametric analysis was recorded on a TGA/DSC (SDT-Q600) analyzer by heating dry powder of the adsorbents at 10°C.

Adsorbate preparation and characterization

Physicochemical parameters including COD, BOD, DO, nitrates, phosphates, pH and metal ion concentration of the effluent sample were analyzed following standard method of water and wastewater treatment. Membrane filters of 0.45 μm that were dried at 103°C for one hour, weighed and placed in a desiccator were used to determine the total suspended solids (TDS). A sterile container was used to collect the sample and mixed thoroughly by inverting the bottles several times to obtain a homogeneous mixture. Sample of 100 mL was poured into the membrane filter assembly holding the previously weighed membrane filter and attached to a suction pump and then filtered. The filter paper was then dried at 103°C and reweighed. Total suspended solids concentration was afterwards obtained by deducting the initial weight of the filter paper from its final weight. Physicochemical parameters such as nitrates, phosphates were all determined using Standard Methods for the Examination of Water and Wastewater 18th edition (APHA, 2012). The pH and temperature of the samples were analyzed using the multi-parameter photometer and thermometer respectively. The concentration of COD of respective samples was calculated using Equation 3.4:

$$\text{COD} = \frac{1000(a-b)N}{\text{volume of sample used (ml)}} \text{ mg/L} \quad (4)$$

Where, a and b are the respective volumes of $\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ used for blank and sample (ml), VIS the volume of sample used (ml) and N normality of $\text{Fe}(\text{NH}_4)_2\text{SO}_4$.

Heavy metals characterization

The heavy metals (Chromium, Cadmium and Copper) and others present in the tannery wastewater were characterized using atomic absorption spectrophotometer (AAS) Atomic absorption spectrophotometer (AAS) (Shimadzu Jenway Spectrophotometer 6400) and Atomic absorption spectrophotometer (AAS) (Shimadzu Japan Spectrophotometer AA 6800).

Batch experiment

The experiments were conducted at room temperature and adsorbents particle size of 0.15 mm to investigate the adsorption capacities of rice husk powder on removal of Cr, Cd and Cu from tannery wastewater. The experiments were conducted to evaluate the influence of variables on removal of the heavy metals by optimizing adsorbents dosage of 5, 10, 15g and contact time of 60, 120, 180 min. Tannery effluent was collected in 12 glass beakers of 50 ml capacity and was put on a mechanical shaker apparatus for different adsorbent dosage and contact time. The treated samples with various processes were filtered and the settled particles removed and collected for characterization. The clear samples after settlement (24 hours) were tested by a digital spectrophotometer to find out the reduction in concentrations of Cr, Cd and Cu in the tannery wastewater. The adsorption removal percentage was calculated using Equation 3.5.

$$\text{Percentage Removal} = [(C_o - C_t) / C_o \times 100] \quad (5)$$

Where: C_o = Initial concentration

C_t = concentration after adsorption by adsorbent.

Isotherm and Kinetics study

For the isotherm and kinetics study, the stock solutions of Cr(VI) of concentration 500 ppm were prepared by dissolving 1.414 grams of analytical grade of $K_2Cr_2O_7$ in 500ml of deionized water. The stock solution is further dilute with distilled water to desired concentration for obtaining the standard solutions for absorbance measurement (Ahmed et al., 2012). The batch experiment for the isotherm study was done at room temperature to determine the equilibrium adsorption isotherms by serial dilution of the stock solution and keeping contact time constant. 5g of rice husk was added to 50ml of the stock solution and was shaken with magnetic stirrer at 250rpm for 1 hour. For the kinetic study a batch experiment was done by adding 5g adsorbents mass into 50ml of the prepared stock solution and was shaken with magnetic stirrer at 250rpm and varying contact time (15, 30, 45, 60, 75 & 90 minutes).

Data analysis

The heavy metals concentration of the tannery wastewater samples was analyzed using excel (2013) and SPSS (V. 20). The kinetics of adsorption was analyzed using two kinetic models, pseudo first order and pseudo second order kinetic models and three adsorption isotherms were used to analyze the data obtained.

Results and Discussion

Rice Husk Characteristics

The result of characteristics of rice husk are presented in Table 1

Table 1: Physicochemical characteristics of the adsorbents

Parameters	Rice Husk
Electrical conductivity	0.60 ds/m
Point of zero charge	5.92
Moisture content	0.01
Bulk density	0.386 g/cm ³
Surface area	973-567 (m ² /g)
Surface morphology	Plate 1

Moisture content

Adsorbent Moisture content is a measure of the amount of water present in the adsorbent. It has no effect on the adsorption capacity of an adsorbent, however, high percentage moisture is usually discouraged, this is because high amount of moisture in an adsorbent increases the mass of the adsorbent required during the adsorption process. The moisture content obtained for the rice husk in this study is 0.136% which is better than the 0.7% moisture content reported by Sivakumar (2014). Dada *et al.* (2012) from the study of Sorption of Zn²⁺ unto Phosphoric Acid Modified Rice Husk and Sivakumar *et al.* (2014) reported much higher percent moisture of 12% and 6% respectively for rice husk silica.

Bulk density

The value of bulk density of prepared sawdust activated carbon as shown in Table 4.2 is 0.386g/cm³ for rice husk and 0.424g/cm³ for banana peel and according to Suleiman *et al.* (2012), bulk density for a good adsorbent should not be less than 0.25g/ cm³. The bulk density of rice husk is better than 0.68 g/cm³ reported by (Colony and Pradesh, 2012).

Surface morphology

SEM images was obtained to study the surface behavior of rice husk, this image shows a more irregular texture and porous nature of the adsorbent surfaces. This rough irregular surface and increased number of pores indicates higher or increased surface area, (Swarna, 2012). The 4 SEM images labelled a, b, c, and d in Plate I for rice husk with different magnifications of 666x, 477x, 477x and 815x respectively.

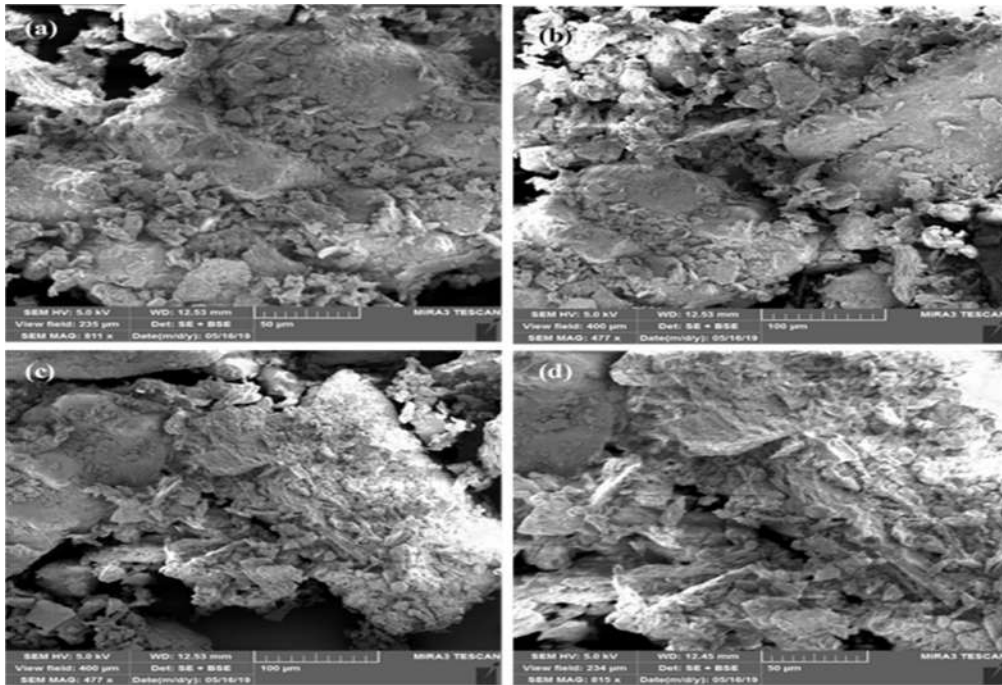


Plate I: SEM images of rice husk

Energy-dispersive-X- ray spectrum (EDS) analysis

The EDS analysis of rice husk, it was observed that CaCO_3 and SiO_2 had the highest atomic percentage weight present of 60.05% and 34.19% respectively. While the Au concentration stands for hydrogen concentration. Compounds such as CaCO_3 and SiO_2 have been shown to have good adsorption characteristics and high surface area particles (Min *et al.*, 2003).

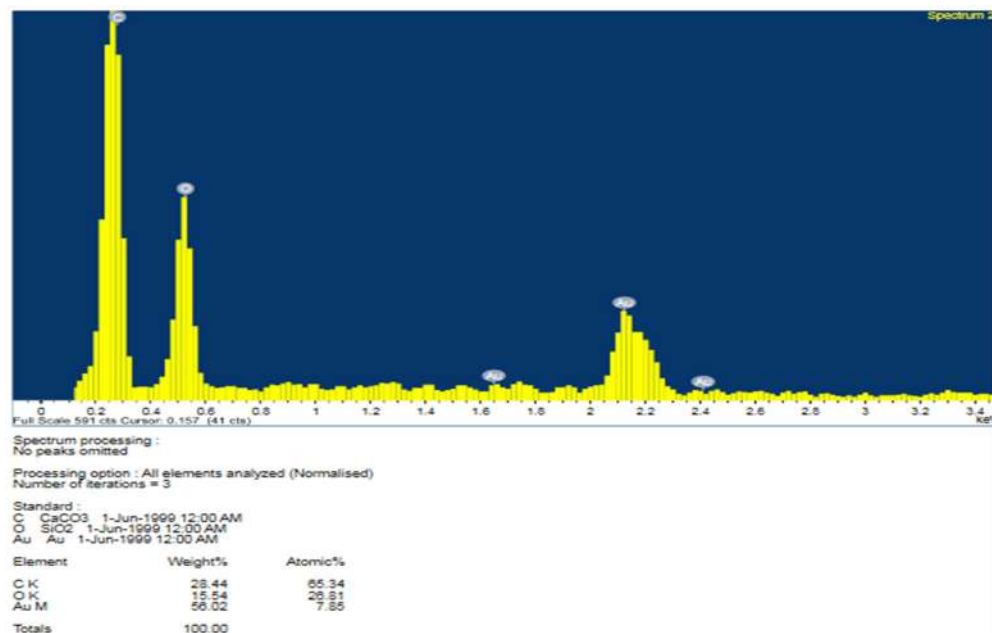


Figure 1: Energy-dispersive-X- ray spectrum (EDS) for rice husk

Dynamic thermos-gravimetric analysis (TGA)

The pyrolysis curve for rate of weight loss and temperature changes. Thermal behavior and temperature dependent decomposition patterns of the adsorbents were investigated by thermo-gravimetric analysis (TGA) under nitrogen environment up to 800°C. Rice husk experienced three modes of weight losses which resulted in total weight reduction by 52% and 64%, respectively. Intercalated and physisorbed water molecules are removed up to a temperature below 200°C in the first stage, and this accounts for 7.5 and 8.5% weight loss. This is followed subsequently by dehy-droxylation (DH), decarboxylation (DC) and removal of other interlayer anions such as nitrates in the second stage of weight loss between 200°C and 300°C, which resulted in 1.2 and 2.5% loss for both. The third stage involves drastic weight loss beyond 300°C with further decarboxylation and dehy-droxylation results in the production of mixed metal oxides. Rice husk experienced two modes of weight reduction which are mainly due to decarboxylation and the interlayer anions removal and formation of MMO. Most of the water molecules have been eliminated due to calcination. Between (35°C and 40°C), the rice husk gained weight due to absorption of water molecules from the environment, and these were subsequently removed with an increase in temperature.

Zeta potential

Zeta potential of each adsorbent in different solutions was averaged with 6 repeats ± 1 SD. The rice husk exhibits a negative zeta potential which is a good indication for the adsorption potential of heavy metals.

Point of zero charge

The point of zero charge for Rice Husk sample was determined to be 5.92, The pH at which the positive and negative charges on the biosorbent surface are balanced is often referred to as the point of zero charge (PZC). The pzc differs for different biosorbents (Andersson, 2014). The charged surfaces of mineral particles results in an ability to attract and adsorb dissolved ions. The extent of this ability depends on the specific surface of the particles, as a larger specific surface can contain more charges and thereby attract a larger number of ions (Andersson, 2014).

Fourier Transform Infrared (FTIR) Analysis

The FTIR spectrum of rice husk indicate complex surface by presence of several peaks with strong absorption band at 3272 cm^{-1} due to O-H stretching from hydroxyl group of carboxylic acid, while the band at 2900 cm^{-1} is due to C-H absorbance typical of organic material. The band 1603 cm^{-1} indicates the presence of carbonyl group via strong absorption, which further corroborates the band at 3272 cm^{-1} by an up field shift while the band at 1319 cm^{-1} corroborates the band at 2900 cm^{-1} in establishing the presence of C-H group through bending absorption. The band at 1033 cm^{-1} reveals the presence of an ether type C-O-R bond via stretching absorption as shown in Figure 2.

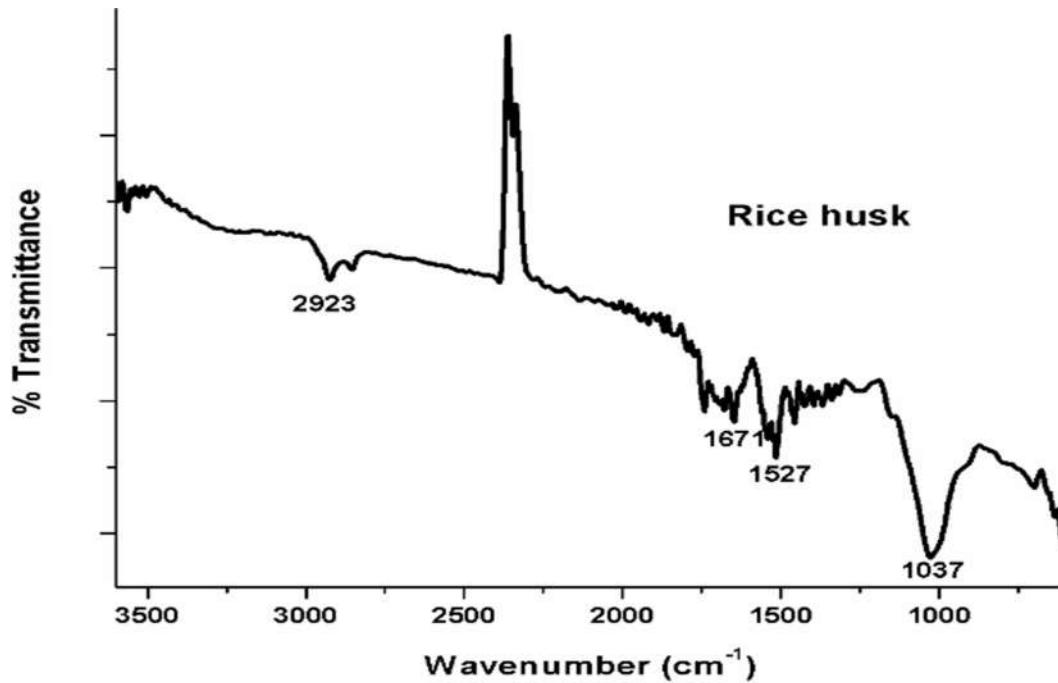


Figure 2: FTIR curve for rice husk

Batch Adsorption Tests

The batch adsorption was carried out with varying adsorbent dosage and contact time at ambient room temperature. The effect of adsorbent dosage was studied at 5g/l, 10g/l, 15g/l, while the effect of contact time was observed at 60min, 120min, and 180min. Figure 3 shows the variation of percentage removal of Chromium with time and rice husk dosage.

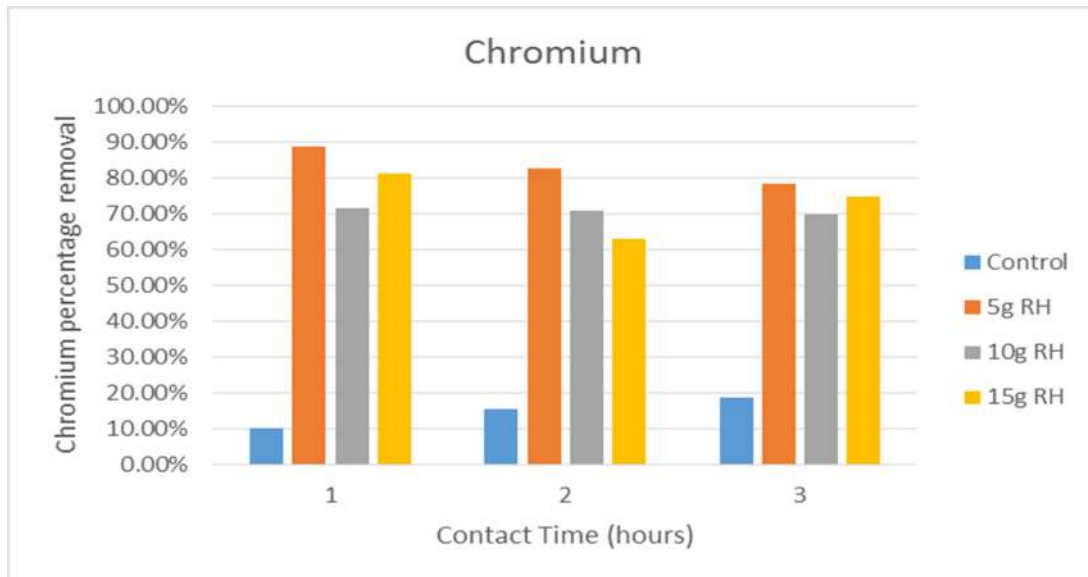


Figure 3: Effect of time and RH dosage on percentage removal of Chromium

The adsorption of Chromium did not show consistent increase in adsorption process with increased adsorbent dosage. The percentage removal of Chromium can be observed to be

optimum with 5g rice husk dosage for the 1hr agitation time (88.6%), 82% for the 2hr and 78% for the 3hr respectively. Hence 1 hour can be considered optimal percentage removal time for chromium using 5g RH. On the other hand, 10g RH shows no significant increase or decrease in Chromium percentage removal with agitation time variation, 72% for the 1 hour to 73% for the 2 hour and 71% for the 3 hour respectively. Hence 2 hr can be considered optimal percentage removal time for 10g RH. Similarly, for 15g RH there is a drastic decrease in Chromium percentage removal for the 1 hour and 2 hour (83% and 63%) respectively, then increase in percentage removal (75%) for the 3 hour shaking time. Hence, the optimal percentage removal time for 15g RH is 1 hour. The reference sample (control or 0 g RH) shows slight percentage removal of Cr 10% for 1 hour agitation time, 16% for 2 hour and 19% for 3 hours respectively probably due to adsorption by the container walls.

About 90 % removal of Cr(VI) in an aqueous solution using rice husk ash was achieved by Anand *et al.*, (2014). Whereas, Singh and Singh, (2012) found that the maximum removal (94 %) of Cr (VI) using rice husk carbon. Nearly 79.94 % removal of Cr(VI) in a tannery industry wastewater was only achieved using rice husk (Swathi *et al.*, 2014) and the removal percentage of 88.3 % in a tannery industry using rice husk silica powder (Sivakumar, 2015). This study removed the maximum of Cr(VI) in a tannery industry wastewater with 88.6%. The maximum removal of Cr(VI) in an aqueous solution achieved with the contact time of 180 min. (Singha *et al.*, 2011), 100 min. (Anand, *et al.*, 2014) and 60 min (Sivakumar, 2015). This study removed the maximum of Cr(VI) in a tannery industry wastewater rather than the aqueous solution with the contact time of 60 min. Figure 4 shows the variation in percentage removal of copper with time and rice husk dosage.

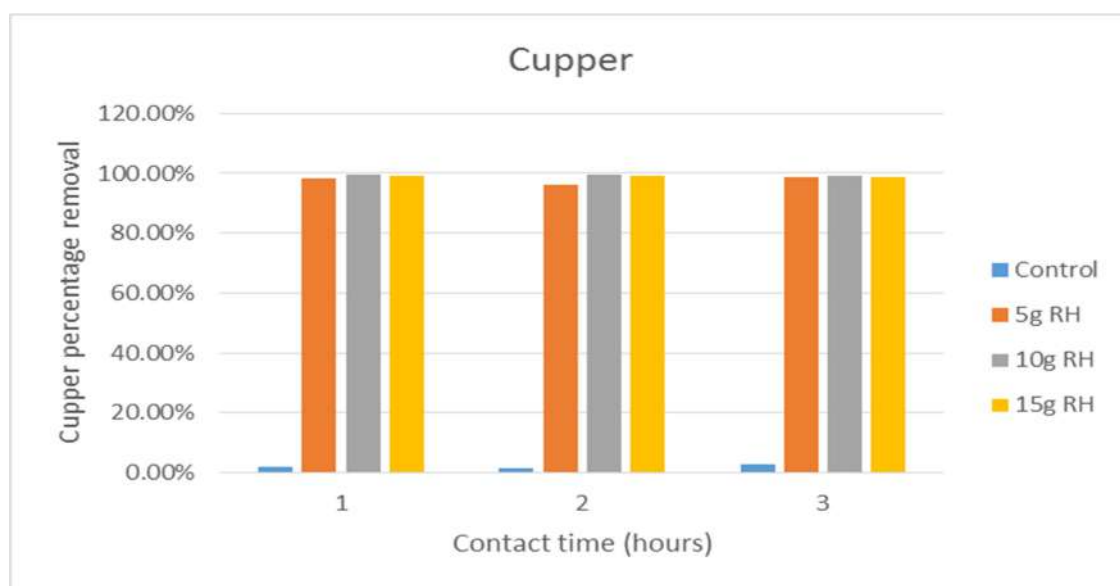


Figure 4: Effect of time and RH dosage on removal of Copper.

The percentage removal can be seen to be (98%, 96%, 98.9%) 5g RH, (99.6%, 99.7%, 99.1%) 10g RH, (99.1%, 99.3%, 98.7%) 15g RH for 1, 2 and 3 hour agitation time respectively. A slight percentage removal was observed in the control sample of 1.99%,

1.44%, and 2.92% for 1, 2 and 3 hour contact time. Figure 5 shows the variation in percentage removal of cadmium with time and rice husk dosage.

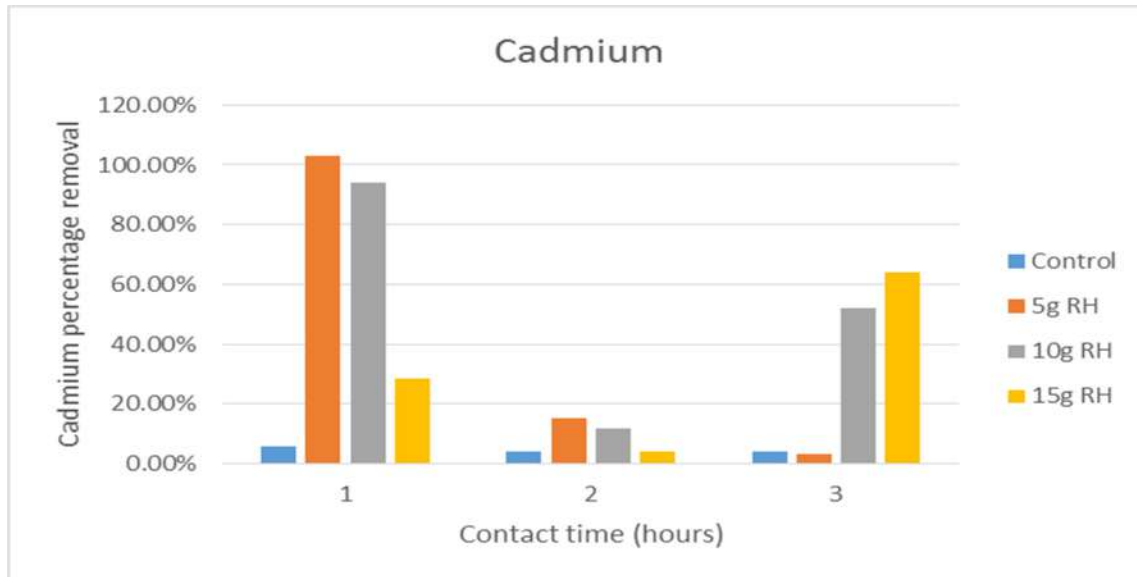


Figure 5: Effect of time and RH dosage on removal of Cadmium

The percentage removal can be seen to be (102%, 14.9%, 3%) 5g RH, (93.9%, 11.6%, 98.89%) 10g RH, (28.6%, 3.9%, 64%) 15g RH for 1, 2 and 3 hour agitation time respectively. There is also a slight percentage removal of (5.7%, 4.2%, 4%) in the control sample for 1, 2, and 3 hour agitation time. Figure 6 shows consistent increase in percentage removal of BOD, COD, PO₄ and NO₃ with increased adsorbent dosage.

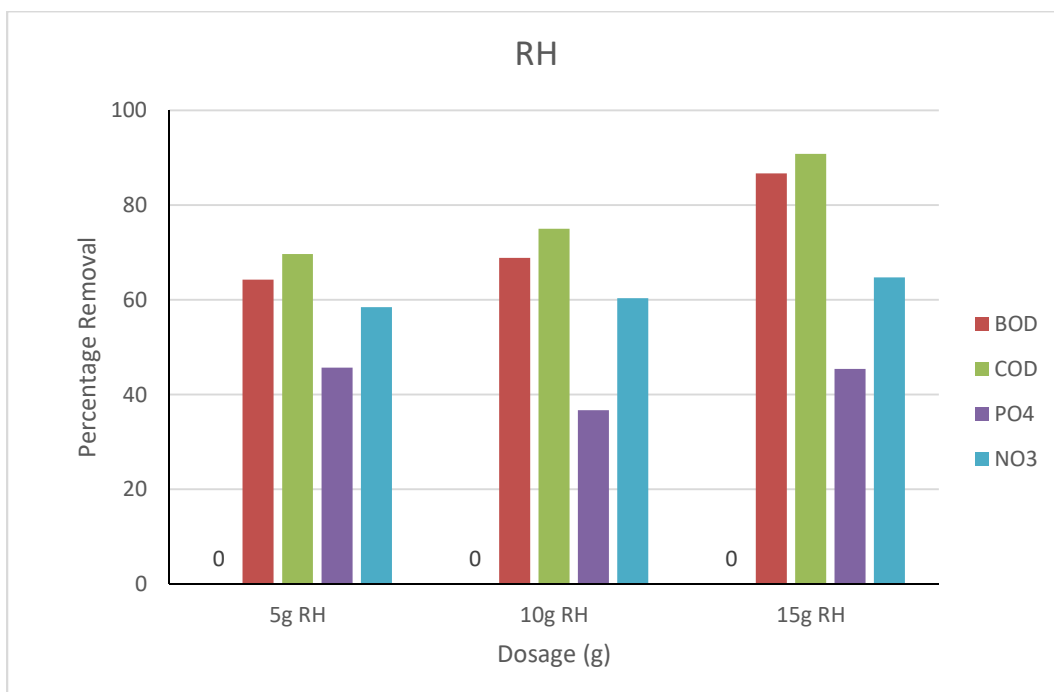


Figure 6 Effect of rice husk dosage on BOD, COD, PO₄ and NO₃

The percentage removal of BOD, COD, PO₄ and NO₃ can be observed to be (64.29%, 69.69%, 45.71%, 58.48%) for 5g RH dosage, (68.89%, 75%, 36.71%, 60.34%) for 10g RH dosage and (86.67%, 90.82%, 45.41%, 64.71%) for 15g RH respectively.

Adsorption isotherms

Two isotherm equations were adopted in this study, the Freundlich and Langmuir equations.

Freundlich isotherm equation

The plot of the linearised form of the Freundlich isotherm equation is shown in Figure 7, which is a plot of $\ln q_e$ against $\ln C_e$. The Freundlich isotherm constants K_f and n , and the correlation coefficient are listed in Table 4.6.

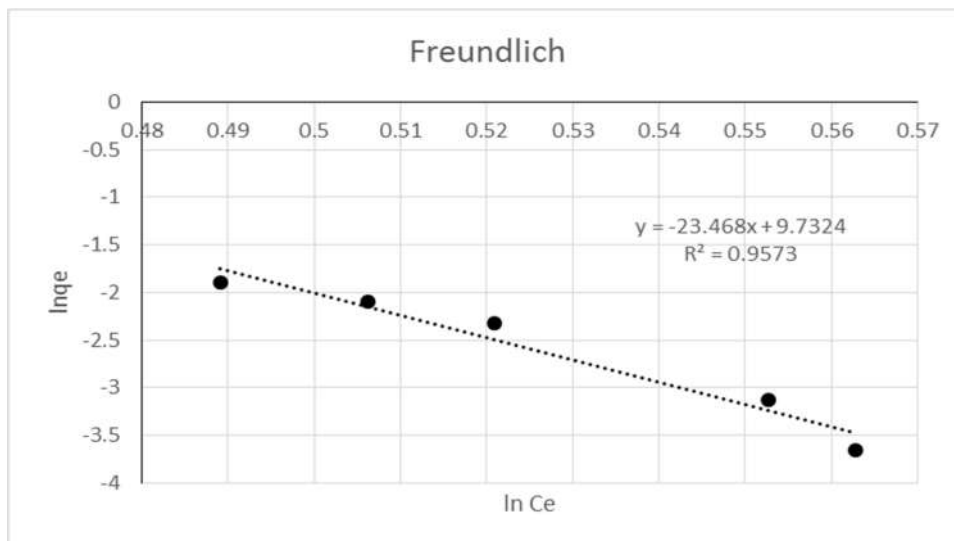


Figure 7: Freundlich isotherm model for sorption of chromium

Table 2: Adsorption Isotherm Parameters

Isotherm Model	PARAMETERS	Rice Husk
Freundlich	$K_f (\text{min}^{-1})$	1684
	$1/n$	0.0426
	R^2	0.9573
Langmuir	$K_L (\text{l/mg})$	1.623
	Q_{\max}	0.00236
	R^2	0.8532
	R_L	0.2636

Boparai et al. investigate the adsorption of lead (II) ions from aqueous solutions using coir dust and its modified extract resins. Although several isotherm models were applied, the equilibrium data was best represented by Freundlich and Flory-Huggins isotherms due to high correlation coefficients (Ayawei *et al.*, 2017).

Langmuir isotherm equation

The plots of C_e/Q_e against C_e for the Langmuir equation are shown in Figure 7 indicating the adsorption of chromium on rice husk powder give a straight line.

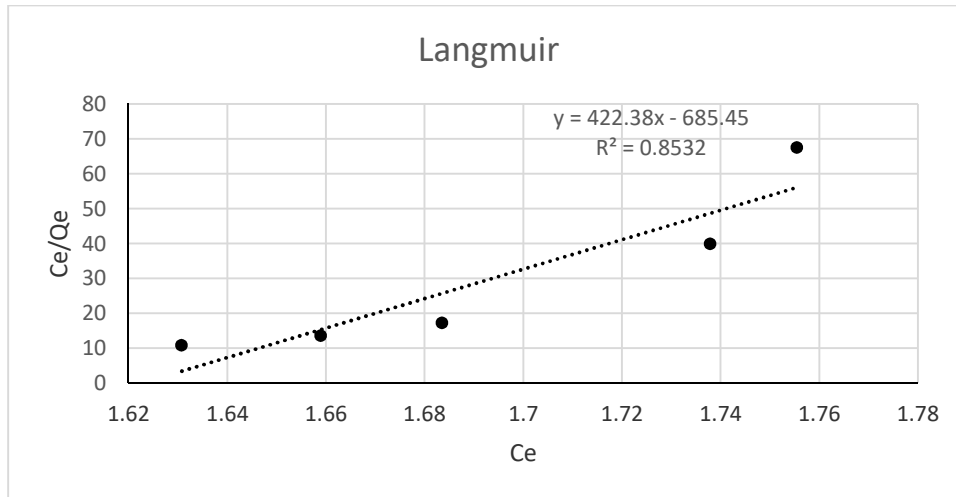


Figure 8: Langmuir isotherm model for sorption of chromium

The Langmuir Separation factor, R_L is a dimensionless constant and is essential characteristic of Langmuir isotherm model. The Langmuir isotherm constant and the correlation coefficient R^2 are listed in Table 4.6. The small value of R_L (0.2636) indicates a favorable adsorption.

Adsorption Kinetics Studies

The plot of linearized form of the pseudo-first order equation is shown in Figure 8, which is a plot of $\log(q_e - q_t)$ against time (minutes).

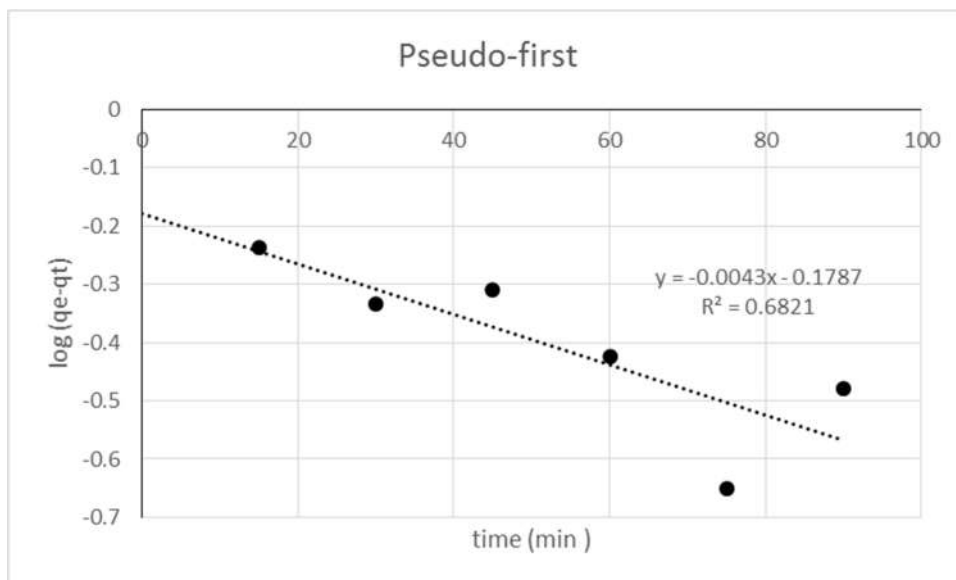


Figure 9: Pseudo-first order sorption kinetics of Cr^{6+}

The pseudo first-order rate constant k_1 , amount of Chromium ion adsorbed at equilibrium q_e , and correlation coefficients are shown in Table 4.7 as 0.0099, 0.015mg/g and 0.6821. The plot of linearized form of the pseudo-second order equation is shown in Figure 9.

Table 3: Adsorption Kinetic Parameters

Kinetic Model	PARAMETERS	RICE HUSK
Pseudo 1 st	k_1 (min ⁻¹)	0.0099
	q_e (mg/g)	0.015
	R^2	0.6821
Pseudo 2 nd	k_2 (gmg ⁻¹ min ⁻¹)	0.1009
	q_e (mg/g)	95.23
	R^2	0.9878

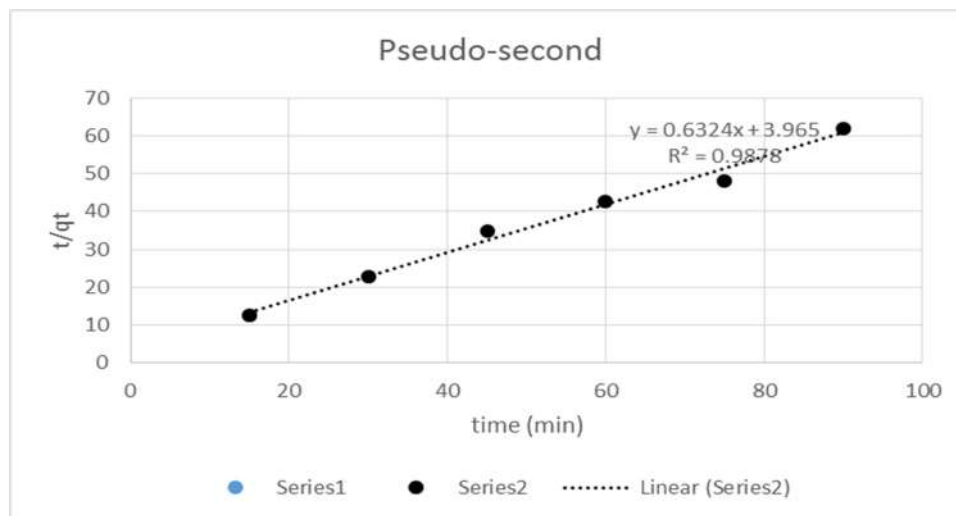


Figure 10: Pseudo-second order sorption kinetics of Cr⁶⁺

The results showed that, the correlation coefficients, R^2 obtained for pseudo first order kinetics model was 0.6821 which is very low compared to the pseudo second order kinetics model constants. The pseudo-second order plot showed a R^2 value of 0.9878, experimental q_e value of 0.0158mg/g and the pseudo-second order rate constant k_2 value of 0.1009 as shown in Figure 4.23, which is a plot of t/q against t . Therefore, the data fitted better with pseudo second-order kinetic model based on the correlation coefficient.

ANOVA for Cadmium, Chromium and Copper Percentage Removal by Dosage

Table 3 shows the Analysis of Variance for Cadmium, Chromium and Copper percentage removal by dosage with a significant value of $p = 0.002$, 0.000, 0.000 respectively. This implies that there is change or significant difference in Cadmium, Chromium and Copper removal between the different levels of dosage with reference to the control sample.

Table 4: ANOVA for Heavy Metals Percentage Removal by Dosage

		Sum of Squares	df	Mean Square	F	Sig.
Cadmium	Between Groups	2.329	10	.233		
	Within Groups	7.993	106	.075	3.089	.002
	Total	10.323	116			
Chromium	Between Groups	7.525	10	.752		
	Within Groups	.745	106	.007	107.122	.000
	Total	8.269	116			
Copper	Between Groups	8.059	10	.806		
	Within Groups	.018	106	.000	4724.741	.000
	Total	8.077	116			

Conclusion

The study revealed that the tannery effluent contains pollutants that are beyond the NESREA discharge limit, hence, should be treated prior to disposal. The results obtained from the characterization of the adsorbents indicated that the prepared bio-sorbents have good adsorptive properties. The use of rice husk mixture in the treatment of tannery effluent, indicated good adsorbent still, rice husk is more effective in removing chromium from tannery effluent. The rice husk is an effective adsorbent in the treatment of tannery effluent prior to disposal with a COD, BOD, Nitrate and phosphate removal. Optimum operating conditions are concluded to be a contact time of 60 minutes at an adsorbent dosage of 5g at ambient room temperature. Experimental data has well fitted into Freundlich isotherm model and second-order kinetic model suggesting second-order nature of the process, clearly indicating that one metal ion is absorbed onto two sorption sites on the adsorbent surface.

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Electrical Machines Skills Needed by Polytechnic Graduates for Employment in Oil and Gas Industry in Niger-Delta, Nigeria

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Abstract: The study was conducted to assess the electrical machines skills needed by polytechnic graduates for employment in oil and gas industry in Niger-Delta, Nigeria. A total of 82 electrical supervisors and graduates working in oil and gas industry were purposively sampled and used for the study which was guided by a research question and hypothesis. A 39-item, self-structured questionnaire designed on a 5-point Likert scale was used to gather data from the respondents. The instrument was face and content-validated by two electrical engineering experts from oil and gas industry and one expert in measurement and evaluation from Rivers State University. The reliability of the instrument was established using Cronbach Alpha having yielded a reliability coefficient of 0.83. Mean and standard deviation were used to answer the research question while t-test was used to test the null hypothesis at 0.05 level of significance. The study found that polytechnic graduates need electrical machines skills to be able to represent energy balance block diagrams, connect transformer for star-star, star-delta, delta-delta operations, carry out transformer winding operations, carry out open circuit tests on synchronous machines among others in the oil and gas industry. Based on the findings of the study, it was recommended among others that government should adequately provide modern engineering and technology tools and gadgets in polytechnics, restructure the Student Industrial Work Experience Scheme, as well as promote industry-institution synergy in the training of engineering students to produce quality graduates for the oil and gas industry.

Key words: Electrical machines skills, unemployment, oil and gas industry, polytechnic, electrical/electronic graduates.

Introduction

Globally, one major threat to the economies of developing countries is unemployment. Unemployment represents a situation whereby the active workforce of a nation is without jobs. The active workforce in Nigeria is made up of youths who formed about 2/3rd of Nigeria's population. According to the National Population Commission (NPC) (2007), about 80 million youths are unemployed in Nigeria. Youth unemployment in Nigeria comes as result of inadequate skilled personnel capable of meeting employers' demands (Omoniwa & Adedapo, 2017). Unemployment pictures a scenario where persons of workable age who are eager to work in order to earn a living could not secure job

placements. Supporting this assertion, Owo and Ajie (2020) submit that presently, unemployment rate in Nigeria has increased significantly due to the aftermath effects of the corona virus pandemic. In the words of Owo (2020), Nigerian youths including graduates who are in dire need of jobs are adversely hit by unemployment due to poor skills acquisition. In other words, to secure job placements in the industry, specifically, graduate youths need to acquire salient skills needed in the industry for productive performance. According to Owo and Ajie (2020), poverty and unemployment which are two monsters causing many Nigerians to go through excruciating situations can be addressed if majority of Nigerians especially the youths are willing to acquire relevant skills.

Skills refer to special abilities or expertise developed by someone for performance improvement on a given job role. In the same vein, Lindner and Dooley (2002) see skill as capacity to apply present competence to execute observable actions yielding some observable outcomes. In the words of Okorie (2000), skill denotes the expertise, dexterity and tact with which one controls situations in the field of work. Furthermore, Osinem (2008) opines that skill is an individual's capacity to control elements of behaviour, thinking and feeling within specified contexts and within particular task domains to achieve meaningful results at work. Also, Ekezie and Owo (2019) posit that skills comprise special abilities gained through committed learning and practice through quality education and training which enables an individual to be proficient at work in any chosen vocation. Thus, from the forgoing, skills could be seen as effective tools for excellent job performance in the industry and as such graduates need to acquire as many relevant skills possible in preparation for an exciting career in the industry. One industry where Nigerian graduate needs to acquire relevant skills for employment is the oil and gas.

Oil and gas industry is any industry supplying energy. Oil and gas industry which came to limelight due to the discovery of petroleum in 1956 in Oloibiri, a community in present day Bayelsa state Niger-Delta, supplies about 80% of the total revenue accrued to the Nigeria's Government. According to Chizoba, Gwen and Chike (2012), the Nigerian oil and gas industrial operations yield much revenue to the Nigerian Government thereby served as the prime mover of the nation's economy. Correspondingly, Atakpu (2007) posits that oil and gas alone generated about \$600 billion to the Nigerian government. As prominent as this industry appears, skills are needed to effectively carry out exploration and production duties. Thus, the oil and gas industry in Nigeria always require the services of skilled graduates of engineering for a rewarding career in the industry. One key area in which skills are sought in the oil and gas sector is electrical machines installation, operation and maintenance.

Thus, electrical engineering graduates from polytechnics who acquired relevant technical skills in electrical motor operation, coil winding, motor speed control, transformer installation and operation, maintenance services among others are always in high demand in the oil and gas industry as these skills are often needed for productive work. This is because polytechnics are special institutions that train local manpower in skills relevant in local industries for the technological and economic advancement of the nation. Graduates of electrical/electronic engineering technology from polytechnics are those who received standard technical training in theories and practice of electrical engineering technology

and consequently, specialized in any one of the numerous areas of electrical/electronic engineering technology such as power system engineering, electrical machines, telecommunications, electronics and computer engineering, instrumentation and control engineering, acoustic engineering and automation technology. Fresh graduates of electrical/electronic engineering from Nigerian polytechnics need to develop skills and proficiency in engineering design, technical drawing, mathematical modeling, basic engineering software like MATLAB, tools and machines usage, instrument calibration, coil winding, digital signal processing, electronic components maintenance and repair, electrical maintenance and repairs, electrical design and drafting, computer graphics, data communication and networking, electronic system design, measuring instruments, information and communication technology, logic, innovation, creativity and among others (NBTE, 2001). According to Owo and Isaac (2020), the electrical/electronic engineering graduates from Nigerian polytechnics are expected to acquire adequate technical competencies in telecommunications, instrumentation, data and information technology, digital electronics, power system technology, electrical machines, power electronic devices, automation, control engineering, among others. This becomes crucial as electrical technologists with expertise in these areas are highly needed for the implementation of the local content policy in oil and gas industry. Therefore, fresh electrical graduates at the point of entry into oil and gas industry for a rewarding career need to have awareness of the skills demand and safety rules applicable within the work environment of the oil and gas industry in order to function effectively in their roles comprising designing of a complex electrical system for oil and gas facilities, carrying out electrical maintenance and operations on an oil and gas facility, executing electrical project engineering or site management roles available in a wide variety of locations. Thus, with relevant electrical machine skills, graduates can be gainfully employed in the oil and gas industry for a rewarding career.

Electrical machines skills are technical skills required for installing, operating and maintaining of electrical systems and devices for optimal workability. Electrical engineering graduates from Nigerian polytechnics are therefore taught to gain pertinent theoretical awareness and practical skills in electrical machines operation to work productively in the industries (NBTE, 2001). Consequently, the National Board for Technical Education (2001) clearly indicates the electrical machines skills required of graduates of electrical engineering from Nigerian polytechnics by stating that electrical graduates need skills in representing the energy balance block diagrams, connecting three single phase transformer star to star operation, star to delta operation, delta to delta operation, sketching the arrangement of three transformer windings, connecting single phase transformers, connecting three phase transformer, conducting heat run test on two single phase transformers, conducting efficiency tests on transformers, executing transformer parallel operations, conducting experiments on induction, interaction and alignment principles of electrical machines, representing the equivalent circuits of synchronous machines, drawing phasor diagrams of synchronous machines working as a motor, drawing the phasor diagrams of synchronous machines working as a generator, sketching the phasor illustration of electrical machines having salient poles, determining open-loop characteristics of synchronous machines, determining the short circuit characteristics of synchronous machines among others. Therefore, with these skills set,

electrical graduates can work excellently in the oil and gas sector. These skills are generally referred to as work skills since they are needed to accomplish tasks.

Work skills are superior set of technical skills applicable in the industry which enable an employee to be productive in the world of work (Ademu, Adah & Atsumbe, 2018). Skillful feats demand the application of already acquired knowledge and competence through training to achieving optimistic outcomes including the acquisition of new knowledge. Thus, a skilled worker is a valuable asset to any organisation as such fellow works meticulously towards the realization of the organizational cardinal objectives. Thus, technical or career skills cover any skill sets, knowledge and competencies that can enhance the capacity of prospective employee to secure, retain and progress at work.

Statement of the Problem

Prior to this time, Nigerian polytechnics produced skilled engineering technologists who served the nation's industries extraordinarily. However, the reverse is the case presently as most Nigerian graduates from polytechnics are found to be lacking in skills (Ejiofor, 2016). Graduates of electrical/electronic technology from polytechnics lack relevant work skills for job placements (Ismail & Mohammed, 2015). The issue of lack of technical skills among graduates is one major reason for ever-increasing unemployment rate in Nigeria. Skills deficiency syndrome among electrical/electronic engineering graduates paves way for non-Nigerians to dominate the nation's petroleum sector thereby impoverish the indigenes (Ojerinde, 2015). Corroborating this assertion, Ari (2020) reports that the disparity between the school curriculum and the actual needs of the local industry in Nigeria results to a situation whereby polytechnic engineering graduates could not secure jobs in oil and gas industry. This observed missing link therefore necessitates this study titled 'Electrical Machines Skills needed for Employment in Oil and Gas Industry in Niger-Delta, Nigeria'.

Purpose of the Study

The purpose of the study is to determine the electrical machines skills needed for employment in oil and gas industry in Niger-Delta, Nigeria. Specifically, the study was conducted to:

Find out the electrical machines skills needed by polytechnic electrical/electronic engineering graduates for employment in oil and gas industry in Niger-Delta, Nigeria.

Research Question

What are the electrical machines skills needed by polytechnic electrical/electronic engineering graduates for employment in oil and gas industry in Niger-Delta, Nigeria?

Hypothesis

There is no significant difference in the mean responses of electrical supervisors and graduates on electrical skills needed by electrical/electronic engineering graduates for employment in oil and gas industry in Niger-Delta, Nigeria.

Methods

The research design adopted in this study was descriptive survey design. A descriptive survey study is a type of study in which data from a large sample drawn from a given

population were collected and certain features of the sample as they are at the time of the study and which are of interest to the researcher were described without altering any independent variable of the study (Nwankwo, 2016). Purposive sampling was used to obtain 89 electrical/electronic technologists consisting of (27 supervisors and 62 graduates) who currently work in Green Energy International Ltd., AMNI and Total Production and Exploration companies. One research question and one hypothesis guided the study. The instrument for data collection was a 40-item self-structured questionnaire titled "Electrical Machines Skills needed for Employment Questionnaire (EMSEQ)". The questionnaire was designed on a 5-point Likert Scale of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD) having numerical values of 5, 4, 3, 2 and 1 respectively. The instrument was first and content validated by two experts in electrical engineering who work as electrical supervisors in oil and gas industry and another expert in measurement and evaluation from Rivers State University Port Harcourt. The reliability of the instrument was ascertained using Cronbach's alpha method having yielded a reliability index of 0.83. A total of 89 copies of the questionnaire were administered to the respondents by the researchers and one other research assistant. The research assistant was properly educated on how to support the researchers in the administration and retrieval of the instrument after duly filled. From the 89 copies of the questionnaires distributed, 82 was retrieved and used for data analysis. Mean and standard deviation are descriptive statistical tools used to answer the research question. Statistical package for social sciences (SPSS) version 20.0 was used to perform all statistical analysis on the hypothesis using t-test. For the research question, decision to accept or reject any item in the questionnaire was based on the Mean of the item. Any item in the questionnaire with a calculated Mean value equal to or greater than 3.00 was accepted, while any item with a calculated Mean value less than 3.00 was rejected. Standard deviation values close or wide apart were used to determine homogeneity in the responses of the respondents. The hypothesis was tested at .05 level of significance using t-test. The decision for accepting or rejecting the null hypothesis was as follows: If the calculated value of t (t_{cal}) is equal or less than the critical value of t (t_{crit}), the hypothesis will be accepted otherwise, rejected.

Result

The findings of the study were stated in accordance with the research question and hypothesis that guided the study as follows:

Research Question

What are the electrical machines skills needed by polytechnic electrical/electronic engineering graduates for employment in oil and gas industry in Niger-Delta, Nigeria?

Table 1: Mean Responses of Electrical Supervisors and graduates on Electrical Machines Skills Needed by Polytechnic Electrical/Electronic Graduates for Employment in Oil and Gas Industry in Niger-Delta, Nigeria

S/N	Item Statement	Supervisors (N ₁ = 24)			Graduates (N ₂ = 58)		
		\bar{X}_1	SD ₁	RMK	\bar{X}_2	SD ₂	RMK
1	Skills in representing energy balance block diagrams.	4.53	0.51	Agreed	4.69	0.47	Agreed
2	Skills in connecting three single phase transformer for Star-Star operation.	4.59	0.51	Agreed	4.67	0.48	Agreed
3	Skills in connecting three single phase transformer for Star-Delta operation.	4.71	0.47	Agreed	4.83	0.38	Agreed
4	Skills in connecting three single phase transformer for Delta-Delta operation.	4.53	0.51	Agreed	4.83	0.38	Agreed
5	Skills in undertaking the connection of three transformer windings.	4.53	0.62	Agreed	4.72	0.45	Agreed
6	Skills to practically demonstrate single phase transformer connections.	4.59	0.62	Agreed	4.72	0.51	Agreed
7	Skills to practically demonstrate three phase transformer connections.	4.41	0.51	Agreed	4.53	0.56	Agreed
8	Skills to carry out heat run test on two single phase transformers.	4.35	0.49	Agreed	4.25	0.60	Agreed
9	Skills to carry out regenerative efficiency test on two single phase transformers.	4.18	0.81	Agreed	4.67	0.53	Agreed
10	Skills in executing parallel operations in transformers.	4.35	0.70	Agreed	4.67	0.48	Agreed
11	Skills to connect three single phase transformers to form a single-three phase transformer.	4.24	0.56	Agreed	4.44	0.69	Agreed
12	Skills in experimenting on the principles of electrical machines.	4.12	0.70	Agreed	4.58	0.55	Agreed
13	Skills in carrying out energy conversion.	4.35	0.49	Agreed	4.61	0.55	Agreed
14	Skills in drawing the development diagrams of electrical windings.	4.29	0.59	Agreed	4.36	0.76	Agreed
15	Skills in representing through drawing, the magnetomotive force (mmf) due to distributed windings using graphical method.	3.88	0.70	Agreed	4.44	0.69	Agreed
16	Skills in interpreting the equivalent circuit of synchronous machines.	4.53	0.62	Agreed	4.75	0.60	Agreed

17	Skills in representing the phasor diagram for synchronous machine operating as a motor.	4.29	0.59	Agreed	4.72	0.45	Agreed
18	Skills in representing the phasor diagram for synchronous machine operating as a generator.	4.18	0.81	Agreed	4.72	0.51	Agreed
19	Skills in drawing the phasor diagrams for salient pole machine.	4.29	0.47	Agreed	4.47	0.56	Agreed
20	Skills in determining the open-circuit characteristics of synchronous machines.	4.29	0.59	Agreed	4.53	0.56	Agreed
21	Skills in determining the short-circuit characteristics of synchronous machines.	3.71	0.69	Agreed	3.94	0.83	Agreed
22	Skills in representing Potier diagram.	3.82	0.73	Agreed	4.08	0.87	Agreed
23	Skills in determining direct axis synchronous reactance.	3.94	0.66	Agreed	4.47	0.61	Agreed
24	Skills in determining the load characteristics of an alternator.	4.06	0.43	Agreed	4.67	0.48	Agreed
25	Skills in carrying out parallel operations of synchronous machines.	3.94	0.75	Agreed	4.47	0.61	Agreed
26	Skills in representing the effect of variation of excitation of synchronous generator connected to an infinite bus-bar.	4.35	0.61	Agreed	4.44	0.61	Agreed
27	Skills in determining the torque angle characteristics of synchronous generator.	4.12	0.49	Agreed	4.28	0.78	Agreed
28	Skills in determining the power angle characteristics of synchronous generator.	4.18	0.81	Agreed	4.39	0.64	Agreed
29	Skills in drawing the operating chart for synchronous machines.	3.82	0.64	Agreed	4.17	0.70	Agreed
30	Skills in drawing the winding arrangement for charge motor.	4.18	0.81	Agreed	4.39	0.60	Agreed
31	Skills in drawing the winding arrangement of the universal motor.	4.00	0.50	Agreed	4.69	0.52	Agreed
32	Skills in determining the rise in temperature in an electrical machine.	4.06	0.66	Agreed	4.58	0.65	Agreed
33	Skills in determining the cooling curves of an electrical machine.	4.24	0.56	Agreed	4.42	0.60	Agreed
34	Skills in determining speed control of direct current (D.C.) motor using Ward Leonard system.	4.06	0.66	Agreed	4.58	0.55	Agreed
35	Skills in determining the characteristics of speed control systems.	4.47	0.62	Agreed	4.26	0.61	Agreed
36	Skills in determining the various speeds of an A.C. commutator.	4.30	0.72	Agreed	4.75	0.50	Agreed
37	Skills in determining the torque/speed characteristics of charge motor	4.29	0.69	Agreed	4.61	0.64	Agreed

38	Skills in determining the speed control of A.C. motors using thyristors.	4.35	0.70	Agreed	4.72	0.51	Agreed
39	Skills in determining the speed control of D.C. motors using thyristors.	4.35	0.70	Agreed	4.83	0.38	Agreed
Average Mean/SD		4.2	0.6			0.5	
		4	2		4.54	8	

Source: Researchers' Field Result; 2022

The result in Table 1 shows the response of electrical supervisors and graduates on electrical machines skills needed by polytechnic electrical/electronic graduates for employment in oil and gas industry in Niger-Delta, Nigeria as well as their decisions on each item. The result revealed that electrical supervisors and graduates' responses show that all the items are electrical machines skills needed by polytechnic electrical/electronic graduates for employment with average mean values of 4.24 and 4.54 for electrical/electronic supervisors and graduates respectively which are both greater than 3.00 being the cut-off point. The standard deviation values ranging from 0.00 to 0.99 indicate that the respondents were close in their responses while standard deviation values of 1.00 and above implies that the respondents (electrical supervisors and graduates) were far apart in their views.

Hypothesis: There is no significant difference in the mean responses of electrical supervisors and graduates on electrical machines skills needed by polytechnic electrical/electronic graduates for employment in oil and gas industry in Niger-Delta, Nigeria.

Table 2: t-Test Analysis on Electrical Machines Skills Needed by Polytechnic Electrical/Electronic Graduates for Employment in Oil and Gas Industry in Niger-Delta, Nigeria

S/N	\bar{X}	SD	N	df	α	t_{cal}	t_{crit}	Remark
Supervisors	4.24	0.62	24	80	0.05	2.00	1.67	Rejected
Graduates	4.54	0.58	58					

Source: Researchers' Field Result; 2022 Accept H_0 if $t_{cal} \leq t_{crit}$, Otherwise Reject H_0 .

From Table 2, the calculated mean was greater than the value obtained from the table. Therefore, as calculated value of t ($t_{cal} = 2.00$) is greater than the critical value of t ($t_{crit} = 1.67$) at .05 level of significance, the null hypothesis is rejected. Thus, there is a significant difference in the mean responses of electrical supervisors and graduates on electrical machines skills needed by polytechnic electrical/electronic graduates for employment in oil and gas industry in Niger-Delta, Nigeria.

Discussion

The finding of the study as indicated in Table 1 reveals that for polytechnic graduates to secure employment in the oil and gas sector, they need to acquire adequate technical skills in line with the present demands of the labour market in oil and gas industry. In other words, electrical/electronic graduates need to acquire skills in representing energy balance block diagrams, connecting three phase single phase transformer windings for star-star, star-delta and delta-delta operations, drawing winding diagrams, determining open-circuit characteristics of synchronous machines, running tests on transformer, installing all kinds of industrial motors among others. This study corroborates the views of Ogwo (2010) that graduates needed technical skills in operating industrial production engines, equipment and machines in oil and gas industry. This finding was further supported by the National Board for Technical Education (NBTE) (2001) which states that electrical engineering graduates from Nigerian polytechnics are expected to develop relevant skills in electrical machines installation, operation and maintenance as these skills are needed to drive the technological advancement of Nigeria as applicable in many industries including oil and gas which demands the services of indigenous skilled electrical/electronic engineering graduates. This finding however disagrees with Omoniwa and Adedapo (2017) who emphasize that Nigerian graduates have all it takes to secure quality employment in the industry. The implication of this assertion is that, Nigerian graduates possessed the needed technical skills for job placement in the world of work upon graduation. Furthermore, the study disagrees with Agbonna, Yusuf, Ajidagba and Olumorin (2009) who posit that Nigerian graduates were employable. This means they possessed the requisite job specific skills needed for employment and as such can be employed in the oil and gas industry in Nigeria.

Conclusion

In the industrial world, skills are more preferred to paper qualifications because the world of work needs to proffer solutions to any observed technical issues capable of halting production processes which only skilled workforce can offer. Electrical machines are key tools for increased productivity in the oil and gas industry as the efficiency of the workforce is enhanced with the acquisition of these skills. Thus, in oil and gas industry, the services of skilled electrical engineers and technologists are greatly needed and for graduates of electrical/electronic engineering to be employed in the industry to perform technical roles, they need to have good knowledge and skills for installing, operating and maintaining electrical machines and devices.

Recommendations

From the findings of the study, the following recommendations are suggested:

1. Government should adequately provide modern engineering and technology tools and gadgets in all accredited polytechnics in Nigeria for the training of polytechnic electrical/electronic graduates.
2. Government should restructure the Student Industrial Work Experience Scheme (SIWES) to ensure its effectiveness.

3. Industrial visits/field trips should be made compulsory in all skill-based programmes of polytechnics in Nigeria.
4. The industries should collaborate effectively with Nigerian polytechnics in the training and supervision of engineering students so as to produce graduates with relevant work skills.
5. Polytechnic education in Nigeria should not be treated as inferior to university education to attract the best brains.

Authors' Biographical Notes

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