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TABLE OF CONTENTS

Assessment of Heavy Metals Pollution in Utorugu Creek Water and Bioconcentration in Fish Tissues
Amolo Igwe Richard[1]* and *Amolo Gloria Felicia[2] **1**

Evaluation Of Household Use of Gasoline Generator and Carbon Footprint: A Case Study of Sagbama Town, Sagbama Local Government Area
Yenagoa Bebe Edwin* and *Oyadongha Edisemi **6**

Green Synthesis of Silver Nanoparticles Stabilized by Nypa Fruticans Wurmb Extract for Efficient Leachate Treatment
Umukoro Collins; Orubite-Okorosaye, K;* and *Adowei, P **15**

A Maslovian Perspective on Human Motivation in Chinua Achebe's *Anthills of The Savannah* and Abubakar Gimba's *Footprints*
Deinmotei Erefaghe Igbe* and *Patience Ayebaemi Zuokemefa **27**

Effect of *Phyllanthus Niruri* Extract on Semen Characteristics of Male Rabbits
Ebipa Edison Gabriel* and *Nodu Medubari. **35**

Improved E-Learning Model for Public and Private Institutions Using Cloud Computing
Egi, Lambo Kenibanemi* and *Assor, Emmanuel Dalton **39**

The Effect of Motivational Financial Scheme on Employees Satisfaction and Job Commitment in Oil And Gas Companies in Rivers State
Bolou Joy Ugo **50**

Early Lay Characteristics of Local and Crossbred Chicken Genotypes Bearing Plumage Modifying Genes
Adugba, Tamadu **60**

Effect of Feeding Graded Levels of *Costus afer* on the Semen Quality of Male Rabbits
Wozi, Ebikobowei Elvis* and *Nodu, Medubari **67**

Political Influence and Human Resource Management (HRM) In Bayelsa State Civil Service 2015-2024
Abidde Kilegha Victoria **71**

Ownership Structure and Earnings Management of Listed Pharmaceutical Companies in Nigeria
***Obalakumo, Anderson Pereowei; Ayah, Funke Bonny* (FCNA, FCTI, FCCRFA*);* and *Avi, Matthew Eyinanaboemi* (FCNA)** **77**

Tax Incentives and Financial Performance of Listed Agribusiness in Nigeria
Obalakumo, Anderson Pereowei; Okpobo, Timinipre Joseph; Zibaghafa Sunday (PhD) **89**

The Effect of Accounting Measurements on The Value Relevance of Financial Statements of Listed Companies in Nigeria.
Okpobo, Timinipre Joseph; Biriabebe Fun-ebi (FCNA); and Koru, Mercy Yoninoniba (FCNA, FCTI) **98**

Efficient Metaheuristic Algorithmic Course Scheduling System in Bayelsa State Polytechnic, Aleibiri
Kilakime, Warikaramu-ere, Bridget; Mark, Karinatei Robertson; **and** ***Sese, Tuperekiye Ebimobowei*** **105**

Causality Analysis of Reforms and Risk Management in the Nigeria Banking Industry
Saborogha, Uchechi Boneri; Obantey Austin Amawei; and Ofoniofoni Suenemen Bobkime **115**

Skill Improvement Needs of University Lecturers of Woodwork Technology in Instructional Delivery in Enugu State: Imperative for Socio-Economic Development and Global Relevance
Ebiegberi Kontei **122**

Impact of Clove Seed (*Syzygium Aromaticum*) Extract on Semen Metabolites of Post Pubertal Male Rabbits
Perekeme, Tolumor-Ere Ruth **and** ***Nodu, Medubari*** **129**

Evaluation of Vulnerability to Flooding of Communities Along Epie Creek in Yenagoa Metropolis of Bayelsa State, Nigeria
Wolisi, Ibebiwaru Harcourt Nelson **132**

Predictive Analytical Determination of Safety Event Progression in Oil & Gas Industry in Nigeria
Bokolo Abovie; Daniel Igonideriga; **and** ***Egbo Walamam Mansi*** **140**

ASSESSMENT OF HEAVY METALS POLLUTION IN UTORUGU CREEK WATER AND BIOCONCENTRATION IN FISH TISSUES

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ABSTRACT
Uncontrolled development and upsurge of manufacturing industries in and around river banks globally have resulted to the pollution of many rivers and other surface water bodies. The aim of this study is to assess the heavy metals concentrations such as, Cadmium (Cd), Chromium (Cr), Iron (Fe), Lead (Pb), Manganese (Mn), Nickel (Ni) and Zinc (Zn) in two matrices including surface water and Fish tissues from Utorugu Creek in Ughelli-North Local Government Area of Delta State, Nigeria. Water and fish (Tilapia oreochromis niliticus) samples were collected from Utorugu Creek at three different sampling stations and then prepared for laboratory analysis. The prepared water and fish samples were then analyzed for heavy metals concentration using Atomic Absorption Spectrophotometer (AAS). The results obtained showed that the mean concentrations of heavy metal in surface water were (2.97mg/kg for Ni, 2.81mg/kg for Fe, 2.31mg/kg for Mn, 1.73mg/kg for Cr, 1.46mg/kg for Pb, 1.13mg/kg for Zn, 0.97mg/kg for Cd. The results of analysis of heavy metals in fish tissues show that mean concentrations were 0.69mg/kg for Ni, 0.84mg/Kg for Fe, 1.12(mg/kg for Mn, 0.37mg/kg for Cr, 0.77mg/Kg for Pb, Zn-0.67mg/Kg for Zn and 0.41mg/Kg for Cd. These results demonstrate that the concentrations of heavy metals in the surface water were higher than the concentrations in fish tissue. Nickel has the highest concentration in the water while Iron (Fe) has the highest concentration in fish tissue. The results revealed that surface water is a repository of metals in fish. The concentrations of heavy metals analysis in the fish tissue shows some level of bio-accumulation. While, the concentration of metals in fish samples were lower than the permissible level of FAO/WHO standard the concentrations in surface water were higher these suggest that the water of Utorogu Creek was not good enough for drinking. Although, the bio-concentration factor of heavy metals in fish is beyond the tolerable level, which poses significant risk to consumers of fish and water from this creek. It is recommended that regular monitoring of the Creek water should be undertaken and the people of the area should be sensitized on the public health implication of drinking the Utorugu Creek water
Keywords: Pathogens, Living organisms, Tilapia oreochromis niliticus, Heavy metal, Toxin, Utorogu Creek

1.0 INTRODUCTION

Uncontrolled development and upsurge of manufacturing activities in and around river banks globally have resulted to increasing pollution of rivers and other water bodies with attendant risk to public health. Utorugu Community in Ughelli-North Local Government Area of Delta State, of Nigeria is a host to divers' companies such as Beta Glass Plc and a Gas Plant, with natural gas processing plant, that procures natural gas and associated crude oil. All these companies generate waste water which is discharge into the Utorugu Creek. Natives of the community and adjoining communities depend heavily on the creek for fishing. Others depend on the water from the creek for their domestic use include drinking, hence, heavy metals pollution of the creek may pose significant health risk to the inhabitants

Industrial effluent discharge poses risk to surface water bodies due to the introduction of toxic chemicals, heavy metals and excess nutrients leading to oxygen depletion (Eutrophication) of the water surface. Other effects of effluent discharge into water bodies include: increasing turbidity as a result of elevated level of suspended solid in the water bodies which make the water cloudy thereby blocking sun light needed by aquatic plants and fish. Industrial effluents also increase water pH and temperature which make the water deleterious to aquatic life. Hossain et al., (2010) in Abdullateef et al., (2021), reported that effluents coming from different industrial and commercial establishments have being posing serious threats to the environment, particularly in urban and semiurban areas.

Heavy metals are among the hazardous substances thrown up into the environmental media from industrial activities. heavy metals have great tendency of bioaccumulation, biomagnifications, persistence in the environment thereby presenting serious threat to human health through the food chain (Amolo et al., 2022). Heavy metals contamination in surface water poses significant health and environmental risks, especially in industrial region (Nur-Jannat et al., 20250. The accumulation of heavy metals in fish tissues poses momentous biochemical, physiological, and histological changes in fish and other freshwater fauna (Amolo et al., 2024). The bioaccumulation of heavy metals in fishes has become a health issue of concern as most fishes do not have the

ability to break them down into nontoxic states and therefore have destructive effects on human health as well as aquatic organisms. (Farombi et al., 2007; Abdel-Baki et al., 2011 and Lu, 2015). Heavy metals contamination negatively affects the growth and reproductive activities of fish by lowering their gonadosomatic index (GSI), fertilization and hatching rate (Luszczek., 2014; Santos 2018. The aim of this study therefore, was to assess the heavy metals concentration in water and uptake in tissues of fish samples from Utorugu Creek in Ughelli North Local Government Area of Delta States.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study area is Utorugu. It is a community located in Ughelli-North Local Government Area of Delta State, Nigeria. It houses Beta Glass Plc and a Gas Plant, with natural gas processing plant, that procures natural gas and associated crude oil. Ughelli-North is situated within latitude 5 °301 N and longitude 5 °591 E. the settlement was initially an agricultural hub, however industrialization has open up this rural area into a mega city, were most of its citizens are gainfully employed by these companies while others are actively engaged in fishing and farming.

2.2 Sample Collection, Preparation and Identification

Samples of Tilapia fish (Oreochromis) were caught using gill nets. The fish samples were washed with deionized water and preserved in an ice stuffed box and then transported to the laboratory for Identification and analysis. Water samples were collected by immersing sampling bottles at about 10 cm below the water surface. Two 500 ml of water samples were taken at three different sampling stations along the Utorugu Creek and stored in ice stuffed box while been transported to the laboratory for analysis. The samples were filtered through 0.45 µm micropore membrane filter and acidified with concentrated (65 %) Nitric acid (HNO_3) to a pH less than 2. The samples were kept at 4 °C before treatment.

2.3 Sample Treatment

The fish samples were dried in an oven at 75 °C for 48 hours. The tissue was removed using a stainless-steel knife and ground to fine powder form with the aid of a porcelain mortar and pistle. 2 g of each homogenized fish samples were weighed into separate beakers. Conc. HNO_3 and H_2O_2 were added into the beakers in ratios of 3:1 and allowed to digest on a hot plate in a fume chamber at 120 °C for 20 minutes, according to the method of (Tawari-Fufeyin, 1998). The digested samples were allowed to cool at room temperature, filtered through Whatman filter papers and each solution made up to 25 ml mark with deionized water and analyzed for heavy metal concentrations. Digestion of water samples was carried out by adding about 9 ml of concentrated (HNO_3) to filtered water samples and gently heating at 80 °C until the solution become transparent (Taweel et al., 2003). The solutions were allowed to cool and filtered using 0.45 µm membrane filter. The solutions were then added up with deionized water to 50 ml and kept ready for AAS analysis.

2.4 Heavy metal analysis

Digested samples were analyzed for Cadmium (Cd), Chromium (Cr), Iron (Fe), Lead (Pb), Manganese (Mn), Nickel (Ni) and Zinc (Zn) using atomic absorption spectrophotometer (Perkin Elmer, Analyst 100). Element standard solution from Perkin Elmer was prepared by diluting stock solutions of 100 mg/mL of each element. The concentrations of heavy metals were presented in mg/kg, wet weight (ww) for fish samples mg/L for water.

Heavy metals bioconcentration factor in fish tissue was evaluated with equation 2.1

$$BCF = \frac{Cf}{Cw} \quad 2.1$$

Where BCF is heavy metals bioconcentration factor is fish

C_f = Concentration of metal in fish

C_w = Concentration of metal in water According to (Adeosun et al., 2015).)

2.5 Statistical Analysis

All data generated were subjected to descriptive statistics where the mean and standard deviation of each of the measured parameters were computed.

3.0 RESULTS AND DISCUSSION

3.1 Results

The result of heavy metals in fish sample and surface water are presented in Tables3.1 and 3.2.

Table 3.1: Heavy metal concentration in tissues of Fish (Tilapia Oreochromis) (mg/kg)

Heavy Metals	SS A	SS B	SS C	Mean	SD	WHO (**mg/kg**)
Cd (mg/kg)	0.36	0.38	0.41	0,38	0.03	0.5
Cr (mg/kg)	0.36	0.37	0.37	0.36	0.01	0.3
Fe (mg/kg)	0.64	0.66	0.84	0.71	0.26	0.3
Mn (mg/kg)	1.12	0,85	0.94	0.99	0.13	0.02
Ni (mg/kg)	0.67	0.69	0.35	0.57	0.11	0.05
Pb (mg/kg)	0.74	0.77	0.50	0.67	0.10	0.05
Zn (mg/kg)	0.47	0.67	0.36	0.5	0.07	5.0

Note: SD=Standard Deviation, SS=Sample Station.

Heavy metals concentrations in the fish tissue are demonstrated graphically in Fig 2.1

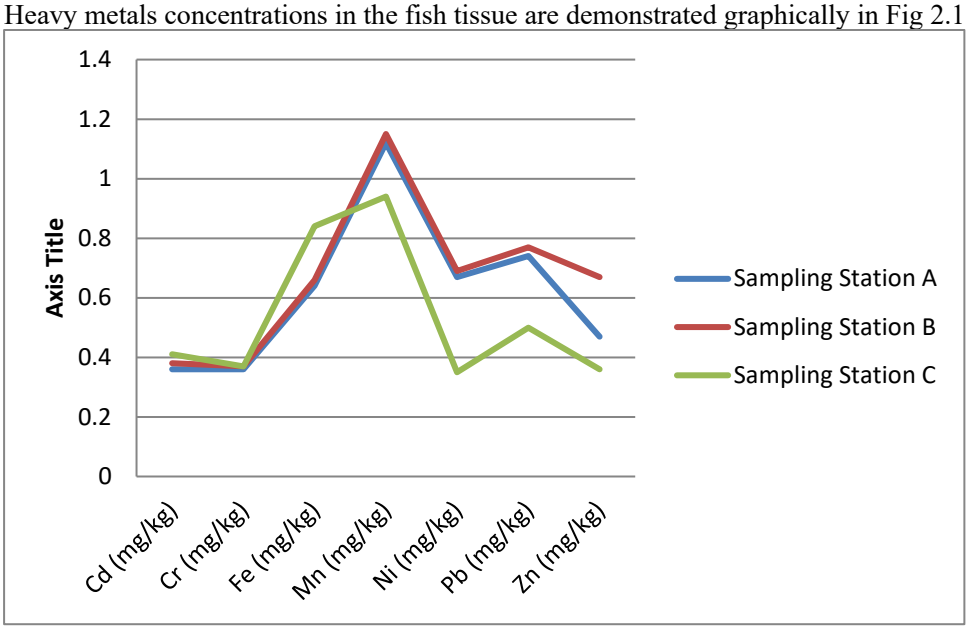


Fig 2.1: Graphical demonstration of heavy metals concentration in Fish ((Tilapia Oreochromis) tissue.

Table 3.2: Heavy metal concentration in water sample (mg/kg)

Heavy Metal	SS A	SS B	SS C	Mean	SD	WHO (mg L−1)
Cd (mg/kg)	0.93	0.89	0.97	0.93	0.04	0.5
Cr (mg/kg)	1.08	1.73	1.68	1.49	0.36	0.3
Fe (mg/kg)	2.81	1.88	1.14	1.94	0.25	0.3
Mn (mg/kg)	2.31	1.47	1.23	1.67	0.36	0.02
Ni (mg/kg)	2.97	1.59	2.64	2.4	0.72	0.05
Pb (mg/kg)	1.46	1.09	0.47	1.01	0.20	0.05
Zn (mg/kg)	1.13	0.63	0.51	0.76	0.21	5.0

Note: SD=Standard Deviation, SS=Sample Station.

Heavy metals concentrations in the water are demonstrated graphically in Fig 2.2

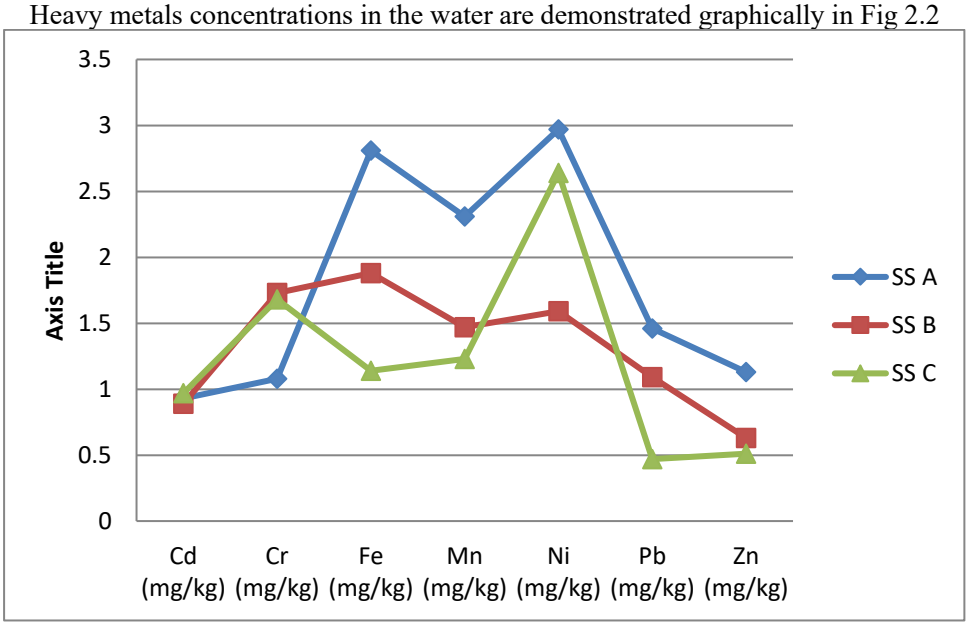


Fig 2.2: Graphical demonstration of heavy metals concentration in water.

The result of the evaluation of the heavy metals bioconcentration factor is presented in Table 3.3

Table 3.3. BCF of heavy metals in fish samples.

Metal	Cd	Cr	Fe	Mn	Pb	Ni	Zn
SS A	0.39	0.33	0.23	0.48	0,23	0.51	0.42
SS B	0.43	0.21	0.35	0.58	0.43	0.71	1.06
SS C	0.42	0,22	0.74	0.76	0.15	1.06	0.71
Mean	0.41	0,25	0.44	0.61	0.27	0.76	0.73

3.2 Discussions

The observed results show that surface water sample recorded the highest concentration of heavy metals amongst the two matrices at sample station A. Heavy metals analyzed include: Nickel, Iron, Manganese, Chromium, lead, Zinc and Cadmium (Ni>Fe>Mn>Cr>Pb>Cd>Zn). The results revealed Nickel recorded its highest concentration in surface water (2.97mg/kg) at sample station A and the lowest concentration at sampling station B with an overall mean value of 1.26mg/kg. The Heavy metals concentration in Fish tissue is in the following order (Mn>Fe>Pb>Ni>Zn>Cd>Cr) This revealed that Mn has the highest concentration in fish tissue followed by Fe. Mn recorded the highest concentration of (1.12mgh/Kg) in fish tissue at sampling station A while it recorded its lowest concentration of (0.85mg/kg) in fish tissue at sampling station B with an overall mean value of 0.99mg/kg± 0.72. The mean concentration of Fe in water is 1.94mg/Kg while its mean concentration in Fish tissue is 0.71mg/Kg. Cr recorded mean concentration of 1.49mg/Kg, while it recorded 0.36mg/Kg in fish tissue. The mean concentration of Pb in water is 1.01mg/Kg while it recorded mean concentration of 0.67mg/Kg in fish tissue. Cd recorded mean concentration of 0.93mg/Kg in surface water and 0,38mg/Kg in fish tissue. Zn recorded mean concentration of 0.76mg/Kg in water and 0.5mg/Kg in fish tissue.

Result of the evaluation of the heavy metals bioconcentration factor is in the following order Ni>Zn>Mn>Fe>Cd>Pb>Cr i.e. 0.76>0.73> 0.61>0.44 >0.41>0.27>0,25 respectively**.** This show that Ni has the highest bioconcentration factor which is a demonstration that the higher the concentration of heavy in water, the higher it is bioconcentrated in fish. However, the bioconcentration factors recorded for all the heavy metals analyzed in this study are lower than the WHO and FEPA limit of 1.0. the average concentration of Cr, Ni, Mn and Pb in the surface were higher the WHO limit this could be attribute to anthropogenic influence. The higher level of these heavy metals in the water show that the water is not healthy for human consumption.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Heavy metals in aquatic environments are generated by natural and anthropogenic sources such as (soil formation), non-point sources, transportation, domestic wastes, urban run-offs, agricultural and industrial activities. Increasing level of anthropogenic activities in and around Utorugu Community must have significantly contributed to the high concentration of heavy metals observed in creek water. The results of this study indicate that the concentrations of heavy metals analyzed in the water samples were above the threshold set by WHO & FEPA. More so, some level of heavy metals bioaccumulations was established in the fish sample collected from Utorugu Creek as evaluation of bioconcentration factor revealed a measure of heavy metals bioconcentration in the fish tissue.

4.2 Recommendations

Based on the findings of the study, it is recommended that: regular monitoring of the Utorugu Creek water in Ughelli North Local Government Area of Delta State and other rivers should be undertaken and the people of the area should be sensitized on the public health implication of drinking the Utorugu Creek water.

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EVALUATION OF HOUSEHOLD USE OF GASOLINE GENERATOR AND CARBON FOOTPRINT: A CASE STUDY OF SAGBAMA TOWN, SAGBAMA LOCAL GOVERNMENT AREA

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ABSTRACT
This study investigates the carbon footprint of household gasoline generator use in Sagbama Town, Bayelsa State, Nigeria. Households in the region rely heavily on gasoline-powered generators due to frequent power outages, there by contributing to environmental pollution. A descriptive research design was adopted for the study. Data were collected by means of well-structured questionnaire. 120 questionnaires were administered to respondents and all administered questionnaires were retrieved (100%). Results revealed that majority of households in Sagbama town use gasoline generators, with most operating their generator set for 4 to 12 hours daily. The carbon emissions from gasoline generator usage were estimated, highlighting the significant environmental impact. The study also identified demographic factors influencing generator use, such as income level, education, and household structure. Despite the availability of solar energy alternatives, reliance on fossil fuels remains high. The study emphasizes the need for policy interventions and public awareness campaigns to reduce the carbon footprint of households in Sagbama. Key findings suggest that widespread use of gasoline generators in Sagbama contribute to global warming. The study recommendations a transition to cleaner energy sources to mitigate the environmental impact of global warming.
Keywords: Carbon Footprint, Gasoline Generators, Environmental Impact, Town, Greenhouse Gas Emissions.

1.0 INTRODUCTION

A household's carbon footprint refers to the total greenhouse gas (GHG) emissions primarily carbon dioxide (CO_2) produced directly or indirectly through daily activities such as electricity generation, transportation, and consumption patterns (UNEP, 2022). According to Ridhosari and Rahman (2020), carbon footprints are a key metric for quantifying the environmental impact of human activity and are crucial for managing GHG emissions that contribute to climate change. In many developing regions, including Nigeria, erratic electricity supply has compelled households to rely heavily on gasoline-powered generators, particularly in urban and semi-urban areas (Odeyale et al., 2023).

While gasoline generators provide immediate relief during power outages, they release significant amounts of CO2 and other pollutants into the atmosphere. The World Meteorological Organization (WMO, 2019) reported that the continuous rise in atmospheric CO_2 is largely attributed to fossil fuel combustion, which includes small-scale gasoline usage by households. This rise has spurred increased global protests and advocacy for climate action (Hoffman, 2020). In Nigeria, fossil fuel-based energy remains predominant, with widespread generator use contributing to localized pollution and global carbon emissions (IFC, 2019). Gasoline generators, though convenient, come at a high environmental and financial cost. Nigeria is currently one of the world's largest consumers of small-scale generators, accounting for about 16% of global generator energy use (USAID, 2020). Households and businesses reportedly spend over $21.8 billion annually on generator fuel and maintenance (GIZ, 2013). In addition to economic concerns, air quality is severely affected Lagos, for instance, records average PM2.5 levels of 68 μg/m³, far exceeding the WHO's recommended limit of 10 μg/m³.

The case of Sagbama Town reflects a broader national challenge where household reliance on gasoline generators remains largely overlooked in environmental assessments. Frequent power outages and limited access to clean energy force residents to depend on these generators, increasing their carbon footprint and endangering environmental health. Despite Nigeria's abundant solar potential, the transition to renewable energy remains slow, limiting access to sustainable alternatives (IFC, 2019). This study investigates the carbon footprint associated with household generator usage in Sagbama Town. Sagbama Local Government Area, to understand how local energy practices contribute to national environmental concerns.

2.0 METHOD

2.1 Study Area

The study was conducted in **Sagbama Town**, located in the Sagbama Local Government Area of Bayelsa State (Fig 2.1), Nigeria, at coordinates 5.1593° N, 6.1971° E, covering an area of 951.3 km². Sagbama is an urban settlement characterized by frequent power outages, which have led to widespread reliance on gasoline generators for electricity. The town, with its limited access to clean energy alternatives, provided a relevant context for investigating household energy practices and their contribution to carbon emissions. The map of Bayelsa showing the study area is presented in Fig 2.1.

2.2 Research design:

This study used a **descriptive research design** to assess the carbon footprint of households in Sagbama Town, focusing on gasoline generator usage and its environmental impact
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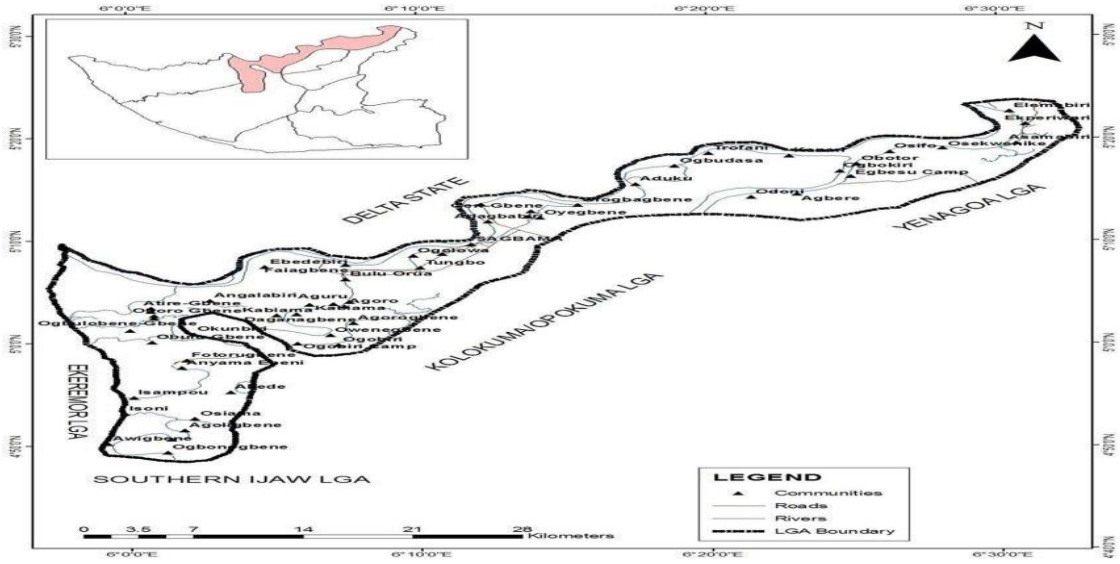


Fig 2.1: Location of the study area (Wali, 2022)

2.3 Data Collection

This research was carried out following relevant standards and procedures to Evaluate the Household use of Gasoline Generator and Carbon footprint A case study of Sagbama town. Primary data about the household use of gasoline generator in the study area were collected through a well-structured questionnaire. 120 questionnaires were administered to respondents and all were retrieved. Household survey was conducted to determine the quantity of gasoline consumed, and the results were analyzed to calculate the appropriate emissions. The quantity of CO_2 emissions was determined using a formula that accounts for the carbon footprint from household use of gasoline generator. The formula used to calculate the quantity of CO_2 emissions per liter is presented in Equation 2.1

CO_2 emission (Kg) = fuel. Used (liters) × Emission factor ($KgCO_2$/liters) Eqn 3.1

Where: **2.31$KgCO_2$/litters**

Is the IPCC default emission factor

2.4 Population of Study

The population of the study area, Sagbama Town, was 278,200 as of 2022, according to the National Population Commission of Nigeria. This population size reflects the diverse demographic composition of the town, which includes households that rely heavily on gasoline-powered generators due to frequent power outages. The sample for this study was randomly selected from this population, with a focus on households to assess their energy consumption patterns and associated carbon emissions.

2.5 Sample/Sampling Technique

The study employed a **simple random sampling** technique to select 120 households from the population of Sagbama Town. This sample size was deemed sufficient to provide a representative cross-section of the town's household energy consumption patterns. The households were randomly chosen to ensure that every household had an equal chance of being selected, thereby reducing bias and enhancing the generalizability of the findings to the larger population.

2.6 Research Instrument for Data Collection

Data were collected using a structured questionnaire titled "Carbon Footprint by Household from Gasoline Generator (CFHGGQ)." The questionnaire was divided into two sections: Section A gathered demographic information from the respondents, while Section B focused on collecting data related to household gasoline generator usage, frequency, quantity consumed, and awareness of its environmental impact. It featured closed-ended questions with "Yes" and "No" options. This design facilitated the collection of clear and measurable data on household energy practices and their contribution to carbon emissions

2.7 Validity and Reliability of Instrument

The questionnaire was reviewed by experts in environmental science and research methodology to

ensure content validity and alignment with the study objectives. To establish reliability, a pilot test was conducted with a small sample of respondents, and necessary adjustments were made based

2.8 Method of Data Collection

A survey method of data collection was used in this study. The data were collected through questionnaire directly from households. The questionnaire details frequency and duration of generator usage, fuel consumption, fuel purchase, and purchase frequency and generator runtime.

2.9 Method of Data Analysis

The data collected from the administered questionnaires were coded and entered into the Statistical Package for the Social Sciences (SPSS) version 25 for analysis. Descriptive statistics such as frequency counts, percentages, means, and standard deviations were used to summarize the demographic characteristics and gasoline generator usage patterns of respondents. Additionally, the estimated carbon emissions per household were calculated and analyzed using emission factors, enabling the identification of trends and the extent of carbon footprint contributions within Sagbama Town.

2.10 Ethical Considerations

The study adhered to ethical standards by ensuring informed consent was obtained from all participants before data collection. Respondents were assured of confidentiality, and their responses were used solely for academic research purposes.

3.0 RESULTS AND DISCUSSION

3.1 Results

Demographic Variables

Table 3.1: Demographic Characteristics of Respondents (n = 120)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	68	56.7%
	Female	52	43.3%
Household Type	One Person	10	8.3%
	Nuclear	62	51.7%
	Extended	34	28.3%
	Composite	14	11.7%
Age Group	11–20	6	5.0%
	21–30	28	23.3%
	31–40	38	31.7%
	41–50	30	25.0%
	51 and above	18	15.0%
Education	Primary	12	10.0%
	Secondary	28	23.3%
	Intermediate	20	16.7%
	Graduate	38	31.7%
	Postgraduate	22	18.3%
Occupation	Students	18	15.0%
	Government Employee	22	18.3%
	Private Sector	28	23.3%
	Business	30	25.0%
	Unemployed	22	18.3%
Household Income	≤ ₦20,000	14	11.7%
	₦20,001 – ₦40,000	20	16.7%
	₦40,001 – ₦60,000	26	21.7%
	₦60,001 – ₦80,000	28	23.3%
	₦80,001 – ₦100,000	18	15.0%
	₦100,001 and above	14	11.7%

In Table 3.1 above the majority of respondents were male (56.7%), and the dominant household type was nuclear (51.7%), reflecting a typical family structure in urban Nigerian communities. Most participants were within the productive age groups of 31–40 years (31.7%) and 41–50 years (25.0%), indicating active involvement in household energy decisions. Educationally, graduates made up the largest group (31.7%), followed by secondary school holders (23.3%), suggesting a moderately educated population. In terms of occupation, business (25.0%) and private sector workers (23.3%) were the most represented, indicating diverse income sources. The household income distribution showed that the highest proportion earned between ₦60,001–₦80,000 (23.3%), while only 11.7% earned above ₦100,000, pointing to a mostly middle-income community. These demographics provide a vital context for understanding how socioeconomic characteristics influence generator use and resulting carbon emissions in Sagbama Town.

Table 3.2: Respondents' Source of Power Supply (n = 120)

Power Source	Frequency (n)	Percentage (%)
Power Holding (PHCN)	18	15.0%
Gasoline Generator	62	51.7%
Solar Power	10	8.3%
Gas Generator	14	11.7%
Diesel Generator	16	13.3%
Total	**120**	**100%**

The data in Table 3.2, revealed that gasoline generators were the most commonly used power source, accounting for 51.7% of the responses. Only 15.0% of respondents relied primarily on electricity supplied by Power Holding Company of Nigeria (PHCN), reflecting poor grid reliability in the area. Solar power was used by just 8.3% of households, indicating low adoption of renewable energy despite its environmental benefits. Gas and diesel generators made up 11.7% and 13.3% respectively, further highlighting the community's dependence on fossil fuel-based alternatives. This distribution underscores the significant reliance on fuel-powered generators, which contributes to increased carbon emissions in Sagbama Town.

Table 3.3: Usage of Gasoline Generator among Respondents (n = 120)

Response	Frequency (n)	Percentage (%)
Yes	96	80.0%
No	24	20.0%
Total	**120**	**100%**

The data in Table 3.3 shows that 80% of the respondents (96 out of 120) use gasoline generators, indicating a strong reliance on this energy source in the community. Only 20% of the respondents (24 out of 120) do not use gasoline generators, suggesting that alternative energy sources are less commonly adopted. This distribution underscores the widespread dependence on gasoline generators, which may have significant environmental and policy implications.

Table 3.4: Frequency of Gasoline Generator Use per Day (n = 120; Generator Users = 96)

Duration (Hours)	Frequency (n)	Percentage of Generator Users (%)	Percentage of Total Respondents (%)
1	5	5.2%	4.2%
2	10	10.4%	8.3%
3	12	12.5%	10.0%
4	15	15.6%	12.5%
5	11	11.5%	9.2%
6	10	10.4%	8.3%
7	8	8.3%	6.7%
8–12	18	18.8%	15.0%

Duration (Hours)	Frequency (n)	Percentage of Generator Users (%)	Percentage of Total Respondents (%)
Above 12	7	7.3%	5.8%
Did not use generator	**24**	—	**20.0%**
Total	**120**	**100% (of 96 users)**	**100%**

Table 3.4 above shows that among the 96 generator users, the highest proportion (18.8%) operated their generators for between 8 and 12 hours daily, followed by 15.6% who used them for 4 hours. Usage between 2 to 6 hours was also common, indicating moderate reliance. Only 5.2% used generators for just 1 hour, while 7.3% ran them for more than 12 hours daily, suggesting high energy needs or poor electricity supply. Overall, the pattern reflects significant dependence on generators, with only 20% of the total respondents not using them at all.

Table 3.5: Frequency of Gasoline Generator Use per Week (n = 120; Generator Users = 96)

Days per Week	Frequency (n)	Percentage of Generator Users (%)	Percentage of Total Respondents (%)
1	8	8.3%	6.7%
2	10	10.4%	8.3%
3	15	15.6%	12.5%
4	18	18.8%	15.0%
5	20	20.8%	16.7%
6	15	15.6%	12.5%
7	10	10.4%	8.3%
Did not use generator	**24**	—	**20.0%**
Total	**120**	**100% (of 96 users)**	**100%**

The data in Table 3.5 above indicates that the majority of generator users operate their units multiple times a week. For instance, 20.8% of users run them 5 days a week, while 18.8% use them 4 days a week, and 15.6% use them 3 or 6 days weekly. Additionally, 10.4% report daily use (7 days). This confirms a consistent pattern of dependency on gasoline generators, further emphasizing the community's limited access to reliable public electricity.

Table 3.6: Daily Gasoline Consumption per Household (n = 120; Generator Users = 96)

Liters of Gasoline Used per Day	Frequency (n)	Percentage of Generator Users (%)	Percentage of Total Respondents (%)
1	8	8.3%	6.7%
2	14	14.6%	11.7%
3	16	16.7%	13.3%
4	18	18.8%	15.0%
5	14	14.6%	11.7%
6	8	8.3%	6.7%
7	6	6.3%	5.0%
8	4	4.2%	3.3%
9	3	3.1%	2.5%
10	3	3.1%	2.5%
Above 10	2	2.1%	1.7%
Did not use generator	**24**	—	**20.0%**
Total	**120**	**100% (of 96 users)**	**100%**

Table 3.6 shows most households using gasoline generators consume between 2 and 4 liters daily, with 14.6%, 16.7%, and 18.8% of users falling into this range, respectively. A combined 49.5% of generator users consume within this bracket. Only a few households reported consumption above 6 liters per day, indicating that while dependence on generators is widespread, extremely high consumption is less common.

Table 3.7: Average Daily Cost of Gasoline Usage per Household (n = 120; Generator Users = 96)

Cost Range (Naira)	Frequency (n)	Percentage of Generator Users (%)	Percentage of Total Respondents (%)
500 – 1,000	22	22.9%	18.3%
1,000 – 2,000	28	29.2%	23.3%
2,000 – 3,000	20	20.8%	16.7%
3,000 – 4,000	14	14.6%	11.7%
Above 4,000	12	12.5%	10.0%
Did not use generator	**24**	—	**20.0%**
Total	**120**	**100% (of 96 users)**	**100%**

Among generator users, the highest proportion (29.2%) spent between ₦1,000 and ₦2,000 daily on gasoline. Another 22.9% spent ₦500–₦1,000, and 20.8% spent ₦2,000–₦3,000. Although fewer households reported spending above ₦3,000 per day, a combined 27.1% of users fall into this category, highlighting a substantial economic strain linked to generator dependence. These insights underscore the need for sustainable and affordable energy alternatives to mitigate financial hardship.

Table 3.8: Carbon Footprint for Households using Gasoline Generator(n = 120, Generator Users = 96)

Litres of Gasoline Used Per Day(L)	Household Gasoline Users F	No: of liters used in households F * L	CO_2 Emissions per day (Kg)	CO_2 Emissions per month (Kg)
1	8	8	18.40	554.40
2	14	28	64.68	1940.40
3	16	48	110.88	3326.40
4	18	72	166.32	4989.40
5	14	70	161.70	4851.00
6	8	48	110.88	3326.40
7	6	42	97.02	2910.60
8	4	32	73.92	2217.60
9	3	27	62.37	1871.10
10	3	30	69.30	2079.00
>10	2	20	46.20	1386.00
Total	96	425	981.78	29447.30

In Table 3.8 above a total number 96 households that uses Gasoline Generator, emit 29447.30CO_2/Kg per month using the formula,

Monthly CO_2(Kg) = DailyCO_2 * 30

Where CO_2 emission factor for Gasoline ≈ 2.31KgCO_2 per litre (U.S EPA)

3.2 Discussion of the Result

The results show that gasoline generators are the most commonly used source of power in Sagbama Town, with 51.7% of respondents relying on them. This affirms earlier findings by Ibrahim *et al*. (2021) who identified generator use as a dominant coping mechanism for poor electricity access in Nigeria. Similarly, Odeyale et al. (2023) observed that over half of Nigerian households use generators due to unreliable grid supply. The low dependence on PHCN (15%) recorded in this study aligns with the work of Oshevire et al. (2016), who attributed this to frequent power outages and system collapse. The minimal use of solar energy (8.3%) suggests slow adoption of renewable alternatives, echoing the concerns raised by Ohunakin et al. (2014) regarding the affordability and awareness of clean energy technologies in rural Nigeria. 80% of respondents use gasoline generators, highlighting a high level of dependency. This supports Solomon et

al.(2019), who stated that the inefficiency of the national grid pushes citizens towards self-generation. Odeyale et al. (2023) similarly noted that in many Nigerian communities, generator use is not a luxury but a necessity for survival. In agreement, Awofeso (2011) emphasized that the widespread generator usage contributes significantly to indoor and outdoor air pollution, raising both health and environmental concerns. This level of usage further indicates energy insecurity and inadequate access to affordable, sustainable electricity in Sagbama.

The findings reveal that 18.8% of respondents use their generators between 8–12 hours daily, while others operate them for moderate between 2 and 6 hours). This frequency is similar to that reported by Janghorban et al. (2024), who found that Nigerians often run generators for multiple hours per day to support household and business needs. Babalola et al. (2022) observed that such prolonged use reflects the unreliability of the national grid. According to Ogundipe et al. (2021), the long usage hours significantly increase operating costs and environmental degradation, especially in semi-urban communities like Sagbama.

The data in this study reveals that a substantial number of respondents (20.8%) use generators five days a week, with others using them regularly throughout the week. This is consistent with the findings of Unegbu et al. (2024), who noted that daily or near-daily generator use is common in off-grid or poorly served areas. Chanchangi et al. (2022) reported similar patterns in other Nigerian towns, highlighting systemic dependence on generators. Additionally, Nwokolo et al. (2023) stressed that frequent usage reflects not just infrastructural failure but also a burden on household income and environmental sustainability. Most households consume between 2 and 4 liters of gasoline daily, with a few using above 6 liters. This correlates with data from Unegbu et al. (2024), who observed that most households try to limit fuel usage due to cost implications. Akinbami et al. (2001) also found that middle- and low-income families often restrict generator use to minimize daily fuel consumption. Odeyale et al. (2023) noted that such consumption levels, while moderate, still contribute significantly to greenhouse gas emissions and localized air pollution.

The study shows that the majority of users spend between ₦1,000 and ₦2,000 daily, and about 27.1% spend above ₦3,000. This finding is consistent with that of Oseni (2012), who argued that high gasoline expenses impose economic strain on Nigerian households, particularly those living below the poverty line. Adaramola et al. (2014) similarly observed that the cost of fuelling generators often exceeds what consumers would pay for reliable grid electricity. In line with Udoakah and Akpan (2019), these economic burdens reveal the hidden costs of Nigeria's power crisis, making it difficult for households to save or invest in alternative solutions like solar power.The Carbon footprint analysis of a gasoline generator highlights its significant contribution to greenhouse gas (GHG) emission primarily in the form of Carbon dioxide (CO_2).

Gasoline combustion in generator releases approximately 2.31Kg of CO_2 per litre of fuel burn (EPA). Depending on the generator fuel consumption rate. For the 96 households that uses gasoline generator approximately 29447.30Kg (29.45 metric tons) of CO_2) is emitted monthly. This has critical environmental implication especially where generators are relied upon heavily due to unreliable grid power.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

This study underscores the significant environmental burden of gasoline generator use in Sagbama Town, where households are heavily reliant on fossil fuels due to unreliable power supply. The widespread use of gasoline generators contributes substantially to carbon emissions, exacerbating both local air pollution and global climate change concerns. Despite the presence of alternative renewable energy sources such as solar power, the transition to cleaner energy in the area remains slow. Therefore, it is crucial to promote renewable energy adoption, raise awareness, and strengthen policies aimed at reducing carbon emissions. This research highlights the urgent need for a sustainable energy shift to combat environmental degradation.

4.2 Recommendations

1. The government should incentivize the use of solar energy by offering subsidies or tax breaks for solar panel installations in Sagbama Town.
2. Public awareness campaigns should be launched to educate households on the environmental impact of gasoline generators and the benefits of cleaner energy alternatives.
3. The electricity grid should be improved to reduce the need for households to rely on gasoline generators during power outages.
4. Policies that promote energy-efficient appliances and low-carbon technologies should be implemented to reduce the carbon footprint of households.
5. Research into affordable and accessible renewable energy solutions should be encouraged to ensure a sustainable energy future for Nigeria Towns, cities and rural communities.
6. Renewable energy such as Solar energy, Wind energy and Hydro power should be consider as alternative energy source, which are consider

more sustainable and environmental friendly compare to fossil fuel.

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GREEN SYNTHESIS OF SILVER NANOPARTICLES STABILIZED BY NYPA FRUTICANS WURMB EXTRACT FOR EFFICIENT LEACHATE TREATMENT

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Abstract
This research focuses on the eco-friendly synthesis of silver nanoparticles (Ag-NPs) using Nypa Fruticans Warm extract as a stabilizing and reducing agent. The study explores the potential application of these synthesized nanoparticles in the treatment of leachate, addressing environmental concerns associated with industrial and municipal waste. The unique properties of Ag-NPs, coupled with the natural stabilizing capabilities of Nypa Fruticans Wurmb extract, offer a sustainable and effective solution for leachate remediation. The research investigates the synthesis process, nanoparticle characterization, and assesses the treatment efficiency through various analytical techniques. The findings contribute to the development of green nanotechnology for environmental remediation, emphasizing the importance of utilizing natural resources for sustainable solutions in wastewater treatment.
Keywords: Silver; Green; Nanoparticles; Synthesized; Stabilized; *Nypa Fructicans*; Wurmb Extract

1. INTRODUCTION

The improper disposal of industrial and municipal waste has led to the generation of leachate, a complex and environmentally hazardous liquid. Conventional treatment methods often fall short in addressing the diverse pollutants present in leachate. This study explores the use of silver nanoparticles synthesized through a green approach, utilizing the extract of Nypa Fruticans Wurmb as a stabilizing and reducing agent. The choice of Nypa Fruticans Wurmb extract is motivated by its abundance and unique chemical composition, which imparts stability to the synthesized nanoparticles.

The negative impacts of water contamination are a major concern around the world. Clean and sanitary water (for consumption) is essential for the daily growth, metabolic activity, and survival of animals, humans, and other organism in the environment. (Ali *et al.,*2004).

Foreign elements enter water bodies (rivers, oceans, deltas, and seas) as a result of man's direct or indirect activities, causing the water to be unfit for its intended purpose. Landfill leachate is a Water percolating through dumped garbage at a landfill and ground water seepage are common and accessible ways for ground water or water bodies (rivers, lakes, oceans, deltas, and seas) to get contaminated (Ali et al., 2004). Rainfall is a conversant method of this leachate generation. Rainfall percolates through the deposited wastes, causing many chemical and physical reactions that occur throughout the leachate migration processes of degraded wastes, increasing the amount of all suspended and dissolved components present in it.

Leachates from landfills can also be generated by other means, such as; groundwater inflow, biological breakdown, surface moisture, and the liquid state of biodegradable wastes (Reinhart & Townsend, 1998). Chemical changes and microbiological activity occurring within the cell of dumped wastes, rainwater percolation through waste materials, and the quantity of waste compactions all influence the amount of leachate available within the waste. The latter is an imperative factor that influence the amount of leachates produced. If there is little to no compaction of the wastes, leachate formation will be significant because more wastes will be compacted, which will lessen or lower the filtration rate (Lema *et al.,* 1988).

Leachates at different land fill locations have leachate has various compositions and components depending on the type of wastes, waste composition, landfill age, and seasonal weather fluctuations. A leachate is considered old if it has been there for more than five years, medium if it has been there for one to five years, and young if it has been there for less than a year (Baig, *et al.,* 1999; Silva, *et al.,* 2003).

This study therefore focuses on the green synthesis of silver nanoparticles stabilized by nypa Fruticans wurmb extract for efficient leachate treatment and plant extracts give a sustainable platform for nanoparticles synthesis. Plant extracts are the most widely accepted form of green, environmentally friendly nanoparticles synthesis, with the added benefit that plants are safer to treat, serve as a source of a variety of metabolites and widely available (Kavitha & Baker, 2013).

2.0 METHODOLOGY

2.1 Sample Collection and Locations

Silver ions are reduced during the formation of silver nanoparticles by the bioactive substances found in the Wurmb extract of Nypa fruticans. The method is designed to be as environmentally friendly, reproducible, and efficient as possible. To determine the size, shape, and crystalline structure of the produced nanoparticles, methods like transmission electron microscopy (TEM), X-ray diffraction (XRD), and UV-Vis spectroscopy are used.

Four liters of labeled plastics containers were used to sample the landfill leachates in order to determine the quality of the leachate. Prior to the collection of these samples, the containers were washed with nitric acid (HNO3) and then rinsed with distilled water. Prior to being collected, the leachate samples were additionally washed through these sample containers multiple times. Samples were taken in the state of River from the Obio-Akpor Local Government Area.

The gathering of waste from landfills As leachate drains under gravity from ground level (low lying) land in the heap of solid waste dump at the landfill locations, leachates were obtained at random by digging vertically at four separate corners of the specified landfills. A Mettler Toledo pH meter was used on-site to measure the sample's pH. Samples were taken in January 2022, and after being filtered through a transparent glass micro-filter measuring 0.47 mm, they were kept in a research laboratory at 4 °C until additional examination could be done. Fresh leaves of Nipa palm (*Nypa fruticans*) were collected from Emuoha Local Government Area of Rivers state. Taxonomical identification and authentication were carried out at Spring Research and Analytical Laboratory Rivers state.

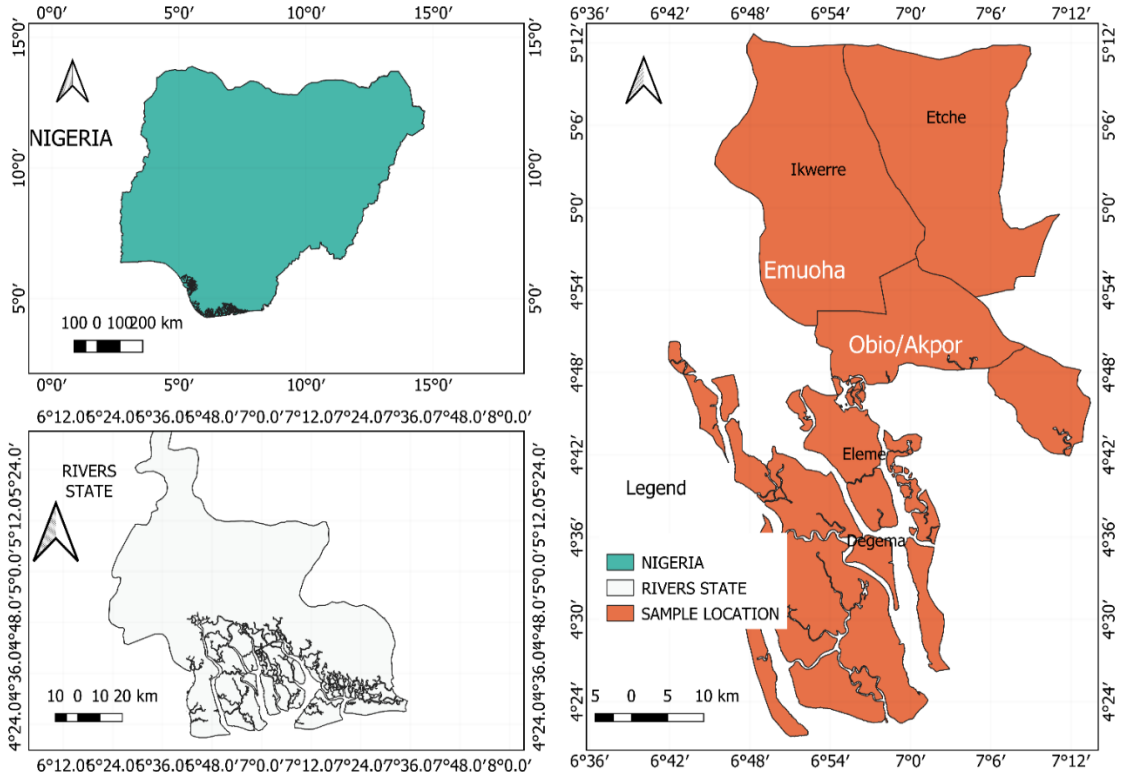


Figure 3.1 Maps showing sampling locations (RIVERS STATE)

Growth in TSB Media

TSB media was made by weighing out the following recipe and autoclave; 8.5g/l trptone, 2.5g/lNaCl, 1.5g/l soytone, 1.25g/l dipotassium phosphate and 1.25g/l glucose D. Thereafter, overnight cultures of both strains of *S.aureus* were grown in 20ml TSB in a shaking incubator. The cultures were then diluted with 60ml TSB (in a conical flask previously autoclaved) of each culture to approximately 0.05 at optical density 595_{nm}. 10ml of the diluted SH1000 culture was then measured into 5 falcon and different concentrations of copper; 0(control), 1mM, 2.5mM, 5mM and 10mM was added and kept in a shaking incubator. $O.D_{595}$ readings of each of the different concentrations were then taken per one hour until 7 hours. The same was repeated for SH1000*copA*.

Growth in Chelex -Roswell Park Memorial Institute (C-RPMI) Media

RPMI was depleted of metals by adding 60g of Chelex to 1L of RPMI and left overnight. The depleted metal was then compensated for by replacing 10% of the C-RPMI with 10% RPMI. Replenished CRPMI was then used to grow overnight cultures of SH1000 AND SH1000copA in a mini-incubator at 37° C. Then, the overnight cultures were then centrifuged for 10 minutes and supernatant poured out. The culture sediments were then re-suspended in 1ml of CRPMI and diluted in 60 ml of CRPMI (in a previously

Glass Wares and Equipment

Four (liters) liters of labeled sampling rubbers, Filter papers (whatmann No: 42) micro-filters (0.47 mm, 60 jum, 75 m), beakers (50 ml, 250 ml), test tubes and holder, volumetric flask (250 ml), thermometers (0 - 360 C) reagent bottles, 50 ml burettes, 25 ml pipette, micro-pipette, Reflux apparatus (retort stand, clamp and clips, transparent boiling tubes, transparent funnel, plastics sample bottles, spatula, indicator bottle. porcelain mortar and pestle, conical flasks (50, 250 and 500 ml) hot plate coupled with magnetic stirrer, weighing balance (model no. RADWAG: AS22C/2), electric oven (model no. J.P.SELECTA: 2001243565 02), transparent oxygen determination bottle with glass stopper (250 ml - 300ml) and water bath.

However, laboratory gadgets (equipment) employed for the experiment include Mettler Toledo pH meter, powder Pillow method (Model 08155; Standard methods), UV-Vis spectrophotometer (Genesis 10 UV), Flame Atomic Absorption Spectrophotometer (Model no: 55B SPECTRA), Resonance Wavelength Machine (Model no: D310; Standard Method) and Atomic Absorption Spectro-photometer (UNICAM SOLAR 32).

Reagents

All analytical reagents were supplied by Spring Research and Analytical Laboratory Rivers state, Reagents used were; Sulphuric acid (H_2SO_4), Manganese sulfate ($MnSo_4$), Alkali-iodide-azide, Sodium thiosulphate ($Na_2S_2O_3$), Potassium dichromate ($K_2Cr_2O_7$), Ferrous ammonium sulphate $(NH_4)_2 Fe(SO_4)_2.6H_2O$, Hydrogen nitrate ($HNO_3$), Hydrogen chloride (HCL), Potassium mercuric iodide ($K_2(Hgl_4)$, Ethanol (C_2H_5OH), deionized water.

Sample Preparation and Method for the Analysis Extraction of the Plant's Materials

In order to get rid of dirt, bird droppings, and other contaminants, fresh leaves were taken from Nypa fruticans tree plants and cleaned four times with tap water and three times with distilled water. For seven hours, the cleaned leaves were shade dried to eliminate any remaining moisture. The dried leaves were pulverized into a powder and stored as samples for further use. According to Sofowora's (1993) instructions, 50g of powdered Nypa fruticans was steeped in 50ml of 100% ethanol and extracted using the cold maceration process. 500ml of 99% ethanol was used to percolate 50g of powdered Nypa fruticans leaves in a 1-liter conical flask, which was then shaken continuously for three days. Next, a funnel and Whatman filter paper were used to filter the mixture. A rotary evaporator was used to evaporate the filter, and the recovered extracts were refrigerated at 4oC.

2. RESULTS

The result for characteristics of landfill leachate (LFL) before treatment and after treatment using both silver nanoparticles synthesized by (*Nypa fruticans*) plant extract and $NaBH_4$ are presented in figure 4.1, 4.2 and 4.3 respectively. Similarly, these results were influence by Ph, COD, BOD, TDS, Cd, Ni and Pb reduction using both the plant extract and $NaBH_4$. However, the nanoparticles were successfully extracted and was characterized using UV-visible spectroscopy, Fourier transformation infrared spectroscopy, and scanning electron microscopy. Phytochemical analysis was also carried out on the plant extract to reveal the constituents present.

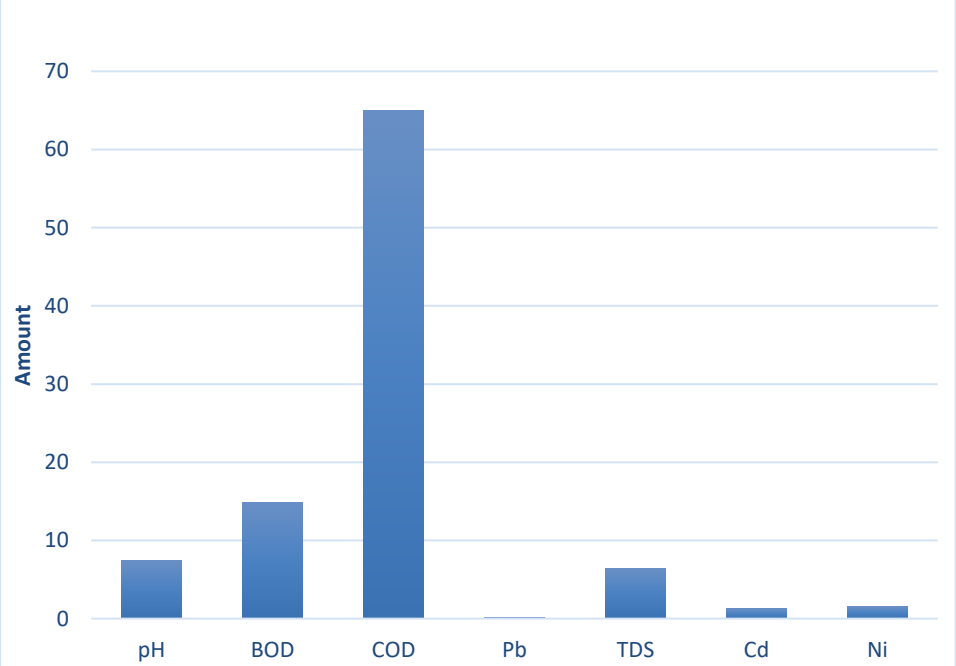


figure 1: Physicochemical characteristics of LFL before treatment

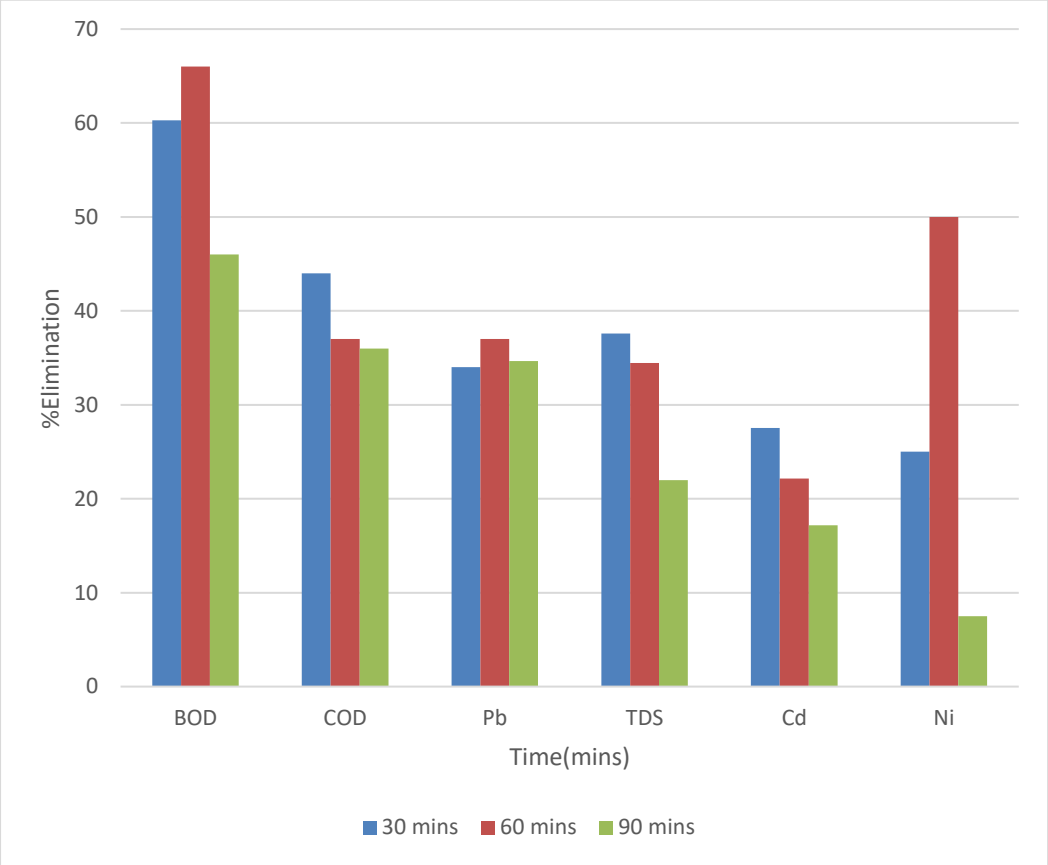


Figure 2: Physicochemical reduction of silver nanoparticles synthesized by $NaBH_4$

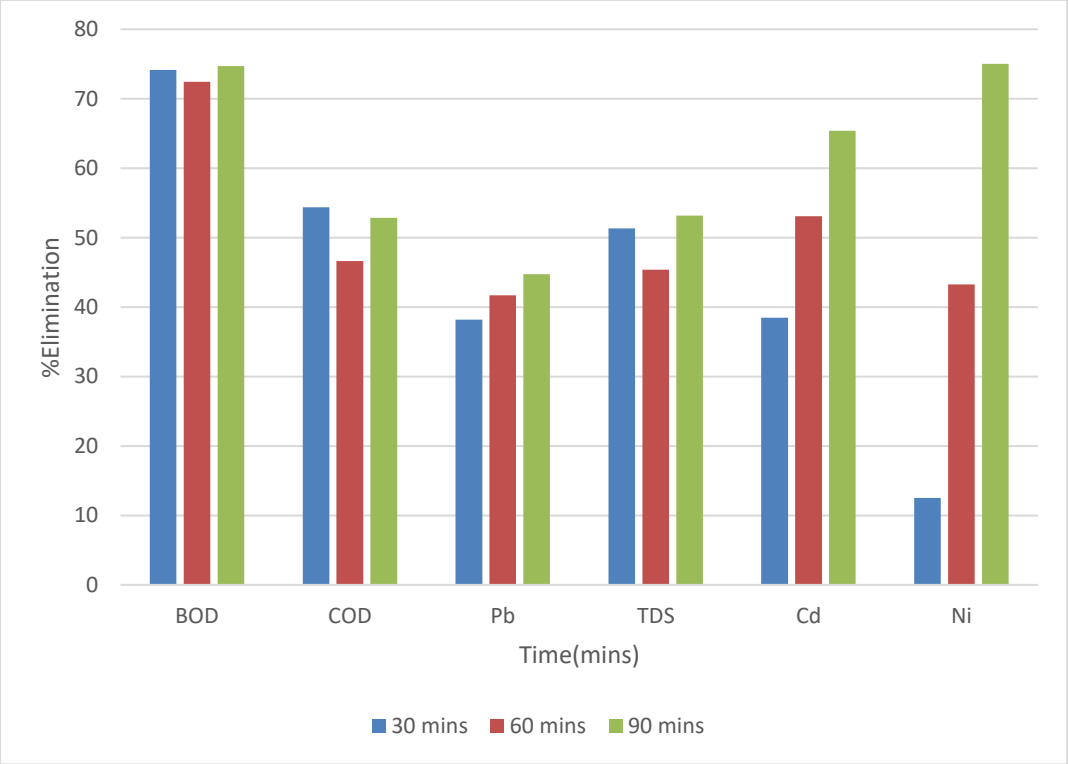


Figure 3: Physicochemical reduction of characteristics of LFL using silver nanoparticles synthesized by Nypa fruticans plant extract

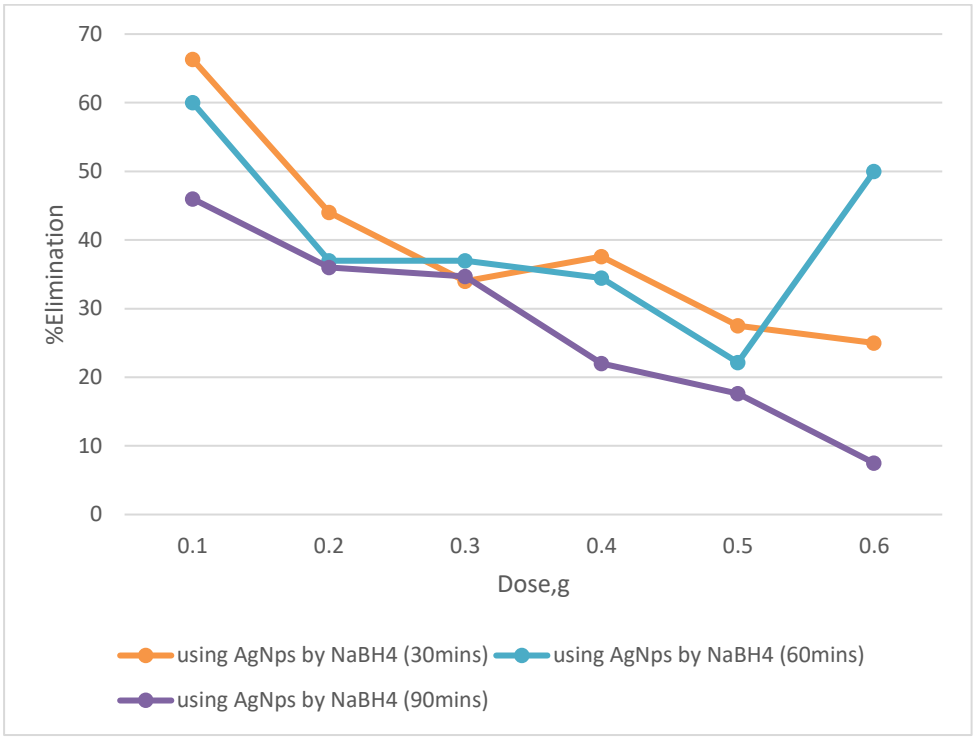


Figure 4: Effect of Adsorbent Dose on elimination of physicochemical parameters with AgNps by $NaBH_4$

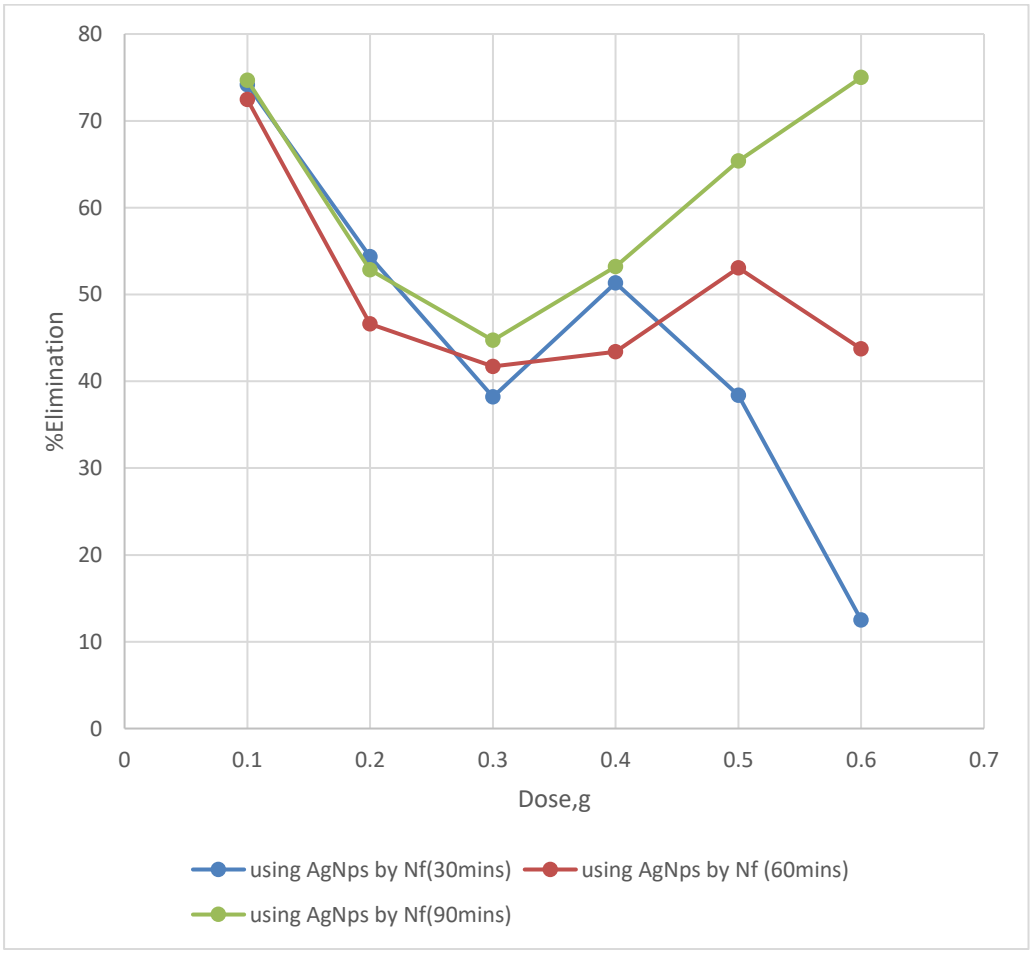


Figure 5: Effect of pH of the elimination of physicochemical parameters using (SB-AgNps)

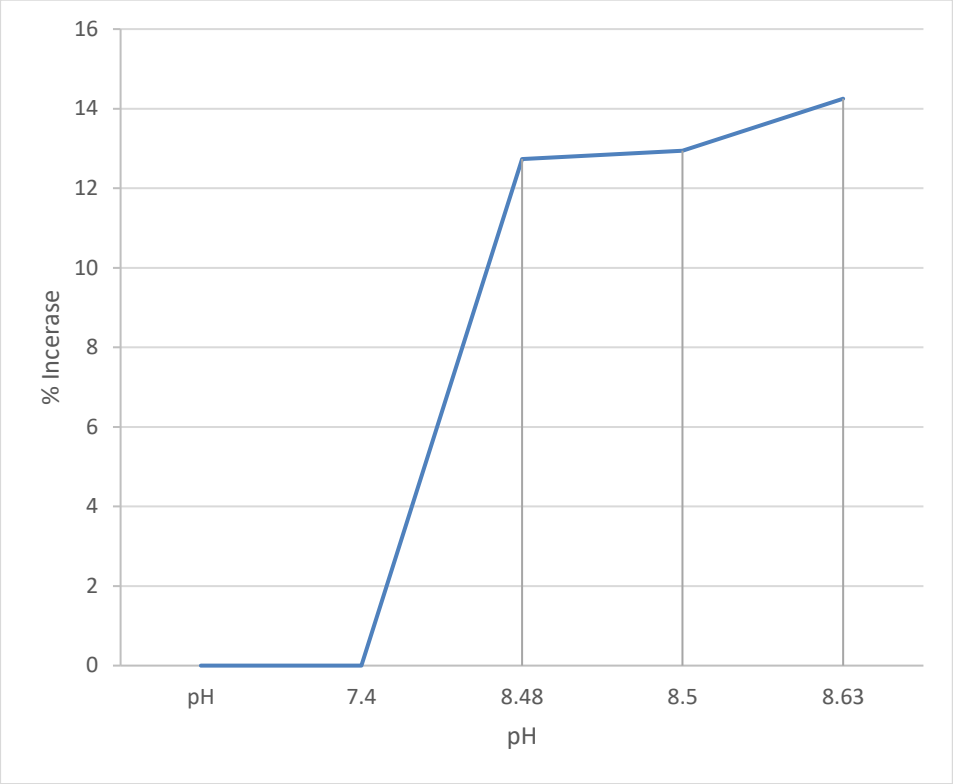


Figure 6: Effect of pH of the elimination of physicochemical parameters using (SB-AgNps)

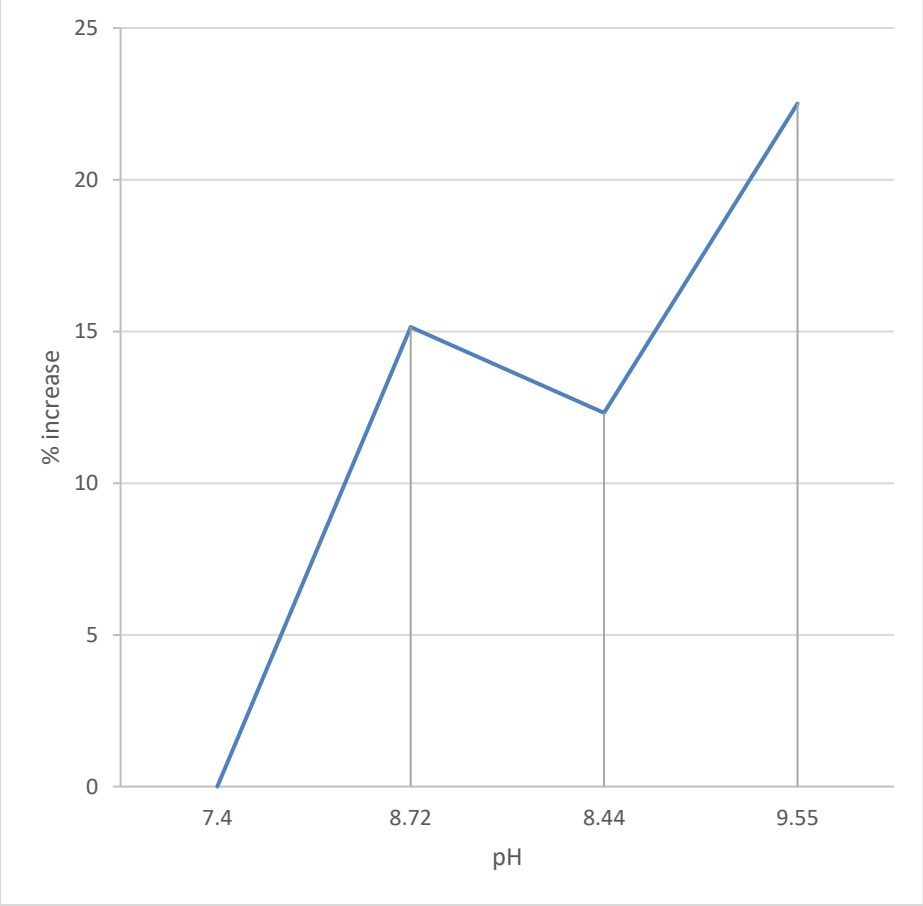


Figure 7: Effect of pH of the elimination of physicochemical parameters using (NF-AgNps)

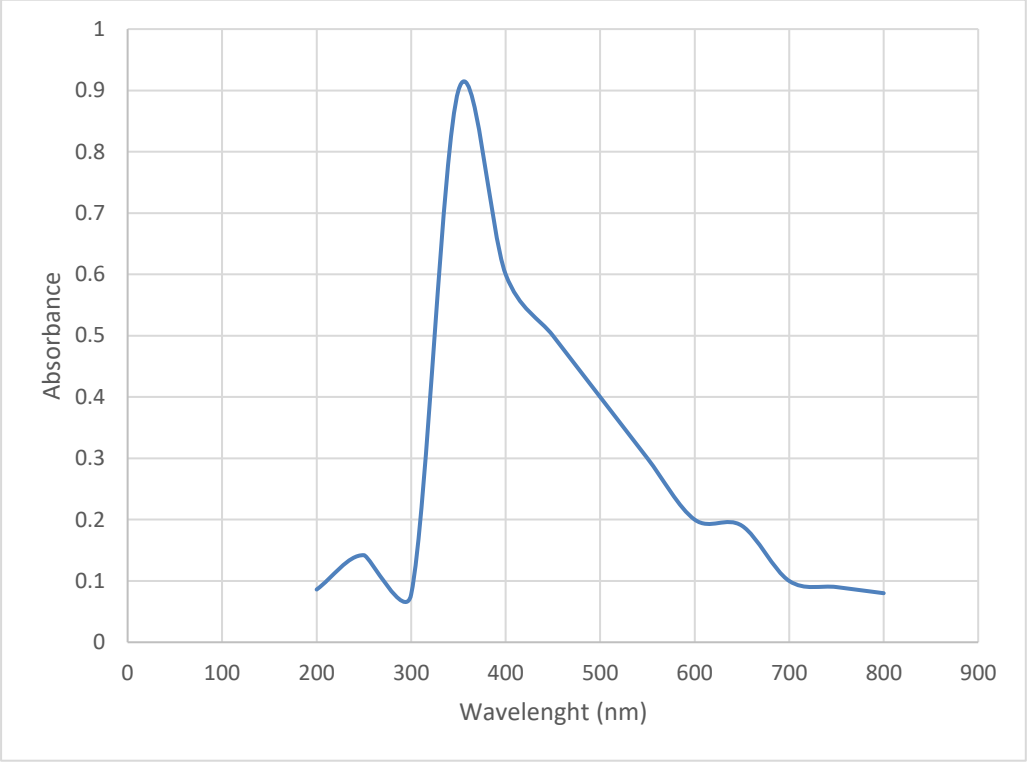


Figure 8: Ultra-violet visible spectrum of silver nanoparticles synthesized by $NaBH_4$ (SB-AgNps)

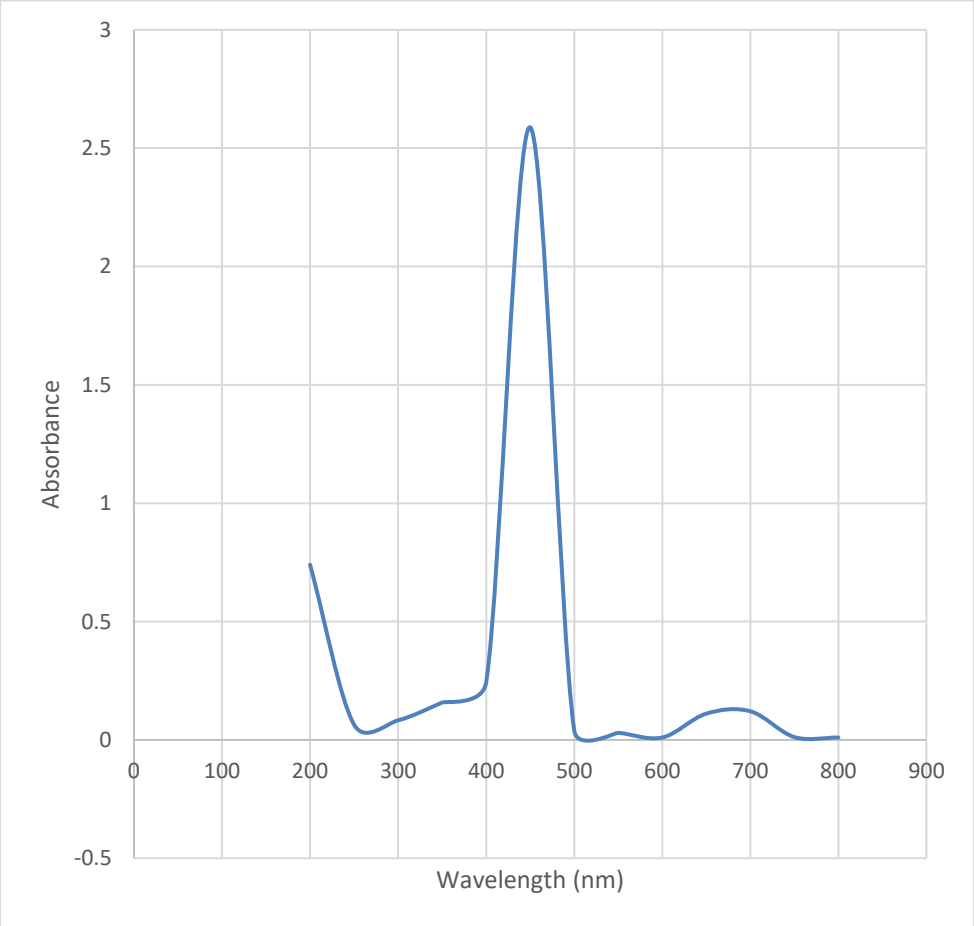


Figure 9: Ultra-violet visible spectrum of silver nanoparticles synthesized by Nypa fruticans plant extract (NF-AgNps)

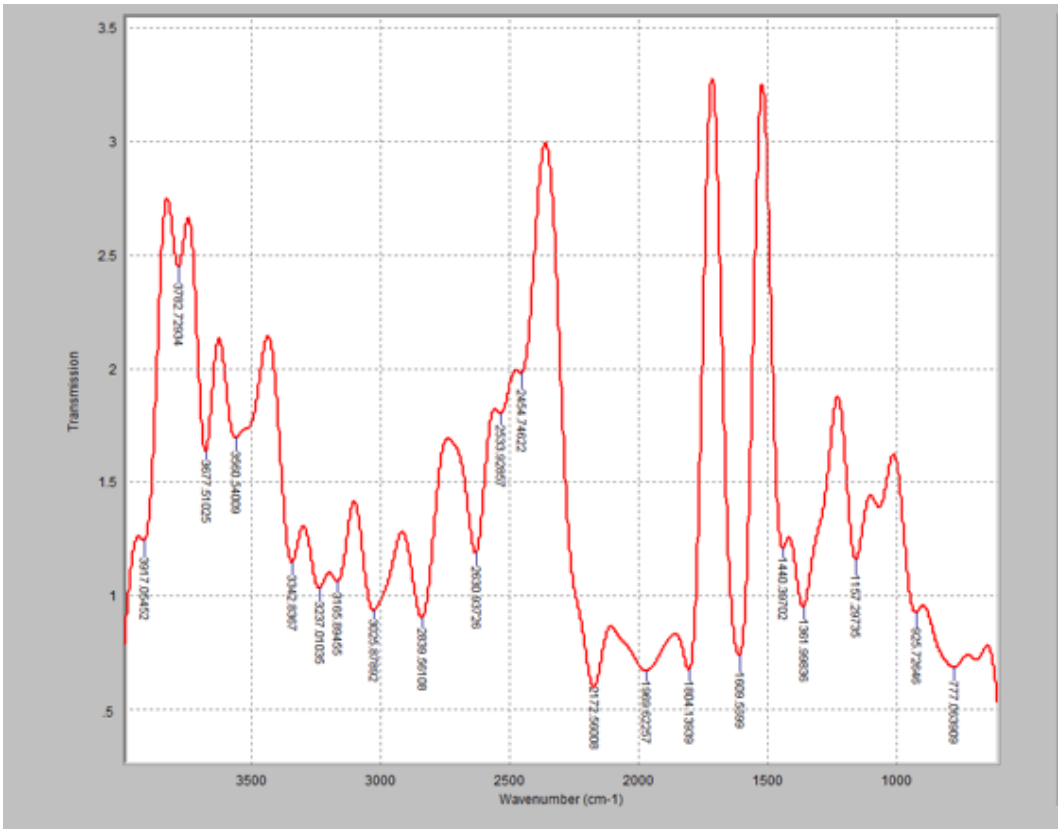


Figure 10: FTIR of silver nanoparticle synthesized by $NaBH_4$(SB-AgNps)

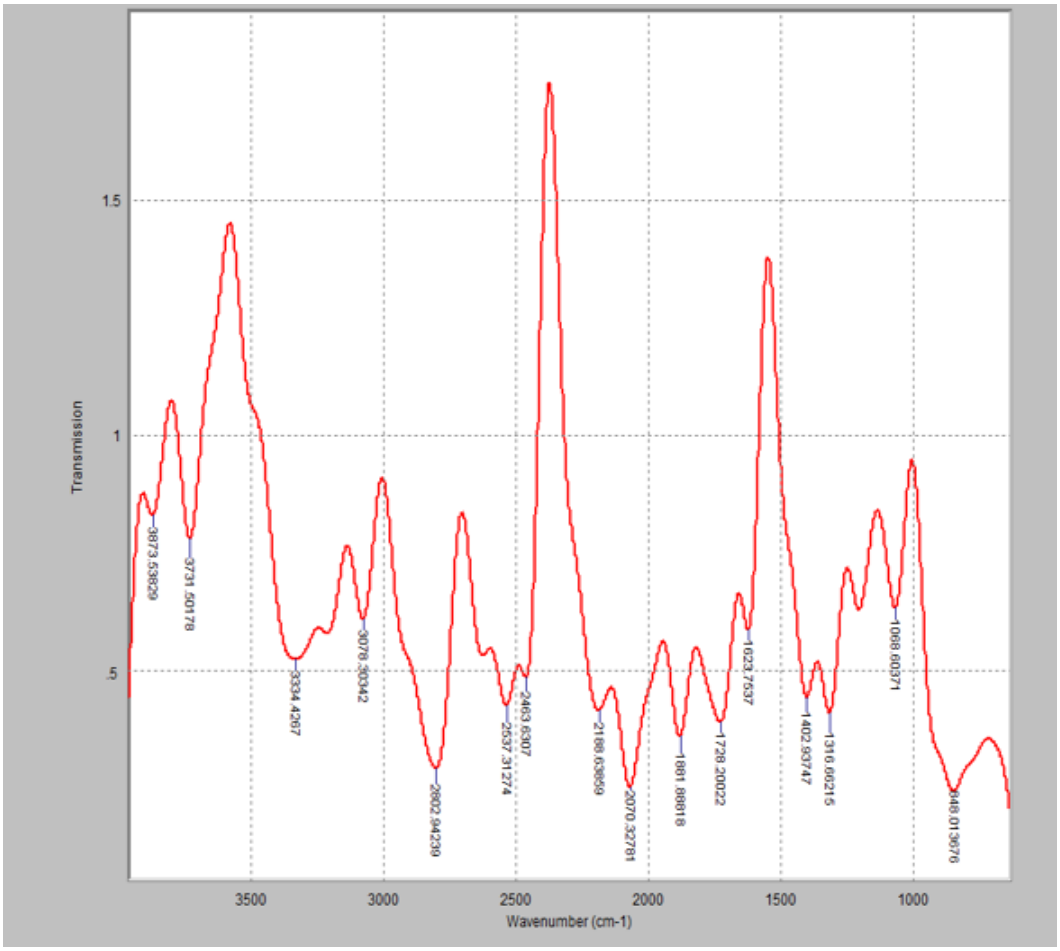


Figure 11: FTIR of silver nanoparticles synthesized by Nypa fruticans plant extract(NF-AgNps)



Figure 12: SEM imaging on silver nanoparticles synthesized by $NaBH_4$(SB-AgNps)

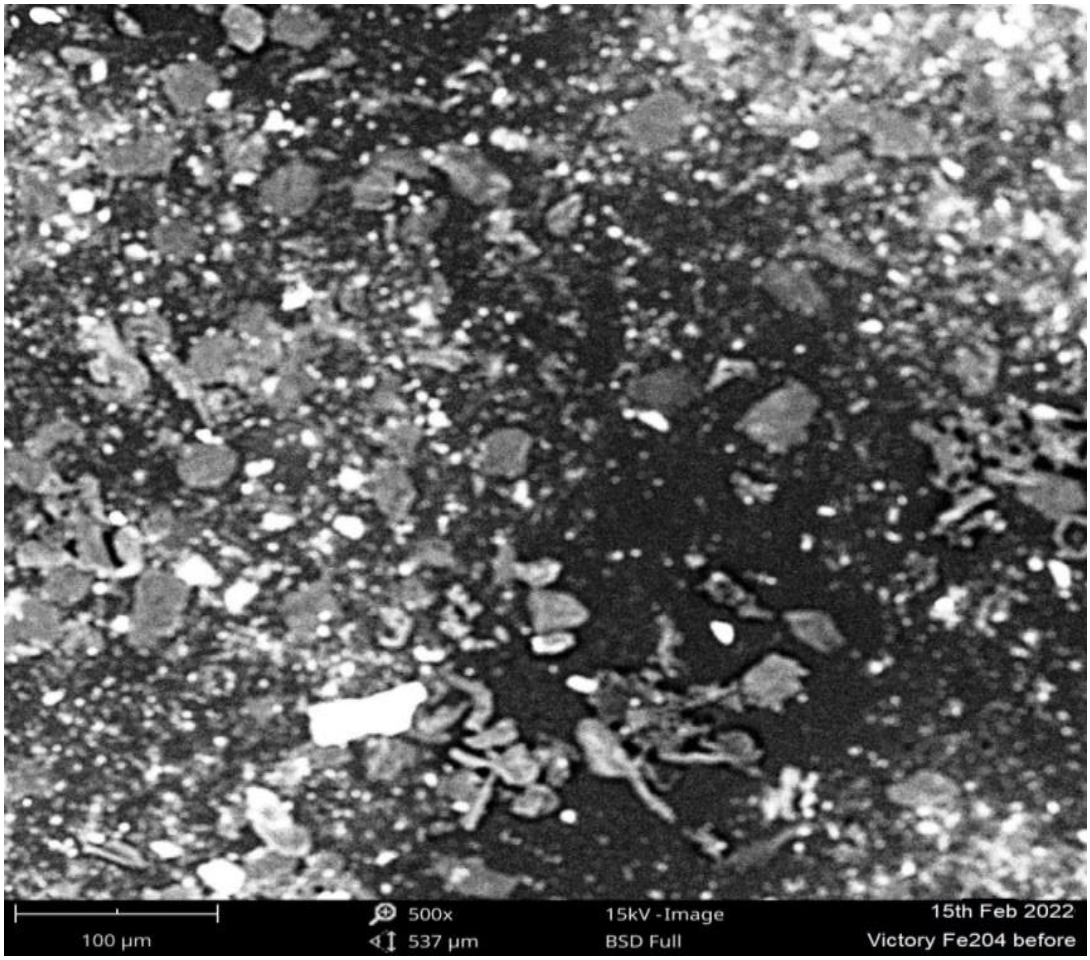


Figure 13: SEM imaging on silver nanoparticle synthesized by (Nypa fruticans) plant extract (NF-AgNps)

3. DISCUSSION

Concentrations of Characteristic of Landfill Leachate (LFL) Before Treatment

Figure displays the different concentrations of landfill leachate characteristics in land fill. Heavy metals including Pb, Cd, and Ni were detected, along with BOD5, COD, and TDS, among other characteristics found in the landfill leachate sample.

Percentage Reduction of the Characteristics of Landfill Leachate on Silver Nanoparticle by ($NaBH_4$)

Figure 4.2 depicts the lowering of the different landfill leachate (LFL) characteristics using sodium borohydride. The result was given at various time intervals for 30, 60 and 90 minutes. In the LFL using sodium borohydride for BOD_5 at 60 minutes was more pronounced compared to the other time interval. While COD at 30 minutes was more pronounced as compared with 60 and 90 minutes. For Pb and Ni the most pronounced reduction was at 60 minutes when compared to the others. For TDS and Cd, it has more percentage elimination at 30minutes.

This result demonstrated that silver nanoparticles synthesized by sodium borohydride might be utilized and exploited for the systematic removal of organic and inorganic contaminants from the leachate as well as the adsorption of COD and BOD5 at 60 minutes, hence diminishing their varied concentrations in the wastewater sample. The observed favorable impact that lowers these pollutants from the leachate may be associated with the usage of sodium borohydride, which stabilizes the silver nanoparticles and reduces silver nitrate (Okeacha, 2018).

Percentage Reduction of the Characteristics of Landfill Leachate on Silver Nanoparticle by Nypa fruticans plant extract

The plant extract (Nypa fruticans) was applied to landfill leachate cleanup. Figure 4.3 displayed the percentage reduction of the landfill characteristics. The outcome showed that each characteristic's percentage reduction was greater than 70% for BOD_5 irrespective of the time. In the LFL using plant extract BOD5 at 90 minutes had the greatest reduction of 74.68% while that for both 30 and 60 minutes were 74.14 and 72.45% respectively, while COD at 60 minutes had the least reduction of about 46.62% thus the order of reduction of COD at different time interval (54.35> 52.83>46.62). in the LFL using plant extract Pb showed the highest reduction at 90 minutes which was 44.72% while 30 and 60 minutes were 38.19 and 41.71 respectively. TDS, Cd and Ni has the highest percentage reduction at 90minutes.

The result demonstrated that when plant extract is used in the production of nanoparticles it showed a very high effectiveness on the landfill leachate in the synthesis of the nanoparticles which is attributed to the various secondary metabolites present in the plant extract which acts as reducing and stabilizing agent for bio reduction reaction to synthesized novel metallic nanoparticles. (Hedaginal & Taranath, 2016).

Comparison Between Silver Nanoparticles using Plant Extract and Sodium Borohydride

The reduction of the various landfill leachate (LFL) characteristic using both $NaBH_4$ and plant extract for treatment of leachate were showed in figure 4.2 and 4.3 respectively. In the treatment of LFL using plant extract the reduction of Pb from the leachate sample was more pronounced compared to the one when $NaBH_4$ was used.

The order of the characteristic's reduction in the leachate sample after treatment using the silver nanoparticle synthesized by plant extract and sodium borohydride are;

Treatment with plant extract, BOD_5 (74.68) > COD (54.35) > Pb (44.72)

Treatment with $NaBH_4$, BOD_5(66.00) > COD (44.00) > Pb (37.00)

It therefore means that the plant extract used in the synthesis of the nanoparticle showed more effectiveness on the land fill leachate, thus the plant extract has an effective positive influence on the contaminant's reduction from the landfill leachate sample than the one of sodium borohydride.

It could be inferred that using plant extract in the production of nanoparticle is proficient, prowess capabilities and could be the best method employed for landfill leachates remediation.

Effect of Adsorbent Dosage

According to figure 5.1, the rate of elimination increased in the adsorbent as time changes from 60 to 90 minutes (AgNps synthesized using plant extract), which indicates that at dose 0.1g the rate of elimination increased from 70 to 74.68% for BOD. At dose 0.2g it was observed that 54.35%, 44.62% and 52.83% were eliminated while AgNps by NaBH4 (figure 5.2) gave 44%, 37% and 36% respectively. It therefore means that the rate of elimination of contaminants were higher when using AgNps by plant extract at of dose of 0.2g. Subsequent dose of 0.3, 0.4, 0.5 and 0.6g corresponding resulted in Pb (38.19%, 41.7%, 44.7%) TDS (51.32%, 43.39%, 53.19%) Cd (38.4%, 53.07%, 65.38%) and Ni (12.50%, 43.73%, 75%). While the percentage elimination by AgNps by NaBH4 gave Pb (37%, 37%, 46.7%) TDS (37.59%, 34.47%, 21.99%), Ni (12.5%, 50%, 7.5%) respectively.

The increase in adsorption with increase in adsorbent dose occurred as a result of increase in the surface area available for the AgNps to adsorb (Dada *et al.,* 2015). The data showed that at any given dose the AgNps synthesized by plant extract has a better elimination rate for contaminants than the one synthesized by $NaBH_4$.

Effect of pH on treatment landfill leachate using Nano-particles

Functional groups, surface modifications, degree of ionization, and solubility of the adsorbent are significant aspects that are affected by pH of aqueous solution during the adsorption process. The result obtain for elimination of contaminates for land fill leachate at various pH (figure 6.1 and 6.2) increased from 7 to 9.55. increase in pH were observed as the LFL was treated with AgNps synthesized by $NaBH_4$, the percentage elimination at pH 8.48, 8.5, 8.6, were 60.3%, 44% and 34% respectively, this is because as the pH increases there is low number of hydrogen ions present and thus, the degradation reduced. On the other hand, the percentage elimination of AgNps using plant extract increased slightly with increase in pH. At pH 8.72, the elimination efficiency increased from 74.14% to 74.68% and at pH 8.44 the elimination efficiency also increased for 38.19% to 44.72% respectively.

The result showed that increasing the contact time from 30minutes to 90 minutes of the iron nano-particles increased the COD, BOD, and TDS efficiency. The removal efficiencies in various pH level using AgNps synthesized by $NaBH_4$ showed that increasing the pH value to 8.63 decreased the removal efficiency. While the AgNps synthesized by plant extract at pH 8.72 there was increase in the removal efficiency and makes it more effective for treatment of land fill leachate (Kashitarash *et al*., 2012). Hence assessment pH of the leachate sample was a paramount factor that must not be overlooked during landfill leachates remediation (Shabiimam & Dikshit, 2012)

Ultra-violet visible spectrum of silver synthesized by sodium borohydride

Our tests yielded silver nanoparticles with a size between 300 and 600 nm. Figure 4.8 displays the results of the identification of the silver nanoparticle absorption peaks. The maximum absorption was found at 360 nm, and the absorption peaks of the silver nanoparticles formed by chemical reduction using silver nitrate by sodium borohydride were concentrated within 250-800 nm.

The absorption peaks of silver nanoparticles generated with various capping and reducing agents have generally been reported in the wavelength region of about 450nm in the literature when silver nitrate is used as the silver precursor.

When producing silver nanoparticles, the dominating wavelength range varies depending on the capping and reducing chemical used. For instance, the absorption of silver nanoparticles made utilizing a green manufacturing process and plant extract might vary from 300 to 800 nm, depending on the specific plant extract utilized. It is commonly known that reducing agents such as sodium borohydride can reduce silver from Ag+ to Ag0. It is well known that surface Plasmon resonance in a nano-silver solution is the cause of the absorption band at 360 nm. Actually, depending on the ratio of silver ions to zero-valent silver, the degree of Plasmon resonance which shifts either side of the value would determine the absorption energy.

Ultra-violet visible spectrum of silver synthesized by plant extract

The spectroscopic examination of the reaction medium and isolated nanoparticles, along with the color change, verified the effective production of AgNPs using Nypa fruticans plant extract (figure 4.9). In fact, a noticeable hue shift was seen after agitating the AgNO3 and plant extract mixture for fifteen minutes. The reaction mixture's color changed from yellowish green to brown, indicating that ionic silver (Ag+) was transformed into metallic silver (Ag0), which then self-assembled to form colloidal particles (AgNps). This finding is in line with previously published research (Oliveira et al., 2019; Singh et al., 2018), It states that certain secondary metabolites, such as alkaloids, flavonoids, cardiac metabolites, glycosides, and phenolphthaleins, have reducing characteristics that cause silver ions to be reduced when plant extracts are present. Jain & Mehata (2017); Gurunathan et al. (2014); Jadhav et al. (2016).

AgNps' brown color actually results from the simultaneous vibration of free election of metallic silver that is in resonance (SPR) absorption, which is frequently observed with metallic nanoparticles. This is confirmed by uv-vis spectroscopy, which is often used in conjunction with visual observation to confirm AgNPs formation (see figure 4.5).

The produced AgNps showed a Uv-vis absorption band, peaking at 450 nm in absorbance. Similar to the color shift, the Uv-vis bands that are seen are caused by SPR absorption and verify the presence of AgNps.

The synthesised AgNps may be interacting with phytoconstituents in the plant extract to cause varying interference with the SPR absorption signals, which could explain the rather large changes at various absorption that were seen.

Comparison Between the Uv-visible spectrum of the Plant Extract and Sodium Borohydride

The UV-visible data peak in Figures 6.3 and 6.4 represents a silver nanoparticle that was produced using plant extract and NaBH4. The plant extract has a value of 450 nm and sodium borohydride has a value of 360 nm. One major cause of the variation in the peaks could be the variable concentrations of the bio-reducing agent that were utilized. It's also probable that, in comparison to chemical reducing agents, bio-reducing agents are typically utilized in larger concentrations.

Nucleation is a rare event that typically results in a decreased rate of nanoparticle development. Additionally, the reason for these variations in the peaks is the contrasting nature of the reducing agent

that was used, as various agents exhibit distinct surface Silver Plasmon Resonance.

4. CONCLUSION

Using Nypa fruticans, an environmentally safe method of producing silver nanoparticles Wurmb extract offers a potentially effective method of treating leachate. The work highlights the significance of sustainable solutions in solving environmental concerns and add to the expanding subject of green nanotechnology. Additional investigation could examine potential for scaling up and the suitability of this strategy for actual wastewater treatment situations.

Ethical Consideration

Not applicable

Conflict of Interest

The authors have no conflict of interest to declare in connection with this article.

Credit authorship contribution statement

Umukoro Collins[1] : Data acquisition and bench work; **Ajie Michael[1]:** Data Analysis and drafting of manuscript; **Third Author:** Supervision of student (Dickson Godspower Ejike)**; Fourth Author[2]**: Conceptualization, Supervision, Writing - review & editing, Validation.

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A MASLOVIAN PERSPECTIVE ON HUMAN MOTIVATION IN CHINUA ACHEBE'S *ANTHILLS OF THE SAVANNAH* AND ABUBAKAR GIMBA'S *FOOTPRINTS*

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Abstract
This research examines human motivation through a Maslovian lens in Chinua Achebe's Anthills of the Savannah and Abubakar Gimba's Footprints, using Abraham Maslow's "Hierarchy of Needs" as a theoretical framework. It studies how characters in both novels circumnavigate psychological growth under socio-political domination, economic unpredictability, and social change. In Anthills of the Savannah, Achebe presents a crumbling nation where food, water, and shelter are discussed and weaponised by an oppressive military government. The scarcity in Abazon and Bassa validates how state neglect undermines rudimentary subsistence. The novel further reveals a pervasive environment of fear that dents safety needs, resulting in psychological subjugation and internal struggle. In Footprints, Gimba exemplifies how women represent various layers of Maslow's pyramid (from physiological survival and safety-seeking to self-fulfillment and social change). By juxtaposing these two Nigerian novels, the study affirms Maslow's claim that unmet basic needs hinder human development, while fulfilled needs can empower people in the direction of resistance, responsiveness and transformation. The examination contributes to post-independence African literary criticism by combining psychological theory with post-colonial socio-political circumstances, revealing how motivation, endurance and action are molded by structural violence and pliability in modern-day Nigerian literature.
Keywords: Maslow, physiological, safety, love/belonging, esteem, self-actualisation

1.0 INTRODUCTION

1.1 Background of the Study

In Nigerian literature, the question of human motivation is not just an issue of individual psychology but a reflection of the wider socio-political and economic certainties that silhouette human actions. Chinua Achebe's *Anthills of the Savannah* and Abubakar Gimba's *Footprints* present convincing portrayals of how people and societies scuffle to meet their basic and intricate needs amidst political unpredictability, systemic subjugation and social disparity. As Zishiri and Mugadza (2024) state that African settings often reveal that self-actualisation can co-exist with unmet lower-order desires, particularly when individual and cultural flexibility act as supporting forces. This offers a critical standpoint for studying the resilience of characters in *Anthills of the Savannah* and *Footprints*. This study adopts Abraham Maslow's "Hierarchy of Needs" as a theoretical lens to examine how the characters in both novels try to accomplish physiological, safety, belonging, esteem and self-actualisation needs in circumstances noticeable by poverty, totalitarianism and social change.

In *Anthills of the Savannah*, Achebe surveys a society in crisis where starvation, uncertainty and fear become tools of political oppressions. Similarly, Gimba's *Footprints* shows female characters who challenge societal prospects and institutional fiascos while looking for a sense of uniqueness. Through a comparative psychological examination, this paper argues that both Achebe and Gimba use fiction to accentuate the pressing need for a society that allows human development at all levels of Maslow's hierarchy. By portraying how people struggle to interchange from basic subsistence to higher levels of determination and self-contentment, the novels jointly promote a rehumanisation of the post-colonial experience. Thus, the study examines the Maslovian perspective on human motivation in Achebe's *Anthills of the Savannah* and Gimba's *Footprints.*

1.2 Statement of the Problem

Motivation remains a dominant concept in psychological and literary studies, particularly within situations of political cruelty, economic adversity and cultural disturbance. While Maslow's "Hierarchy of Needs" offers a valuable framework, its submission to Nigerian literature is limited. In *Anthills of the Savannah* and *Footprints*, Achebe and Gimba portray characters whose quests for survival, self-respect, and purpose reflect deeper motivational dynamics shaped by systemic crises. Despite these rich depictions, Scholars have not studied the characters in these novels from the perspective of Maslow's theory of human needs. This research addresses that lacuna by examining how both authors utilise fiction to explore human motivation within socio-political and cultural constraints.

1.3 Aim and Objectives

This research aims to examine the Maslovian perspective on human motivation in Achebe's *Anthills of the Savannah* and Gimba's *Footprints.* To fulfil the aim of this study, the objectives are:

a) To examine the socio-political and psychological circumstances that shape individual and collective motivation in both novels;

b) To appraise how these authors reveal the struggle for Maslow's "Hierarchy of Needs" within an unbalanced socio-political environment;
c) To study how gender, power and class influence access to various levels of Maslow's theory in the novels under study.

1.4. Significance of the Study

This study holds noteworthy value within literary, psychological, and socio-political scopes by reconnoitering how Abraham Maslow's Hierarchy of Needs expands our understanding of character motivation and organisational oppression in the Nigerian novel. The research contributes to interdisciplinary scholarship by combining psychological theory with post-colonial literature. It shows how unmet needs inspire human action, identity construction and struggle within oppressive systems. In *Anthills of the Savannah*, the study shows how Achebe reviews the collapse of political morals and emotional subjugation under military dictatorship. Thus, presenting the human cost of governance bereft of kindness. In *Footprints*, the research reveals how Gimba recreates gendered experiences of motivation, not just in isolated spaces but as catalysts for social change.

2.0 LITERATURE REVIEW

2.1 Theoretical Framework: Maslow's Hierarchy of Needs

Abraham Maslow's "Hierarchy of Needs" theory, first presented in his 1943 text *A Theory of Human Motivation* and later expounded in *Motivation and Personality*, offers an organised ideal for understanding the development of human motivation. The concept postulates that individuals are moved by five hierarchical classes of needs. They are physiological, safety, love and belonging, esteem, and self-actualisation (Osemeke, & Adegboyega, 2017). These groupings are organised in a pyramid, with the lower-level needs functioning as a precondition for the quest for higher-level ones (Maslow, 1943, p. 372). Also, Maslow claims that "man is a perpetually wanting animal," whose needs are arranged in an ascending order of prepotency (Maslow, 1954, p. 35). This progression suggests that rudimentary needs such as hunger and housing must be rationally gratified before a person can pay attention to psychological and self-actualisation goals. This understanding is critical when examining post-independence African novels, where individuals experience splintered motivational ways as a result of external interruptions.

2.2 Conceptual Framework: The Notion of Motivation

In African literature, motivation has repeatedly been knotted to socio-political circumstances, historical practices and empirical predicaments (Hakibou, 2018). Some African writers have revealed how colonialism, cultural fragmentation, deficiency and political unpredictability shape the motivational aspect of their characters. For example, in Chinua Achebe's *Anthills of the Savannah*, the citizens of Kangan are revealed to be principally motivated by physiological and safety needs. Similarly, Abubakar Gimba's *Footprints* reveals motivational brawls in post-colonial Nigeria, mainly around gender issues, education and the longing for self-realisation. This requires investigating how traditional standards and modern goals cooperate within African characters (Okiche, 2018). This is because in the African novel, motivation is designed by scarcity, gender, politics, institutions and colonial heritages (Chandna, 2022).

2.3 Empirical Framework

2.3.1 Review of Related Literature on Achebe's *Anthills of the Savannah*

Ononiwu & Njemanze (2015) claimed that Achebe's *Anthills of the Savannah* is divided into four levels of binary oppositions. Firstly, the opposition is between the rich elite and the deprived illiterates. Secondly, the opposition is in the point of view in the text (Ononiwu & Njemanze, 2015). Thirdly, the level of binary opposition in the novel according to these critics is that flanked by diegesis and mimesis or description and treatise. Fourthly, the binary opposition "is that between the president and his cabinet, the fifth between Chris and the cabinet, the sixth between Chris and Ikem, the seventh between the Director of the state Research council (SRC) and the President's cabinet and finally, the opposition seen in the president's ambivalent nature" (Ononiwu & Njemanze, 2015, p. 96). However, they paid less attention to Maslow's "Hierarchy of Needs" theory in the novel which this paper studies.

Olaluwoye (2016) examined the discourse values of names in Chinua Achebe's *Anthills of the Savannah*. He studied the names of the characters in the novel and analysed them using the register theory, which depends deeply on contextual representations. Olaluwoye's study recognised three discourse standards of names. He examined "names as identity markers, names as markers of social class, and names as expressive and stylistic markers (Olaluwoye, 2016, p. 25). However, he did not examine the impact of motivation on the characters in the novel. Thus, this research examines the impact of human motivation in *Anthills of the Savannah.*

A study of Vekateswaran and Miranda (2018) revealed that Chinua Achebe employed his writing skills to recuperate the culture of his ethnic group and offered Nigerians with a history that had been forgotten in the process of time owing to British colonialism. Achebe's *Anthills of the Savannah* serves "as an

anchorage from which the modern Nigerian man can draw conclusions about his origins, which ultimately enables him to stand proud in front of neo-colonial assertions of power and fight for his freedom and prosperity" (Vekateswaran & Miranda, 2018, p. 366). Also, they argued that Achebe shows that the hope of Nigeria lies in the unity and enduring spirit of the people which can only help them triumph over cruel autocrats and corrupt governments that have been horrifying their nation for years. However, they did not study the impact of human motivation in the novel which this research examines.

2.3.2 Review of Related Literature on Gimba's *Footprints*

The purpose of this section is to review some of the critical works on Gimba's *Footprints*. Usman (2006) examined the relationship between men and women in Gimba's *Footprints*. According to Usman (2006, p.158), *Footprints* is about "the basic things expected of both the man and woman in society according to the teachings of Islam as against the traditional perception". He declared that Gimba succeeded in re-appraising and amending those socially and communally authorised ethics, and customs that documented the hegemony of men over women in post-independence Nigerian societies through the novel. Even though, he examines the novel as one that encourages the development of women in the society, he did not develop his views on the issue of human motivation in the novel. This study examines the impact of human motivation in the novel.

Fajenyo (2018) observed that Islamic beliefs and religion are poignantly realistic in studying the African society in *Footprints*. For Fajenyo (2018, p. 102), "Gimba has creatively explored the themes of disunity in family circle, poverty, administrative hypocrisy, bureaucratic importance, military interventions, politics, violence, corruption, and morality from the Islamic perspective". He believed that Gimba enters into core of the society to correct the above-mentioned abnormalities. Fajenyo was concerned with these themes in *Footprints* and not human motivation. This study, therefore, seeks to fill Fayenyo's omission by examining the impact of human motivation in *Footprints*.

An analysis by Ladan (2019) examined the character of Haliyfah and the part he plays in saving his nation in the novel. According to him, "Gimba uses the life of Haliyfah to show that the youth, symbolic of the future, have been left without any vision, let alone for them to discover and accomplish a mission" (Ladan, 2019, p. 52). Laden applauded the resolve of the youth to change the adverse narrative of their fathers in nation-building in the novel when Haliyfah becomes the spokesman for his classmates on many issues. Thus, he proposes that the youth, like Haliyfah, are the only hope of the Third World nations. However, Ladan ignores Gimba's presentation of human motivation, which is the focus of this present study.

3.0 METHODOLOGY

The method adopted by study textual analysis of Achebe's *Anthills of the Savannah* and Gimba's *Footprints.* Being a literary study, this paper is principally library-based. Also, data were collected from the library (relying on books, journal articles, newspaper articles, official monographs, and reviews) and electronic sources on *Anthills of the Savannah* and *Footprints*, and modern-day issues affecting the Maslovian perspective on human motivation in the development of the African novel.

4.0 RESULT AND DISCUSSION

4.1 Result

4.1.1 Maslovian Perspective on Human Motivation in Achebe's *Anthills of The Savannah*

The most elementary of Maslow's needs (food, water and housing) are revealed to be indefinable for much of the populace of Kangan, mainly in the famine wracked region of Abazon. Achebe uses the people's search for subsistence to prove the unembellished fiscal disparity and political relinquishment maintained by the military government under His Excellency (Saidu, 2025). Thus, Achebe presents Abazon as a setting ruined by scarcity, where its citizens are dying from dehydration and famine (Onunkwo & Chukwumezie, 2014). The worry of the Abazon representatives that visit the provincial capital of Bassa demonstrates this terrible condition when they cry out: "Your Excellency, we come from Abazon… our people are dying of thirst and starvation because the rains have failed us for two years…" (Achebe, 1988, p. 20). Also, Achebe reveals that the government's desertion of basic subsistence needs is not on account of scarceness but to slow government strategy. The military government classifies the luxury of the elite while the provinces perish. In this manner, Achebe presentation show how actions of characters in the novel align with Maslow's declaration that until elementary needs are met, no improvement (whether intellectual, emotive or social) is conceivable.

4.1.1.1 Safety Needs in a Nation Governed by Fear

Maslow's second level of need (safety) consists of protection from viciousness, disorder, and unpredictability. In Kangan, the nonappearance of these conditions is unescapable. Achebe presents a political atmosphere overseen by fear, random ferocity, and suppression. This is because the military rule uses state-run violence and terrorisation to enforce submission in the text. The killing of Ikem Osodi, a columnist and ethical voice of the novel, reveals the regime's ruthless strategies against opposition

(Achebe). The circumstances of Ikem's murder show how the government uses fear to eradicate opposition. Similarly, the continuous surveillance, random arrests and extrajudicial assassinations stop the people from feeling harmless in their own country. In such an environment, the citizens overturn their views and withdraw into quietness as a survival strategy in line with Maslow's philosophy that protection must be available before advanced needs like esteem can blossom (Taormina & Gao, 2013).

4.1.1.2 Fear and Psychological Repression

Chris Oriko, the Commissioner for Information, slowly becomes disenchanted with the regime he once helped. His internal confusion shows how fear destroys truthfulness and paralyses actions (Achebe, 1988). Achebe used Chris's development to display how safety needs range beyond physical intimidation to include the need for emotional autonomy and safety. Chris demonstrated that safety needs include emotional safety and liberty from terror. As the military regime becomes more oppressive, Chris understandood that allegiance and immediacy to power do not promise safety (Achebe, 1988). This internal confusion discloses that psychological protection is as important as physical safety. In due course, Chris's security collapsed when he was labeled as a fugitive after Ikem's murder. Compelled into hiding, he turns out to be one of the chased characters in the text (Achebe, 1988). This instant is crucial in Chris's change; his coming back to the base level of Maslow's ladder, stresses equally a personal and political computation. Stripped of authority, he now understands the scarcity that the citizens of Abazon experience regularly.

4.1.1.3 Love and Belonging in Beatrice's Emotional Connections

Beatrice's idealistic connection with Chris Oriko is vital to her involvement of love and belonging. Their tie was complete, intensely emotional, and noticeable by shared veneration. Contrasting an archetypal depiction of women in an African novel, Beatrice was not inferior. She questions Chris logically and fervently, yet their relationship booms on fairness (Achebe, 1988). Chris saw in Beatrice a safe, emotive harbor and a rare relief in political disturbance. Their darling is not safe to the gravity of the deteriorating state. When Chris was declared a conspirator, their parting becomes representative of the cracking of love by dogmatic horror. Even in nonappearance, the forte of their relationship was intense. Chris's concluding views and his demise with Beatrice's name on his lips confirmed the emotive significance she grips in his life. His death becomes a personal damage, with Beatrice resonating the emotional significance.

4.1.1.4 The Need for Intellectual Integrity and Recognition

Achebe presented Ikem as a character jammed between the grassroots and the leaders. His esteem needs presented him in the absurd situation of speaking for the masses, hitherto being detached from them (Nkouka, 2023). His scorching speeches and theoretical articles incite appreciation but also condemnation. Ikem's speeches, though influential, occasionally lack the unpretentiousness essential for communal construction, which Maslow sees as key to entirely nourishing esteem needs. His want for appreciation became tangled with his rational self, isolating him from those he wishes to allow. Ikem's firm search of intellectual truthfulness lead to his catastrophic death. He was detained and executed under the allegatione of treason.

Thus, becoming a sufferer for a cause. Just as Chris cries after hearing of Ikem's death: "He died for his beliefs. That's more than most of us can say" (Achebe, 1988, p. 159). At this point, Achebe presented a sharp evaluation of a society that gives post-obit reverence, while repudiating living intelligentsias the reverence they need to endure. Maslow recognizes that when esteem needs are habitually displeased, individuals may suffer emotional state of powerlessness or foiling. Thus far, for Ikem, the subject of death became the eventual form of veracity. Beatrice later chairs a naming ceremony for Elewa's baby, in Ikem's remembrance, suggesting the long-lasting influence and appreciation of his principles. The people started to link up with his message by revealing that the true contentment of reverence may happen through legacy, even in the absence of life.

4.1.2 Maslovian Perspective on Human Motivation in Abubakar Gimba's *Footprints*.

Abubakar Gimba's *Footprints* dramatizes the tension between tradition and progress through a gender-sensitive portrayal of characters navigating post-colonial Nigerian society. In agreement with Abraham Maslow's "Hierarchy of Needs", Gimba examines human motivation from the introductory physiological prerequisites to the peak of self-actualisation, mainly in his presentation of female characters. The women in *Footprints* were not just symbols of family life but energetic agents of social change, circumnavigating layers of need in individual and national sceneries (Sunusi & Ojeyokan, 2022).

4.1.2.1 Nashaa's Protective Instincts and Material Responsibility

Maslow's base level (physiological and safety needs) highlights endurance and physical safekeeping. Nashaa, Jibran's wife, exemplifies these requirements through her profound concern for her husband's welfare during Nigeria's petroleum scarceness in the

novel. The text opens with her passionate distressed (Gimba, 1998, p). Nashaa's emotive nervousness shows how unpredictability in the nation interrupts familial safety and aggravates worry. However, her rejoinder is not inactive. Also, her resignation from her nursing profession owing to a strike echoes her respect for human life over institutional allegiance: "She said she could not sit down and watch people die, while a little help could help save such lives" (Gimba, 1998, p. 48–49). Her choice of becoming a grocer and "her earnings from the business had contributed significantly towards sustaining the family" (Gimba, 1998, p. 46), accomplishes Maslow's next level of need (the need for economic steadiness and security). This presents a woman transitioning from dependency to self-reliance. Thus, she was motivated by the longing to secure the existence and poise of her family.

4.1.2.2 Safety Needs: Health, Security and Stability

Outside the physiological, Maslow's safety needs cover physical protection, employment, ethical safety and healthiness. Nashaa's individual selections were best accepted through this emotional ambition on the way to security and truthfulness. When Nashaa resigned from her position as a principal nursing officer, it was not out of individual ambition or displeasure, but an ethical and mental rejoinder to a defilement of what she saw as the sacredness of human life (Gimba, 1998). Additionally, Nashaa's shift to run a grocery business shows that she accepted the need for financial security. Having resigned from paid engagement, she did not go on passive but developed into a self-dependent entrepreneur (Gimba, 1998). Thus, Nashaa's economic forethought supported her family's existence and supplemented her role as an alleviating strength in an unstable socio-economic setting.

4.1.2.3 Zynah's Marital Loyalty and Communal Integration

The third level of Maslow's hierarchy of needs focuses on love and belonging. Zynah Sameer, though submissive in public view, justifies her psychological needs via strong family ties and spousal accord. Her submission to her husband's decisions (such as stopping their daughter Jameelah from going to see Haliyfah) is not just meekness, but a tactic to reserve marital peace (Gimba, 1998). Also, Zynah was contributory in rebuilding strained relationships. An example was in her appeal for Muhtar to reunite with Jibran. She "cheered her husband to bury the hatchet and let bye-gones be by-gones" (Gimba, 1998, p. 69). Although, Zynah might be wrong for being passive, her personal selections highlight the deep-rooted human want for peace and belonging which is central to Maslow's third stage.

4.1.2.4 Maternal Attachment and Familial Belonging

Zynah's closeness to her daughter, Jameelah shows the emotional strength of belonging in her psychological view. Her readiness to let Jameelah visit Haliyfah shows a mother wavering between her fondness for her daughter and her faithfulness to her husband. Though she eventually submits to Muhtar's influence, it was not short of inner struggle, demonstrating that Zynah intensely values her family unity and emotional ties. She negotiates emotive belonging within the limitations of gendered prospects, presenting how women in Gimba's novel circumnavigate emotional contentment under traditional structures. Outside family roles, Zynah's optimism for Nigerian universities to reopen and her cynicism around sending children overseas for schooling show a wider idea of national belonging. Her predilection for local matters over foreign education is not just conceptual but emotive (Gimba, 1998). This shows a psychological necessity for social settlement, reverberating Maslow's interpretation that love and belonging are congruently connected to shared uniqueness and devotion to the nation.

4.1.2.5 Farah and the Drive for Recognition and Self-worth

Farah's account curve typifies Maslow's fourth level (esteem needs) which comprises recognition, attainment and the progress of self-respect. As an intellectually gifted scholar, Farah accomplishes topmost performance in her studies. Her academic and headship quests in unionism and almost elected as assistant secretary of the SUT shows a profound inspiration to earn admiration and influence humanity (Gimba, 1998). Farah became a mouthpiece for gender balance and responsible governance because she carves a space for herself in male-dominated public discourse. Her esteem was not constructed through comparison or protest but by internal competence, intellectual rigor, and civic action. Thus, Farah's role reflects an agreement with Maslow's Esteem Needs**,** which encompasses self-respect, personal achievement, sureness, freedom and the desire for acknowledgement and admiration from others**.** She differentiated herself through academic fineness by earning admission to the most important high school. She puts "an excellent performance, finishing at the top of the class" (Gimba, 1998, p. 35). This success contributed to the advancement of self-assurance and personal fitness.

Additionally, Farah channeled her sense of value into changing society, particularly in a male-dominated world, a place Spivak would call being "world(ed)" by men. Gimba presents Farah as an example of social and political transformation. Nevertheless, Gimba cautiously presents Farah's public facade with her private life, particularly in her marriage to Basil. She is

a caring spouse at home. This depiction stoped her from being satirized as a radical character. Instead, she turns out to be an experienced individual whose esteem needs are seen in both public and individual spheres, exemplifying Maslow's insight that hale and hearty persons mix self-confidence with social obligation and human understanding.

4.1.2.6 Jameelah as a Catalyst for Social Change and Female Agency

Maslow's uppermost level (self-actualisation) refers to the understanding of an individual potential and the quest for fairness or inspiration. Jameelah signifies this determination completely. She challenged injustice even in the presence of visceral state power. During a police invasion after student protest, she remained steadfast: "Leave me alone!" Shouted Jameelah as the other three policemen tried to pull her out of the room by force (Gimba, 1998, p. 337–338). Her courageous antagonism against unfair arrests demonstrated the self-objectified individual who confronts systemic cruelty not out of mutiny but out of ethical persuasion. Thus, confirming her profound commitment to human nobility and independence. Jameelah's boldness, unlike Farah's trade unionist propensities, is more challenging because she represents a generational move towards fundamental responsiveness and impenitent fairness. She acts as a transformation agent for society.

Maslow's philosophy of Self-actualisation, the highest layer in his "Hierarchy of Needs", midpoints on an individual's quest for personal progress, contentment and the comprehension of one's budding. In *Footprints*, Jameelah functions as an influential personification of this psychological model, not just in footings of specific growth but as a reagent for shared social transformation, mainly in indorsing female agency in an oppressive, male-controlled and authoritarian culture. Also, Jameelah's charm signifies a woman who has satisfied the foundational needs of endurance, safety, belonging and reverence. She functions at a higher experiential plane. Her conflict with the oppressive state agencies during the police invasion of the hospital shows this intensely. When male doctors withdraw into silence, Jameelah steps forward (Gimba, 1998, p. 351). This confrontation marks more than a remote act of courageousness but it is emblematic of the woman's fruition in Gimba's novel from inactive subject to an energetic agent. Jameelah regains the public space, interrupted the patriarchal calligraphy that limits women to domesticity and became a life-changing figure who challenged organised machismo with motive, responsiveness and tenacity.

4.2 Discussion of Findings

The study revealed that Achebe's depiction of Kangan, particularly Abazon, line up unswervingly with Maslow's theory that basic physiological needs are lobbied and intentionally denied by the elites. Thus, showing a system that weaponises hunger in the society. This forms a setting where higher psychological needs cannot flourish. However, in Bassa, Achebe outspreads this critique by noting that even elite classes suffer from resource scarcities, underscoring the depth of national disfunction. Also, the government's dependence on fear to preserve control echoes Maslow's emphasis on safety as a basic need. Ikem and Chris's psychological decline shows how emotional and physical safety are both importance for human motivation. The suppression of speech and intellectual liberty proves that esteem and self-actualisation cannot occur under fear. Beatrice's role exposes how emotional bounciness and love can function as subtle forms of confrontation. Her influence in naming Elewa's child emblematically rewrites patriarchal calligraphies and confirms feminine agency.

However, Achebe proposed retrospective thankfulness can restore collective values and reserve a martyr's legacy. Also, Ikem's journey to self-actualisation is noticeable by artistic ingenuity, intellectual liberty and unwavering obligation to truth. His idealism and principled vision represent Maslow's self-actualiser. Achebe repositioned martyrdom as the uppermost form of moral self-fulfillment, leaving behindhand a legacy of confidence and resistance.

Also, the study revealed that in *Footprints*, Gimba used female characters to examine Maslow's theory in a socio-cultural context where women's actions are often limited. Nashaa's change from dependency to economic self-sufficiency echoes a journey from physiological unpredictability to security. Zynah represents emotional balance and traditional wisdom, revealing that belonging can be found even in gendered limitations. However, Farah's esteem needs were satisfied through intellectual performance and social influence, breaking gender barriers without neglecting her domestic distinctiveness. Also, Jameelah represents the peak of Maslow's hierarchy. Her moral bravery and obligation to justice replicate both self-actualisation and perfection, serving as a generational representation of transformative agency. Thus, Gimba and Achebe converge in using female characters not only as emotional anchor-women but as personifications of Maslovian movement toward contentment. Both authors show that under oppressive systems, human motivation becomes both a survival predisposition and a form of protest.

5.0 CONCLUSION AND RECEMMENDATIONS

5.1 Conclusion

This study has shown that applying Maslow's "Hierarchy of Needs" theory to *Anthills of the Savannah* and *Footprints* revealed the profound interaction between psychological motivation and socio-political authenticities in post-colonial Nigeria. Achebe's Kangan echoes a nation where government purposely holds back basic provisions, weaponising hunger and fear to overpower the populace. However, the study revealed that the characters unwavering search for fairness in *Anthills of the Savannah* upholds Maslow's understanding that self-actualisation can display as moral courage and service to humanity. On the other hand, the study revealed that Gimba's *Footprints* foregrounds women's triangulation of Maslow's hierarchy in a patriarchal society. This is because the female characters in the novel challenge traditional boundaries by showing that gratifying each stage of Maslow's hierarchy is not just an individual journey but an act of social change. Together, the two novels confirmed that unmet physiological and security needs perpetuate disempowerment, while their fulfillment promotes agency, flexibility and societal change. In circumstances marked by structural violence, the search for higher needs becomes integrally assertive. Thus, turning individual development into collective struggle.

5.2 Recommendations

Based on the findings and conclusions of this paper, the following recommendations are made:

a) African literary studies should include psychological theory like Maslow's Hierarchy of Needs together with post-colonial theory to expand interdisciplinary studies on motivation, human actions and resistance in fiction.
b) Policymakers should know that sustainable societal development begins with guaranteeing citizens' physiological and safety needs, without which aspirations for education, innovation and public contribution remain restricted.

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EFFECT OF *PHYLLANTHUS NIRURI* EXTRACT ON SEMEN CHARACTERISTICS OF MALE RABBITS

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Target audience: Rabbit Farmers, Animal Breeders

Abstract
This study was conducted to investigate the effect of Phyllanthus niruri extract on blood metabolites and semen characteristics of male rabbits. A total of twenty-four (24) adult rabbits of mixed breeds were randomly allocated to four treatment groups of three replicates per treatment with two rabbits in each replicate. The treatment groups were designated as T_1, T_2, T_3 and T_4. Rabbits in T_1 represented the control group that received no extract of Phyllanthus niruri, while rabbits in T_2, T_3, and T_4 received the Phyllanthus niruri extract at 5ml, 10ml and 15ml per litre of water respectively. The experiment lasted for eight weeks, at the end of which blood and semen samples were collected and analyzed on treatment basis. Semen characteristics examined included semen volume, pH, appearance, normal morphology, abnormal morphology, actively motile and sluggishly motile sperm, dead cells and sperm count. The results showed that total sperm count of (566.67 ± 57.74^a), semen volume of (1 ± 0.20^a), normal morphology of (85 ± 50^a), viability of (83.33 ± 5.77^a) and active motility of (80 ± 50^a) were all improved in treatment group T_4 than the control group and other treatment groups administered Phyllanthus niruri extract. In conclusion, Phyllanthus niruri extract inclusion in drinking water at different levels in this study have enhanced blood metabolites and semen characteristics of male rabbits. It is recommended that15ml inclusion of Phyllanthus niruri extract in rabbit drinking water is the optimal level for rabbits.
Keywords: Rabbit, Semen characteristics, Phyllanthus niruri, Blood metabolites,

1. 0 INTRODUCTION

Rabbits are an important contributor to food and nutrition security and aid in the provision of high-quality protein. Rabbits utilize unusable vegetation material, residue from crop production, organic wastes from the food industry and domestic waste, converting these into rich high protein nutrition for human consumption (Lukefahr, 2007). Rabbits requires small amount of feed, and uses inexpensive and easily constructed housing. In addition, rabbits do not compete with humans for grains as chickens do and its waste is a natural source of soil nutrition (Masawi et al., 2019). But given the central importance of rabbit among other livestock in bridging the animal protein gap, it therefore calls for attention to be shifted towards rabbit production.

Rabbits are highly prolific animals capable of increasing the animal protein intake of Africans. Also, their reputation for fast growth, short gestation period, early maturity, ease of management and their small sizes make them affordable (Chestwort, 2002). Rabbit meat is an excellent source of protein, energy, calcium and vitamins than any other type of animal meat. The amount of cholesterol, fat and sodium is also less than other meat. Their meat is very tasty, nutritious and easily digestible for all age of people and there is no traditional taboo for consuming rabbit meat.

Metabolites are reaction intermediates and products of physiological metabolism which drive significant biological activities in the body such as signaling, stimulatory and inhibitory functions (Larsson et al., 2017). Blood metabolites have been well-investigated to determine their abundance and biological significance, and for their potential use as diagnostic markers. For medical diagnosis, noncellular metabolites from plasma or serum are commonly used due to their simplicity for collection and examination (Psychogios et al., 2011).

Blood constituents have been used by many investigators as a monitor for genetic makeup (Chiericato et al., 1985), health (Zamet et al., 1979), reproduction (Parker and Blowey, 1976), nutrition (Lee and Twardock, 1978) and physiological status of the animals (Hussein et al., 1992).

Semen is a mixture of spermatozoa, produced by testicles, and seminal fluids secreted by the accessory glands, which are combined at the time of ejaculation (Haschek et al., 2010). Its analysis provides measurement on the volume and appearance of the semen, sperm size and shape (morphology), sperm movement (motility), concentration (pH), and number of the spermatozoa per ejaculate. Importantly, semen and sperm evaluation are a crucial procedure in determining the fertility and reproductive health of an animal (Petrunkina et al., 2007). Morphologically, the impairment of semen parameters, such as a decrease in sperm count and sperm motility, is indication of compromised fertility status (Pasqualotto et al., 2005). Kuete (2014) reported that fertility in male animals may be hindered or affected by toxicity of chemical or phytochemical agents, leading to a reduction in sperm production by the testis, maturation of sperm in the epididymis, and decrease in quality of sperm characteristics available for fertilization.

Phyllanthus niruri (Stone breaker) belongs to the family Euphobiaceae. It is a plant with a height of about 30-60 cm. The plant is a common weed of cultivated fields and spreads widely in West Africa and other parts of the world and has been discovered some years ago in Akwa Ibom State (Moshi et al., 1997). It blooms with many flowers and has a rigid, short and prostate stem. Major constituents in *Phyllanthus niruri* which include tannins, flavonoids, lignans, ellagitannins have been isolated (Foo, 1995). This research is therefore, conducted to investigate the effect of *Phyllanthus niruri* extract on semen characteristics of male rabbit.

2.0 MATERIALS AND METHOD

Experimental Location

The study was carried out at the Rabbit Unit of the Teaching and Research Farm, Department of Animal Science, Niger Delta University, Bayelsa State.

Experimental Animals and Management

Twenty-four (24) male rabbits of about 4-5 months, of mixed breeds, with an average weight of 1.5-2.1kg were procured from Yeigba Agro-Allied venture, Okolobiri Town, Bayelsa State. They were housed individually in a single tier hutch constructed with wood and wire mesh. They were assigned to four treatment groups and fed commercial grower feed (pelleted) and forages in the evening to supplement their feeds. Water was given *ad-libitum* on a daily basis for 8 weeks.

Processing of *Phyllanthus niruri*

Fresh *Phyllanthus niruri* leaves were harvested in and around the premises of the Niger Delta University, Amassoma. The leaves were chopped and conditioned to heat treatment by decoction for 45 minutes. The water was left to cool and then filtered to produce the *Phyllanthus niruri* extracts.

Experimental Design

The rabbits were randomly selected into four treatment groups of six rabbits with three replicates per treatment having two rabbits per replicate in a Completely Randomized Design and designated as T_1, T_2, T_3, and T_4. Treatment one (T_1) served as the control group without the inclusion of *Phyllanthus niruri* extract while rabbits in T_2, T_3 and T_4 were administered the *Phyllanthus niruri* extract at 5ml, 10ml and 15ml per litre of water.

Sample Collection

Semen collection

Artificial vagina (AV) was used to collect semen samples from each treatment as described by Herbert and Adejumo, (1995); Aduogu and Ajayi (2010). Prior to semen collection the Artificial Vagina (AV) was warmed by allowing it to stay for 40°-60°C in a container (Herbert and Ajejumo, 1995). A non-cyclic doe was used as teaser rabbit. As the bulk mounted and made trust on the teaser doe, before intromission, the artificial vagina (AV) was applied from the rear and this elicits ejaculation within few seconds. The ejaculates collected from the collection tube was read directly on the last tube to determine the semen volume and other parameters determined in the laboratory.

Data collection and analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) for completely randomized design (Steel and Torrie, 1980) using computerized statistical analysis of SAS (1999). Treatment means were compared using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

3. 0 RESULTS AND DISCUSSION

3.1 Results

The results of the effect of Phyllanthus niruri extract on semen characteristics of male rabbits is shown in Table 3.1.

The semen appearance was generally milky and uniform across all the treatment groups. Semen volume was significantly different ($P<0.05$) across all the treatment groups with T_4 recording the highest value. Semen pH of the rabbit bucks recorded the same value and was not significantly different ($P>0.05$) in all the treatments. Percentage viability of the rabbits significantly increased ($P<0.05$) across the treatments, with the rabbits in T_4 recording a higher value than the other treatment groups including the control. Viscosity of the rabbit semen was also normal in all the treatment groups. For Normal Morphology, there was significant difference ($P<0.05$) observed across the treatment groups, T_4 recording the highest value statistically and T_2 the lowest. Abnormal Morphology of the rabbit semen decreased significantly ($P<0.05$) as *Phyllanthus niruri* extract increased and T_2 recorded a higher value than the other treatment groups, with T_4 being the lowest. There were no significant differences ($P>0.05$) observed in Sluggishly Motile (%) and Dead sperm cells of the rabbit bucks.

The statistical analysis of actively motile semen in treatment group T_3 (70±5.00b) was not significantly different ($P>0.05$) compared to the control group T_1 (70±5.00b). Treatment group T_4 (80±5.00a) was significantly higher ($P<0.05$) than the other treatments. Sperm count increased significantly ($P<0.05$) in treatment group T_4 (566.67±57.74a) and was higher than all the other treatment groups.

There was no significant difference ($P>0.05$) among other parameters as semen appearance (milky), semen pH (8±0.00) and viscosity which was normal in all the treatments. Results for sluggishly motile sperm cells did not show any difference in all the groups. Normal morphology was significantly better ($P<0.05$)

in treatment group T_4 (85±5.00a) compared to other treatment groups. Abnormal morphology increased significantly (P<0.05) in treatment group T2 (35±5.00a) compared to the rest of the treatment groups T_1 and T3 (25±5.00b) with the lowest in T_4 (15±5.00c). Percentage dead cells was highest in T_2 (30.00%) and lowest in T_4 (11.67%).

Table 1. Effect of *Phyllanthus niruri* extract on semen characteristics of male rabbit.

Parameters	T1	T2	T3	T4	SEM
Semen Appearance	Milky	Milky	Milky	Milky	Milky
Semen Volume (ml)	$0.53±0.15^c$	$0.83±0.15^b$	$0.77±0.25^b$	$1±0.2^a$	0.24
Semen pH	8±0.00	8±0.00	8±0.00	8±0.00	0
Viability (%)	$73.33±5.77^b$	$63.33±5.77^c$	$73.33±5.77^b$	$83.33±5.77^a$	8.88
Viscosity	Normal	Normal	Normal	Normal	Normal
Normal Morphology	$75±5.00^b$	$65±5.00^c$	$75±5.00^b$	$85±5.00^a$	2.46
Abnormal Morphology	$25±5.00^b$	$35±5.00^a$	$25±5.00^b$	$15±5.00^c$	2.46
Actively Motile (%)	$70±5.00^b$	$60±5.00^c$	$70±5.00^b$	$80±5.00^a$	0.42
Sluggishly Motile (%)	10	10	10	8.33	0.42
Dead (%)	20.00	30.00	20.00	11.67	2.26
Sperm Count (ml)	$400.00±100^a$	$166.67±57.74^c$	$300.00±100^b$	$566.67±57.74^a$	48.4

^{abc} means with different superscript on each row are significantly different (P<0.05), Mean ± Standard Deviation, SEM = Standard Error of Mean.

3.2. Discussion

The problem of infertility in animals and man, in recent years, is receiving increasing research interest due to the decline in semen quality (Alrabeeah et al., 2014), and varied reasons are associated with male fertility problems. Research evidences have shown that more than 90% of the cases of male infertility are due to the problem of low sperm counts, poor sperm quality, or both (Bensdorp et al., 2007; Levine and Grifo, 2008). Previous studies have shown that some herbal plants can improve sperm production in animals and man (Anandakumar et al., 2013; Jaradat and Zaid, 2019).

The findings of this present study showed that semen characteristics of male rabbits were improved in dose related paterns following treatment of *Phyllanthus niruri* extract.

Total sperm count, semen volume, normal morphology, viability and active motility were all improved in treatment group T_4 (at dosage level 15ml/litre) compared to treatment groups T_1, T_2, and T3 (at dosage level 0, 5 and 10ml/litre) respectively. This may be indicative of improved sperm production in bulk rabbits. Dead cells were also observed to be lowest at higher dose in treatment group T4 (at dosage level 15ml/litre) than treatment group T_1 and T_2 which is an indication of sperm cell preservation and improvement by *Phyllanthus niruri*. However, semen appearance, viscosity and semen pH were similar among the treatment groups. Increased total sperm count, semen volume, normal morphology, viability and active motility as noted in the present study has been associated with increased sperm production ability of the testis and increased transit time and the functionality of the epididymis as reported by Creasy and Chapin, (2013).

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

In conclusion, *Phyllanthus niruri* extract at the treatment levels of 5ml, 10ml, and 15ml had significant positive effect on sperm count, semen volume, normal morphology, viability and active motility which is good for rabbit reproduction.

4.2 Recommendations.

Based on the results obtained in the study, It is recommended that the inclusion of *Phyllanthus niruri* extract in rabbit drinking water up to 15ml level is safe for consumption by rabbits as it enhances the semen characteristics and had no negative effect on the rabbit reproductive health.

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IMPROVED E-LEARNING MODEL FOR PUBLIC AND PRIVATE INSTITUTIONS USING CLOUD COMPUTING

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Abstract
Information and Communication Technology (ICT) has become a major driving force in education in the twenty-first century. Cloud-based e-learning in particular, has gained significant popularity as an emerging trend in educational technology due to its diversity, flexibility, measurability, accessibility, scalability, and improved performance across both public and private institutions. However, the traditional classroom-based learning approach is rapidly becoming outdated and more expensive to sustain, especially in terms of computer laboratory infrastructure and software licensing. To address these challenges, this paper presents an improved e-learning model featuring seven (7) architectural layers, as opposed to the conventional five (5) layer model. The proposed model is designed to host cloud-based e-learning systems for both public and private higher education institutions through cloud infrastructure. Based on the analysis, the study emphasizes that achieving optimal performance requires computing systems equipped with sufficient functionality and advanced security safeguards. An explanatory research approach was adopted to examine how emerging cloud technologies provide higher education institutions with opportunities to outsource their ICT components efficiently. The study further highlights that an improved cloud-based e-learning model is essential for effective implementation, by incorporating utility and security hardware and software provisions at institutional levels. By employing enterprise-based software systems, the proposed model aims to prevent identity intrusions, cyberattacks, and unauthorized access. This paper explains the enhanced e-learning architecture layer by layer, offering detailed insights into how enterprise-based utility controls and robust security measures can be implemented within public and private institutions using cloud computing. The key advantages of the proposed model include faster, more effective learning processes, supported by the Internet of Things (IoT) and multi-facility integration, which collectively contribute to improved educational outcomes.
Keywords: E-Learning, Cloud Computing, Hybrid Cloud, Utility Computing.

1.0 INTRODUCTION

1.1 Background of the study

Modern public and private universities use e-learning technology to deliver remote learning through online lectures, seminars, and presentations, as well as the distribution of learning resources, tests, and procedures. Learning online and creating e-learning environments are becoming more and more popular due to the quick development of information and communication technologies (ICT). There are many different ways to learn or acquire knowledge online these days. E-learning is one of the most promising educational models.

E-learning refers to the use of networked information and communication technologies to acquire knowledge and skills or develop capacity. E-learning offers a wide range of new opportunities for the development of education and brought thoughtful impact to teaching and learning methods whereby e-learning has become one of the most popular teaching and learning system (Dong and Hang 2011).

The internet is constantly changing from a place used to read web pages to an environment that allows end-users to run software applications. These days, new digital content is expected to be interactive and collaborative. Because of the ever-increasing need for education, e-learning solutions must be developed and improved. Nowadays, it is typical to access content on the internet on one's own without consulting the supporting infrastructure. Content providers keep an eye on and manage these data centers, which make up this infrastructure. An extension of this paradigm is cloud computing, which exposes application capabilities as services. Both public and private educational institutions are starting to adopt cloud-based software or applications that allow end users to complete tasks that previously needed site licensing, software installation, and maintenance. Many applications such as word processing, presentation, databases and many more can all be done inside a web browser, while the software and files are housed in the cloud, (Bhruthari & Pund, et al, 2012).

Many public and private institutions are leaning toward implementing e-learning systems through cloud computing, the current model that offers appropriate, on-demand access to a centralized shared pool of computing resources that can be deployed with great performance and minimal management overhead, due to the high investment costs associated with IT infrastructure (hardware and software). (EL-Sofany et.al, 2013).

This model is a new technology which can improve universities functions in terms of students and academic staff services, and institutions themselves. Currently, the cloud computing is a trend that can solve the contradiction between the need to act quickly when experimenting new ideas and the slow traditional processes of planning and developing. The basic idea of cloud computing is to connect the computing resources as a service consumed by people, rather than a product that runs on their individual computers (Radulescu, 2014).

1.2 Problem Statement

The traditional e-learning system which public and private universities are deploying to deliver remote learning programs have serious limitations and draw backs. For instance, the traditional e-learning presents serious difficulties such as organizational, technical, and pedagogical problems, which need to be addressed. this paper is set out to address these identified challenges by integrating cloud-based computing with e-learning architecture, utilizing relevant cloud service models (SaaS, PaaS, and IaaS).

1.3 Objectives of the Study

The main aim of this paper is to **improve e learning model for public and private institutions using enhanced cloud computing architecture**

The specific objectives of this paper are to:

i identify the limitations of traditional elearning models

ii to Propose an improved e-learning model for public and private institutions using cloud computing technologies to overcome existing e-learning challenges and to provide adaptable, efficient, and scalable solutions.

iii. Highlight the benefits derived from implementing cloud-based e-learning systems equipped with adequate electronic software utilities and supported by appropriate cloud computing concepts and services.

iv. Present unified cloud-based e-learning architecture, utilizing relevant cloud service models (SaaS, PaaS, and IaaS).

2.0 LITERATURE REVIEW

2.1 Overview of E-Learning

The field of virtualized online learning through electronic synchronous and asynchronous communication technologies, particularly the Internet, is known as e-learning. It alludes to the application of ICT and electronic media in the classroom. All forms of educational technology used in teaching and learning are commonly referred to as e-learning. Teachers' roles cannot be fully replaced by e-learning, which is merely an update of technology, concepts, and tools that provides new content, concepts, and teaching methods. Teachers will continue to take the lead in creating and utilizing the e-learning cloud. The way we communicate and work has been significantly impacted (Bhruthari et al., 2012).

Madhumathi and Ganapathy (2013) described E-learning as the use of all forms of electronic media to support teaching-learning process. The concept of e-learning has significantly received research attentions as one innovation changing the patterns of teaching across the globe in support or partly replacing the traditional face to face approach to the delivery of knowledge and skills. Arkorful and Abaidoo, (2015) also referred to e-learning as a modern approach towards the delivery of well-designed and interactive learning environments that everyone could adopt in a learner-centred atmosphere and continue to grow as an established method of learning.

Computers are the basic equipment used in the e-learning process. Different kinds of educational software created and verified by domain specialists and educators allow the implementation of the principles of education, which are the individualization of the training by examples. There are many types of training using e-learning techniques. For example, (Abderrahim , et al. 2017) distinguishes two types of training: a type using e-learning between individual (Type A) and a type called group training (Type B), closely related to the form of materials.

Today, and with the current digital age, e-learning has become a necessary instrument in educational environment, allowing the creation of learner-centred learning and offering new more flexible learning methods.

E-Learning Systems

A software program, platform, or system for flexible learning is called an e-learning system. Its goal is to make learning process theory a reality by organizing resources and material, delivering training programs and educational courses, and managing administrative, documentation, and tracking duties. The initial e-learning systems in the academic sector were essentially designed to provide students with knowledge, but as the 1970s rolled around, e-learning began to take on a more participatory nature. E-learning systems include collaborative areas, evaluation methods, synchronous and asynchronous communication tools, and learner tracking. (Sneha & Nagaraja 2013).

E-learning systems usually include tools for controlling the learning process, conveying the desired learning experience, and enabling both tutors and students to participate in it. The entire course material or copies of the handouts and visual aids, along with supplementary materials and links to online and library resources must be used to convey the learning experience. To help with this, simple writing tools or

common office software should be accessible. (Sneha and Nagaraja 2013).

The E-learning innovation also known as internet-based training or web-based training is any form of education reinforced through the adoption of ICT infrastructures or electronic media content management.

But along with electronic learning and education, the internet's components and traditional electronic media channels—like television, radio, telephone, satellite, video, and compact disk read-only memory and digital versatile disk read-only memory—are depicted. (Bork, et al 2001). The multimedia e-learning education is essentially the networked collaborative transfer of digital skills and knowledge through electronic media in a technology negotiated processes, (Matthew, 2019). Digital collaboration, virtual classrooms, computer-based tests, high-definition computer-based simulations, and web-based learning are examples of multimedia e-learning applications and procedures. An inherent connection between e-learning and digital libraries was demonstrated by the innovation of multimedia e-learning education and digital libraries, (Kihoza, 2016).

E-learning includes communication tools (i.e. synchronous and asynchronous), learners tracking, and assessment and collaboration techniques (Sneha & Nagaraja, 2013). E-learning is enhanced learning process based on ICT tools that are used to improve the online activities. There are basically four types of E-learning systems: Learning Support System (LSS), Learning Content Management System (LCMS), Learning Management System (LMS), and Learning Design System (LDS) (Ismail, 2002).

Here are some identified advantages that enhance e-Learning systems:

Saving money: In E-learning, there is production and small implementation costs only, no cost for production, set up, delivery, nor travelling.

Accessibility: The students can access the material anywhere and anytime without worrying of missing important information.

Affectivity: The E-learning has different learning styles and the students can choose their learning styles through variety of media (i.e. presentations, video, audio, etc.). In addition to, the student can replay some segments.

A review of previous studies in the field of e-learning has been conducted by several researchers, including Almarabeh et al. (2014), explored e-learning implementation in higher education, emphasizing usability, accessibility, and infrastructure readiness. Together, these works laid the groundwork for understanding how e-learning systems evolved prior to their migration to cloud-based architectures. These studies collectively provide a foundational understanding of e-learning systems, their pedagogical implications, and the technological frameworks supporting them.

It is important to understand that the cost in E-learning related to the maintenance of hardware (servers, computers, data centers, computing centers), and software which means the institution has to pay for the site license, installation, and the technical support.

Challenges of Current E-Learning Systems

It is obvious that the web-based e-learning systems offer several benefits over conventional classroom-based learning. The popularity of e-learning and e-learning systems is growing rapidly because these systems bring learners from different geographical areas together and create a notion of a single classroom environment which helps them and their teachers to share academic knowledge and exchange experiences (Gamundani et al. 2015). This is made possible without the learners or class participants changing their physical location

However, the traditional learning systems are not dynamically scalable and do not fully utilize the resources, making it impossible to provide active e-learning to the masses on a massive scale to meet the constantly evolving requirements of educational institutions as well as to meet the unique requirements and tastes of the learners. Since knowledge is expanding exponentially at an ever-increasing rate, the traditional e-learning presents serious difficulties. These difficulties, include; organizational, technical, and pedagogical problems, which need to be addressed before e-learning is fully incorporated into the academic sector. To further buttress this point, organizational problems with traditional electronic learning often include a lack of acceptable technical funding, inadequate training of educators on using e-learning platforms, inconsistent and unpredictable access to technology for learners, resistance to alteration within the organization, poor program designs for online delivery, lack of collaboration between departments and inadequate funding for e-learning creativities, leading to difficulties in effectively implementing and maintaining online learning programs. However, pedagogical problems are challenges that are faced as a result of obstacles associated with the process of teaching and educating an online student. (Nouraey, and Al-Badi, 2023).

In multimedia, e-learning in higher institutions, personal computers (desktop, laptops and handheld devices), platform as a service (Paas), infrastructure as service (Iaas) and software as a service (Saas) are combined in delivering essential services such as e-tutoring self-assessment and communication application such as zoom platforms, chart apps, video call apps are utilized in providing support for distance learning education. The mobile e-learning environments concentrates on the extent and perspective of

technology mobility, pervasive learning environments on social interdependence from the sphere of activities and set of relationships between organization and individuals in their environmental ecosystem (Yang, 2019).

2.2 Review of Related Literature

Numerous researches have been conducted in this area; some are on cloud-based learning management systems, some have touched on cloud-based collaborative learning, some have addressed blended learning, and some have explored additional topics of interest.

Chillakanti & Gattaz (2016) paper discussed components of technology architecture and cloud-based learning solutions, suggested the use of the Saas cloud services platform for educational purposes, and concluded that it provided a framework for collaborative learning. Zhong and Shouhong's (2010) study discussed blended learning course design, including the redesign of learning content that is deployed through cloud computing in the Active Learning Cloud program at South Dakota State University. A case study, concluded that a blended learning model through cloud computing achieves learning effectiveness.

Elmasry et.al, (2021) in their publications on Cloud Computing for e-learning: a proposed model for Higher Education Institutions in Developing Countries, the researchers discussed the use of cloud computing in higher education, described its structure and potential for use in a distance learning model for public and private sectors, and proposed a model for using cloud computing in learning management systems to build a hybrid cloud type as a solution for higher institutions. Magyar et al' (2014) study introduced a cloud-based web application for educational purposes through the Google Cloud Platform. The app used the Next Open Automation (NOA) platform which is a new technology concerning internet of things (IoT) for data visualization and data acquisition processing with robot through cloud computing to create an environment that improves the speed and efficiency of e-learning. Alsrasheed et al' (2014), paper presented the architecture of a cloud-based knowledge management system that provides a suitable platform for e-learning in a university environment. The study found that a knowledge management system based on cloud computing provides a suitable environment for learning via the web, reduces the cost burden on universities, and increases learning efficiency.

Arkorful et al. (2015) disclosed that digital libraries permit consumers to gain online access to the electronic versions of full-text documents, the associated images and other digital categorizations as presented in figure 2. 1.

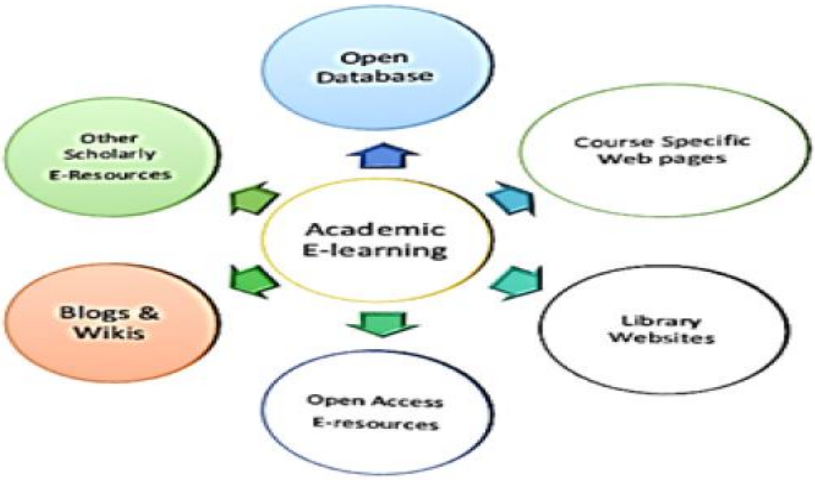


Figure2. 1: Ubiquitous e-learning tools in e-library environment, sourc (Aljawarneh, 2020)

2.3 Review of Cloud Computing Technology

Cloud computing also enables a virtual service network that includes devices, a user interface, and a database, (Anton et al., 2012). Therefore, cloud computing offers promising opportunities for IT organization and business execution in various fields, (Kim et al., 2017). A cloud is a hugh collection of servers and computers that are connected to each other via the internet, (Sampson et al., 2012). It enables data entry, processing, storage, and retrieval over the Internet, thus it connects users to the resources and services available via the cloud. It is one of the effective technological tools suitable for users who have an Internet connection, in relation to figure 2.1 above (Fernandez et al, 2012). The cloud computing platform contributes to the ability of enterprises to start businesses with the least investment in technological infrastructure, as the use of cloud computing services saves spending on hardware or software, in addition to saving the costs of operating and maintaining the infrastructure (Jyoti et al., 2013). Cloud computing offers several advantages. The main advantages of using cloud computing-based learning management

systems in public and private institutions can be explained as stated by Lukare et al., (2011).

Improving the quality of learning
The cloud-based e-learning improves the effectiveness of distance learning through the virtual classroom, overcoming obstacles of potential weak internet and bandwidth that appear in alternative methods.

Cost Saving
The option that best suits the institution's model is either a subscription or, in certain situations, a pay-as-you-go plan. Overall, since customers only pay for the software they require on demand, system management, licensing, and other expenses can be decreased in addition to hardware costs. By just paying for individual software instances and avoiding the effort and expense of patches and upgrades, user agreements and contracts can be made simpler. However, because cloud-based learning eliminates the need for local data center capital expenditures, it lessens the financial strain on colleges. Lowering data center maintenance expenses is another aspect of the cost saving advantage of cloud computing e-learning systems, reducing the amount of old technical hardware assets used for university data storage, Subramanian et al., 2014).

Access to learning resources
The cloud-based learning platform improves access to educational resources. Students can quickly access learning resource with whatever computers or smart phones they own, and what kind of internet browser they use.

Scalability
Scaling across local data centers is very costly. The use of cloud-based learning reduces expansion costs and thus increases expansion potential regardless of increase in student numbers.

Improving Learning environments
Cloud-based learning improves the performance of higher education institutions, which will positively impact a higher level of learning.

Data migration & Replication
Some cloud-based learning allows secure and fast track the transfers between different source and target formats. Storage administrators get a backup through cross-platform data replication.

Flexibility
Cloud computing allows dynamic scalability as demands fluctuate. Renting computer platforms and scalable power makes eminent sense, particularly when institutions feel the threat of the potential theft or destruction of computer hardware.

Accessibility
This help makes data and services publicly available without making sensitive information

3.0 METHODOLOGY

3.1 Identification of e-learning system trends

As technology advances new trend of e-learning keep evolving. Hence there are different trends of e-learning systems. Different trends of e-learning available have been identified and are presented in figure 3.1



Figure. 3.1: E-learning system trends

3.2 Design and architecture of e-learning system

E-learning Solutions

There are various E-learning solutions from open source to commercial. There are at least two entities involved in an E-learning system: the students and the trainers according to (Paul et al., 2009). The students take online course, take exams, send feedback and send homework or projects while the trainers, deal with content management, prepare tests, assess tests, homework and projects taken by students, send feedback and communicate with students (forums).

Usually, E-learning systems are developed as distributed applications, but this is not necessarily so. The architecture of a distributed e-learning system includes software components, like the client application, an application server and a database server and the necessary hardware components (client computer, communication infrastructure and servers).

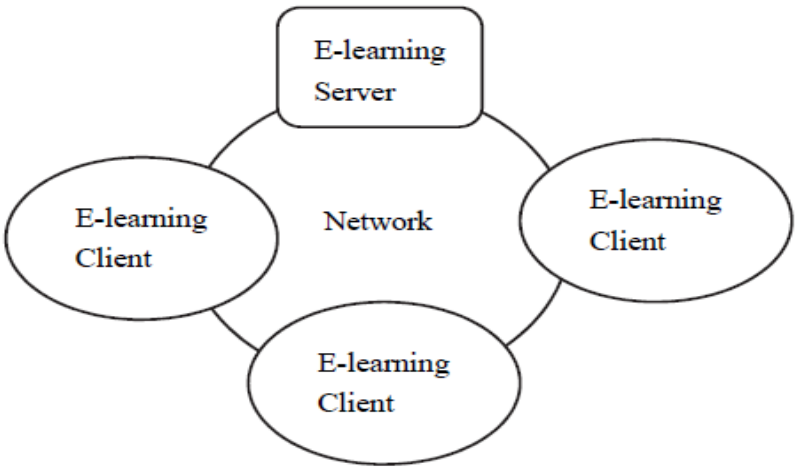


Figure 3.2: E-Learning System

The client hardware could be a desktop computer or a mobile device. The client application can be a simple web browser or a dedicated application. Even with the current hardware and software limitations, mobile devices are supporting multimedia-based applications. Compared with desktop applications. Nowadays mobile applications, especially multimedia-based applications, have serious limitations due the processing power and memory constraints.

Due to the fact that the data processing is on the server side, the use of mobile devices for learning is growing fast. Still, the mobile applications need to be optimized to be used for e-learning. The e-learning server will use cloud computing, so all the required resources will be adjusted as needed. (Paul et al., 2009).

Cloud Service Model

The computing created a sensation as it changed the look and feel of online applications. This virtual environment interacts with users and connects them with multiple services such as data and application storage. According to (Jyoti et al., 2013), Cloud computing can be used to implement complex systems across the web through a variety of application scenarios. Cloud Computing is a new paradigm to organize and manage ICT resources. There are various definitions of cloud computing, one of which is the definition according to The National Institute of Standards and Technology (NIST) which defines cloud computing as a "model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provided and released with minimal management effort or service provider interaction". Generally speaking, the cloud computing service model consists of three layers, among others: (1) Software as a Service (SaaS); (2) Platform as a service (PaaS); (3) Infrastructure as a service (IaaS).

Previous Cloud-Based E-Learning Architecture

The previous cloud-based e-learning architecture was primarily designed to deliver educational content over the internet using centralized cloud resources. It relied on Software-as-a-Service (SaaS) and Infrastructure -as-a-Service (IaaS) models to host learning materials, manage users, and support collaboration. The system has some major limitations based on scalability issues, limited personalization, handling of performance bottlenecks, week integration as well as security concerns especially on basic authentication without advanced identity management or encryption.

The research on e-learning in cloud environments has been extensively explored by earlier scholars. Studies by Chuang, et al., (2011) and Ghazizadeh (2012) were among the pioneering works that examined the integration of e-learning systems with cloud computing technologies. These studies recognized cloud computing as a new paradigm capable of overcoming the limitations of traditional e-learning platforms, such as restricted storage, limited accessibility, and high infrastructure costs. Their findings demonstrated that hosting e-learning

applications in the cloud could enhance scalability, resource sharing, and accessibility for both learners and institutions. Consequently, the application of e-learning in the cloud environment was identified as one of the primary forms of cloud service models for education, particularly under the Software-as-a-Service (SaaS) category.

This early research laid the groundwork for the previous cloud-based e-learning architecture, where educational content and learning management systems were centralized in the cloud to provide flexible, cost-effective, and easily deployable education services. Over the past decade, numerous researchers have proposed different architectural models for implementing e-learning in cloud environments. Each model seeks to optimize scalability, resource management, and user experience in delivering online education. For example, Phankokkruad (2012) proposed a cloud-based e-learning architecture that integrates Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS) to enhance resource sharing and reduce the cost of maintaining educational systems. The model emphasizes virtualization and the use of dynamic resource allocation to support multiple educational institutions simultaneously. Similarly, Masud and Huang (2012) developed an e-learning architecture based on the Software-as-a-Service (SaaS) model, focusing on content storage, collaboration tools, and service interoperability through cloud APIs. Their approach highlights how cloud computing can simplify content delivery and maintenance while ensuring scalability and ubiquitous access. Together, these architectures demonstrate the evolution of e-learning from traditional web-based systems toward more flexible, service-oriented, and cost-efficient cloud-based educational infrastructures.

Elmasry, et al, (2021) proposed e-learning architecture based on cloud computing consists of three basic layers: (1) infrastructure layer, (2) platform (middle) layer, and, (3) application layer. Infrastructure layer is a hardware structural layer that provides the computing and storage capacity for the higher level and this layer specifically, which is used as e-learning and software virtualization ensures the firmness and reliability of the infrastructure.

The second layer is Platform layer, this layer is the middle layer comprising middleware that is Web service with internet compliance. It is used for providing the learning resources as a service which consists of two modules: Item Classification Module (ICM) and Course Selection Module (CSM). They are both used for accessing the items from the items base and selecting suitable learning content from the content database. The third layer is Application layer which is responsible for interface provision for the students which is access compliance.

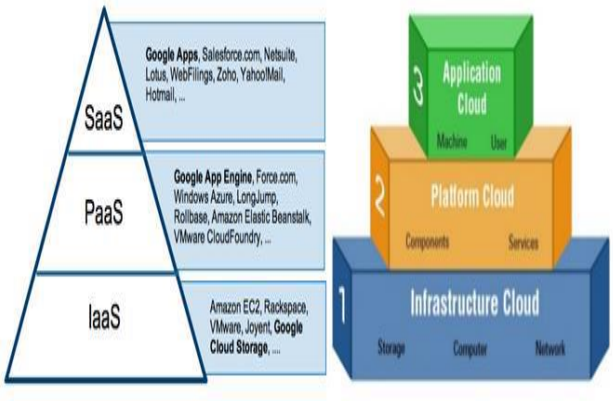


Figure 3.3: Cloud-based e-learning architecture (Elmasry et al., 2021)

Current Cloud-Based E-Learning Architecture

The first layer is infrastructure layer. It is employed as the e-learning resource pool that consists of hardware and software virtualization technologies to ensure the stability and reliability of the infrastructure. This layer also supplies the computing and storage capacity for the higher level.

The second layer is middleware layer. It focuses in providing a sharable platform consisting of two modules: CNRI's (Corporation for National Research Initiatives) Handler System Module and Metadata Transformation System Module.

The final layer is application layer. At this layer, cloud computing provides convenient access to the e-learning resources. The next architecture proposed by Masud & Huang (2012) consists of five layers.

The First layer is infrastructure layer. It is composed of information infrastructure and teaching resources. Information infrastructure contains internet/intranet, system software, information management system and some common hardware. Teaching resources stored up mainly in traditional teaching model and distributed in different departments and domain.

The second layer is software resource layer. This layer is composed of operating system and middleware.

A variety of software resources are integrated through middleware technology to provide a unified interface for software developers to develop applications and embed them in the cloud.

The third layer is resource management layer. In order to effectuate on demand free flow and distribution of software over various hardware resources, this layer utilizes integration of virtualization and cloud computing scheduling strategy.

The fourth layer is service layer. This layer has three levels of services namely, SaaS, PaaS, and IaaS. In SaaS, cloud computing service is provided to customers, contrasting to traditional software, cloud customers use software via the internet without any need to purchase, maintain, and upgrade. They simply pay a monthly fee.

The last layer is application layer. This layer is a specific layer consisting of applications of integrated teaching resources, including interactive courses and the teaching resources sharing. The teaching resources include teaching material, teaching information, as well as the full sharing human resources.

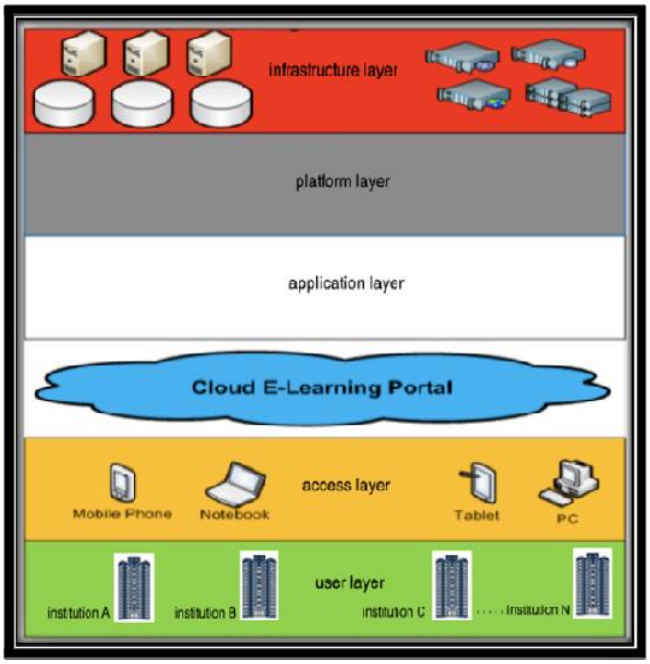


Figure 3.4: Previous Cloud-Based E-Learning Architecture

Proposed Improved Cloud-Based E-Learning Architecture

In this paper we propose the architecture that we have designed by modifying previous architectures that we used as references. Our proposed architecture consists of seven layers namely: (1) infrastructure layer; (2) platform layer; (3) application layer; (4) access layer; (5) user layer; (6) utilities layer and (7) Security layer

First layer is infrastructure layer. This layer contains architecture supporting infrastructure, such as: Cloud platform, virtual machine, virtual repositories and physical infrastructure such as servers, network devices, storage, buildings and other physical facilities. The infrastructure layer shares IT infrastructure resources and connects the system huge system pool together to provide services. Cloud computing enables the hardware layer to run more like the internet, to make the hardware resources shared and accessed the data resources in secure and scalable way.

The second layer is platform layer. In this layer running the operating system where e-learning application will be running. Besides the operating system, this layer also consists of variety of software that support the application layer so that it can run properly.

The third layer is application layer. This layer is a specific e-learning application that is utilized for sharing learning resources and interaction among users that includes synchronous or asynchronous discussion and chatting. This layer is integrated into our proposed architecture as an advancement over the existing architecture.

The fourth layer is the access layer. This layer is in charge of managing access to cloud e-learning services which is available on the architecture such as: types of access devices and presentation models which adopts the concept of multi-channel access which enables a variety of available services that accessible through a

variety of devices (such as mobile phones, smart-phones, computer, etc.) and a variety of presentation models (such as mobile applications, desktop applications, and others), (Mell, et al., 2011).

The fifth layer is the user layer. This layer is in charge of providing the enabling interface with the end users of the e-learning facilities within and outside the institution via cloud connectivity. This layer consists of various educational institutions that can interact with the system.

The sixth layer is the utilities layer. This layer is to have adequate utilities control using enterprise-based application, access and user protection so as to identify intrusions and prevention of attacks.

The seventh layer is the security layer. The layer is proposed to adequately provide security facilities including cameras to protect physical intruders to the locations of the facilities. The proposed Cloud -Based e-learning Architecture is presented in Figure 3.5.

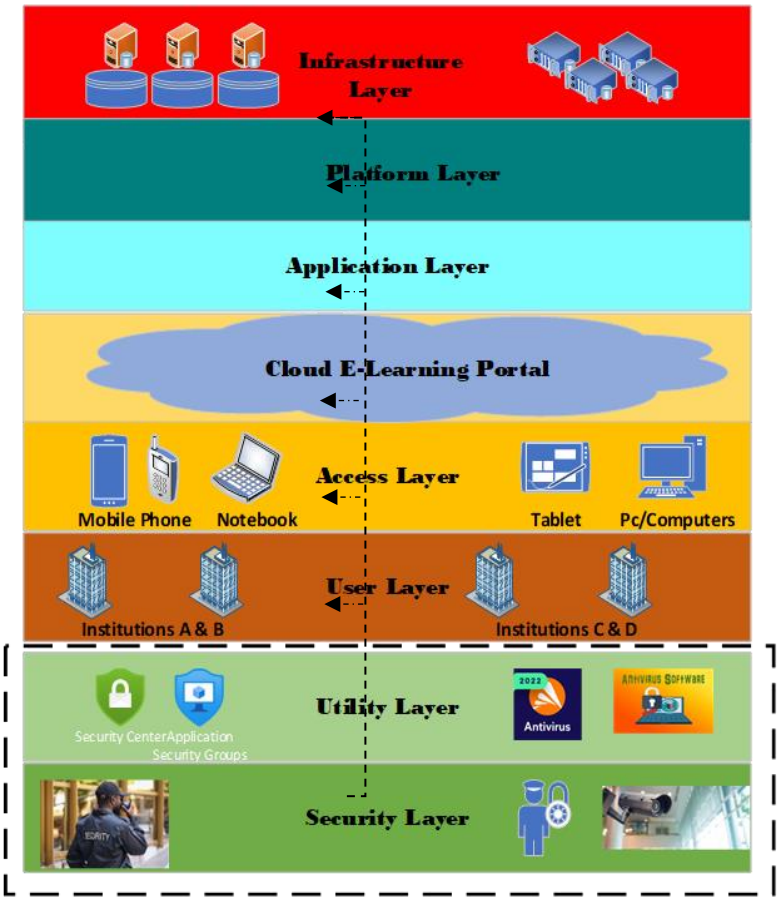


Figure 3.5: Proposed Cloud-Based E-Learning Architecture

As presented in figure 3.5, architecture layer, platform layer, application layer, access layer and user layers require adequate enterprise utility software that can detect and protect software and network treat. However, logical and physical security have to be in place of all installations and in all institutions that would want to implement cloud-based e-learning facilities.

4. 0 DISCUSSION

The main advantages of the adoption of cloud computing is efficiency in terms of cost. This is an interesting point of view that can be adapted to develop e-learning based on cloud computing. Commonly used conventional e-learning that is created by tertiary institutions tends to lead to a number of issues, including the time required to design e-learning systems, infrastructure costs, challenges in choosing between commercial and open-source e-learning platforms, the cost of hiring qualified personnel to maintain and upgrade the e-learning system.

By introducing cloud computing adopted by e-learning, institutions can use a single e-learning based on the cloud provided by a cloud provider of e-learning. This model can reduce the initial costs incurred by the institution for the implementation of e-learning by using cloud computing services, because institutions do not need to pay for the purchase of infrastructure, both in terms of procurement of servers and storage. With cloud computing, an institution of the client can rent the infrastructure to cloud computing service providers, (Ghazizadeh, 2012). Likewise with the human

resources for the development stage, the cloud environment of e-learning has been provided by the cloud service provider, as well as maintenance of the e-learning (Pocatilu, 2010).

According to Jones, . (2012), one of the main important features that can be presented in the use of e-learning in the cloud is scalability, which allows virtualization provide infrastructure layer provided by the cloud service provider. Virtualization helps solve the problem of the physical barriers that are generally inherent in the lack of resources and infrastructure to automate the management of these resources as if they were a single entity through hypervisor technologies such as virtual machine (VM).

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This paper proposes a model of e-learning based on cloud computing for higher institutions. Implementation of e-learning is now generally constructed separately by each institution, the implementation of such conventional models is costly due to infrastructures required at various tertiary institutions, systems development, and hiring IT staff to maintain and enhance e-learning systems. Cloud computing as one of the technologies used currently rife in the IT world can be utilized for the implementation of e-learning which drastically reduce or remove the infrastructural cost. For the cost of developing e-learning systems and staff to maintain and enhance e-learning systems, cloud service providers also provide service for it, and educational institutions will only pay for the services they already use which is very minimal compared to e-learning model.

In this paper we propose the architecture that consists of seven (7) layers, namely: (1) infrastructure layer; (2) platform layer; (3) application layer; (4) access layer; (5) user layer; (6) utility layer; and (7) security layer. The first five layers are the basic of cloud services, then we added two additional layers, namely utility layer and security. The Utility layer consists of a variety of devices and utility software used to protect system from intruders that could have access to the facilities. It could be inform of viruses that can attack through the devices such as desktops, notebooks, PCs, Smartphones, Tablets, etc. The security layer, consists of various facilities and software including cameras to protect the physical locations of such facilities.

5.2 Recommendations

As an advancement to the proposed e-learning model, future work should explore the design and implementation of a unified security system capable of managing and safeguarding interconnected institutional cloud environments. Such a system would allow multiple public and private institutions to operate within a shared cloud infrastructure while maintaining strict data integrity, confidentiality, and access control. The proposed framework should integrate high-level utility control, ensuring efficient resource allocation, as well as advanced security control measures such as multi-layer encryption, intrusion detection, and automated threat response. This would provide comprehensive protection and long-term preservation of both hardware and software assets, thereby enhancing the resilience, trustworthiness, and sustainability of cloud-based e-learning systems.

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THE EFFECT OF MOTIVATIONAL FINANCIAL SCHEME ON EMPLYEES SATISFACTION AND JOB COMMITMENT IN OIL AND GAS COMPANIES IN RIVERS STATE

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Abstract
The working environments of multinational oil and gas companies is very complex and nature of work very demanding. Therefore, employees work attitude such as job satisfaction and commitment are very important for the overall performance and success of oil and gas companies. The aim of this study was to investigate how financial scheme in the oil and gas industry affects employees' job satisfaction and commitment. A survey research design was adopted for the study. Mean and standard deviation were used for the univariate analysis of the data obtained from questionnaire responses, while bivariate analysis was conducted using Spearman Rank Order Correlation with the aid of SPSS Version 23.0. Results show that 190 (65%) of the respondents were male while 102 (35%) were females. Test of hypothesis at alpha level of 0.05, revealed that there is significant relationship between financial scheme and Job satisfaction as well as job commitment in Oil and Gas Producing Multinational Companies in Rivers State. It is concluded that financial schemes such as enhanced pay packages, bonuses and allowance are key motivating factors that give the employees job satisfaction and keep them committed to jobs. The researcher recommends that Management of Oil and Gas Companies should maintain financial incentives such as bonuses, profit-sharing, or stock options tied to individual and organizational performance.
Key words: Oil and gas companies, financial scheme, job satisfaction, job commitment

1.0 INTRODUCTION

1.1 Background to the Study

Considering the complex working environment of multinational oil and gas companies, employees work attitude is very important for the overall performance and success of oil and gas industry. A positive work attitude is very critical because it can drive collaboration, productivity, and adherence to safety standards. According to (James, *et al.,* 2024), collaboration, productivity and adherence to safety standards are essential for meeting global energy demands. On the other hand, negative work attitudes, such as low job satisfaction, poor engagement, or resistance to change and lack of commitment to work can lead to reduced productivity, safety incidents, and high turnover rates, which are inimical to any organization.

It is very important to understand and foster the right work attitudes among employees for sustaining long-term success in the oil and gas industry. **Employees work attitude** in oil and gas companies refers to the collective mindset, perceptions, and behavioral tendencies that employees exhibit towards their work, colleagues, and the organization as a whole (Onyeizugbe, *et al.*, 2021; Harvey, *et al.,* 2016; Baig & Ullah, 2017). In this context, **employees work attitude** encompasses factors such as job satisfaction, job commitment, and job involvement which are critical in an industry characterized by high-risk operations, complex regulations, and challenging work environments.

Employee job satisfaction is a critical factor in shaping the success and operational effectiveness of multinational oil and gas companies. This is because the satisfactory levels of employees directly influence their performance, motivation, and commitment to the organization. Job satisfaction in these companies goes beyond basic compensation and benefits. It encompasses elements such as work-life balance, career development opportunities, safety, organizational culture, and the quality of leadership (Jurgita, 2023). Given the demanding nature of oil and gas production, which often involves long hours, remote or hazardous working environments, and high-pressure situations, job satisfaction plays a pivotal role in retaining skilled talent and ensuring workforce stability. For multinational oil and gas companies, maintaining high levels of job satisfaction is particularly important as they manage diverse teams across different regions, cultures, and regulatory environments. Satisfied employees are more likely to be engaged, productive, and loyal, which translates into better safety compliance, operational efficiency, and innovation. On the other hand, low job satisfaction can lead to increased turnover, absenteeism, and a lack of motivation, all of which can significantly hinder the company's ability to meet its goals and maintain a competitive edge in the global market (Bhatti & Qureshi, 2021).

For oil and gas multinationals, where operations often span across multiple countries and require coordination of diverse, global teams, fostering strong job commitment is particularly important as high levels of commitment lead to enhanced productivity, reduced

turnover, and a deeper alignment with the company's strategic objectives (Irefin & Mechanic, 2023). Committed employees are more likely to go beyond their basic responsibilities, ensuring that projects are completed on time, safety standards are upheld, and operational challenges are addressed with initiative and care. In an industry that operates under challenging conditions ranging from volatile market dynamics to complex regulatory environments and high-risk operational processes employee commitment remain very vital and crucial for maintaining operational continuity, ensuring safety, and achieving organizational goals (Akintayo, 2021). job commitment refers to the emotional attachment and dedication employees have toward their roles and the organization, influencing their willingness. The aim of this study was to determine the influence of financial scheme on job satisfaction and workers commitment in Oil and Gas Producing Companies in Rivers State.

1.2 Research Questions

The following research questions were posed to guide the study:

I. What is the relationship between financial scheme and job satisfaction in Oil and Gas Producing Multinational Companies in Rivers State?
II. How does financial scheme relate with job commitment in Oil and Gas Producing Multinational Companies in Rivers State?

1.3 Research hypothesis

I. **Ho_1:** There is no significant relationship between financial scheme and job satisfaction in Oil and Gas Producing Multinational Companies in Rivers State.
II. **Ho_2:** There is no significant relationship between financial scheme and job commitment in Oil and Gas Producing Multinational Companies in Rivers State.

2.0 LITERATURE REVIEW

2.1 Review of key concepts

2.1.1 Financial Scheme

The financial scheme of oil and gas firms refers to the methods, frameworks, and financial arrangements these companies use to manage capital, revenue, expenses, and risks while funding operations, exploring resources, and maximizing profitability. A financial scheme is a formalized compensation plan that specifies how an organization pays its employees, including the structure of base salaries, additional incentives, and other benefits. It can vary based on performance, seniority, job role, or company policy (Yakubu, *et al.*, 2023). The **financial scheme** in oil and gas companies is crucial for attracting highly skilled professionals. The industry demands a diverse range of expertise, from engineers to technicians, and even data scientists. Given the technical complexity and the specialized knowledge required in areas like drilling, extraction, and environmental management, the competition for talent is fierce. A well-structured **financial scheme,** offering competitive salaries and incentives, ensures that companies can attract the best candidates in the industry. Without this, oil and gas firms may struggle to fill critical positions, which can negatively affect operational efficiency. Many oil and gas jobs are situated in harsh and remote locations, such as offshore rigs or desert oil fields, where employees are exposed to physically demanding and potentially dangerous working conditions. In such environments, **financial scheme** plays a significant role in employee retention (Smart in Yakubu, *et al.*, 2023). Companies often provide additional financial incentives, such as hardship allowances, hazard pay, and retention bonuses, to compensate for the difficult conditions. Without these elements, employees may be more inclined to leave for positions that offer better work-life balance, leading to high turnover and increased recruitment costs.

2.1.2 Job Satisfaction

According to Ndulue and Ekechukwu (2016), satisfaction refers to the level of fulfillment of one's needs, wants and desire. Satisfaction depends basically upon what an individual wants from the world, and what he gets." Employee satisfaction is a measure of how happy workers are with their job and working environment. It is sure that there may be many factors affecting the organizational effectiveness and one of them is the employee satisfaction. Effective organizations should have a culture that encourages the employee job satisfaction (Bhatti & Qureshi, 2021). There is no limit for the employees to reach the full job satisfaction and it may vary from employee to employee. Sometimes they need to change their behaviors in order to execute their duties more effectively to gain greater job satisfaction (Jurgita, 2023). Having good relationships with the colleagues, high salary, good working conditions, training and education opportunities, career developments or any other benefits may be related with the increase in employee job satisfaction.

2.1.3 Job Commitment

Employee commitment seems to be a crucial factor in achieving organizational success. However, Brown in Okpu and Jaja (2014) describes commitment as something of the notion of membership; it reflects the current position of the individual; it has a special predictive potential, providing predictions concerning certain aspects of performance, motivation to work, spontaneous contribution, and other related outcomes; and it suggests the differential relevance of

motivational factors. Committed employees who are highly motivated to contribute their time and energy to the pursuit of organizational goals are increasingly acknowledged to be the primary asset available to an organization (Hunjra, *et al*., 2020). It is therefore important for organization to know the aspects that play important role or have big impact in boosting the commitment of their employees. Thus, Porter *et al.* in Okpu and Jaja (2014) defines employee commitment as an attachment to an organization which is characterized by an intention to remain in it, identification with the values and goals of the organization and a willingness to exert extra effort on its behalf. Employees who are committed have some sense of binding link; an obligation to remain and contribute bountifully to the victory of the team they belong.

As stated by Dixit and Bhati in Zeb-Obipi and Agada (2018) that the concept of employee commitment was derived from an article titled "The organization Man" written by Whyte in 1956 and it denotes the willingness of social actors among others such as employees to give their energy and loyalty to social systems otherwise known as organizations. Employees who are committed to their organization generally feel a connection with their organization that they fit in and equally feel they understand the goals of the organization.

2.2 Review of related studies

James, *et al*. (2024) examined compensation management and employee commitment in Ibom Power Company (IPC) in Ikot Abasi Local Government Area of Akwa Ibom State, Nigeria. The findings revealed that pay-for-performance has positive and significant relationship with employee's commitment in IPC; and skilled-based pay has positive and significant relationship with employee's commitment in IPC; Obieze (2024) examined the impact of compensation management practice on employees' performance of selected banks in Delta State. The study finds that: Recognition has a significant effect on employees' performance in selected banks in Delta State. Pay has a significant effect on employees' performance in selected banks in Delta State. Bonuses/allowances/ has a significant effect on employees' performance in selected banks in Delta State. Fringe benefit has a significant effect on employees' performance in selected banks in Delta. An overall compensation policy has a significant effect on employees' performance in selected banks in Delta State.

Warsame (2024) examined the effect of compensation management practices on employee performance in Wajir County, Kenya. The study found that both direct compensation and incentives have a positive and significant effect on employee performance of Wajir County; Effiong, *et al.* (2022) empirically examined compensation management and employee performance in selected organizations in Cross River State. The findings revealed that all the independent variables had a significant relationship with employees' performance in the selected organizations (Larfage, Honey feed company Limited and Aje Ndoma Nigeria Enterprise) in Cross River State, Nigeria.

Furthermore, Yakubu, *et al.* (2023) explored the effect of compensation on employee job performance of deposit money banks in Kano State, Nigeria. The study found that financial compensation has a positive and significant effect on employee job performance, while non-financial compensation has a positive but insignificant effect on employee job performance of DMBs in Kano State, Nigeria; Muqaddas, *et al.* (2023) studied the impact of compensation practices on employee job performance: an empirical study. SPSS was used to analyzed data and the analysis of the data confirmed a positive relationship between compensation and job performance; Ibojo and Asabi (2014) examined compensation management and employees' performance in the manufacturing sector, a case study of a reputable organization in the food and beverage industry; Onuorah, *et al.* (2019) examined the effect of compensation management and employee performance in Nigeria organization. It was found that equity-based compensation has no negative significance effect on employee performance in Nigeria organization. Competency based compensation has no negative significance effect on employee performance in Nigeria organization. Performance based compensation has no negative significance effect on employee performance in Nigeria organization.

Moreover, Aliku, *et al.* (2020) examined compensation management and employee performance: manufacturing industry in focus. The findings revealed that all the independent variables (Salary (SLY) and Benefits Programs (BP), have a significant relationship with Employees Performance in the Manufacturing Industry; Ijaya (2017) examined the effects of compensation strategies on employees' performance in the Public Health Sector in Nairobi City County Kenya. The study established that competitive salaries, incentives, indirect compensation and rewards had a positive and significant influence on employees' performance; Ohene *et al.* (2020) investigated the effect of compensation on employee's performance Accra Technical University: Ghana. They find that housing loan and accommodation are the most crucial needs; Hameed *et al.* (2014) measured the impact of compensation on employee performance in different banks of Pakistan. ANOVA results reveal that education have not same impact on employee performance.

3.0 RESEARCH METHODOLOGY

3.1 Research Design

The correlational research design was adopted for the study. This design was deemed fit for the study considering the fact that the study involves investigating the relationships between two different variables in different Oil and Gas Producing Multinational Companies at the same time. The study also involves the test of hypotheses (which is explanatory in nature).

3.2 Population of the Study

The accessible population of the study consisted of Two Thousand Nine Hundred and Forty-Eight (2948) full-time staff of seven (7) Oil and Gas Producing Multinational Companies operating in Rivers State. The above information was obtained from the Human Resource Department of the respective company. Although, there are several Oil and Gas Companies in Rivers State, most of them are either servicing or maintenance Oil and Gas companies and not multinational. This informed our decision to settle for the seven (7) companies that are multinational and really involve in Oil and Gas production in Rivers State

3.3 Sample Size and Sampling Techniques

The sample size of the study was Three Hundred and Fifty-Two (352) respondents of the seven (7) Oil and Gas Producing Multinational Companies operating in Rivers State. The above sample size was obtainable using the Taro Yamene Sampling Formula as presented in Eqn 3.1

$$N = \frac{N}{1+N(e)2} \qquad Eqn\ (3.1)$$

Where:

n = Sample size required
N = Population size
e = Precision of error

Applying the formula, we have

$$n = \frac{2948}{1+2948\ (0.05)^2} = \frac{2948}{1+2948\ (0.0025)}$$

$$= \frac{2948}{8.37} \qquad n = 352$$

In order to address the differences in the distribution of the population across the companies, Bowley's 1960 Population Proportionate Allocation Formula was applied. Equation 3.2

$$nh = \frac{nNh}{N} \qquad Eqn\ (3.2)$$

Where:

nh= number of units allocated to each organization
n = total sample size
Nh = number of staff in each organization
N = population size

Addax Petroleum Nigeria Limited

$$nh = \frac{352 \times 233}{2948} = \frac{82016}{2948} = 28$$

Chevron Nigeria Limited

$$nh = \frac{352 \times 593}{2948} = \frac{208736}{2948} = 71$$

Nigeria Agip Oil Company

$$nh = \frac{352 \times 533}{2948} = \frac{187616}{2948} = 63$$

Nigeria ExxonMobil

$$nh = \frac{352X\ 204}{2948} = \frac{71808}{2948} = 24$$

Nigeria Liquidified Natural Gas

$$nh = \frac{352 \times 383}{2948} = \frac{134816}{2948} = 46$$

Shell Petroleum Development Company

$$nh = \frac{352 \times 459}{2948} = \frac{161568}{2948} = 55$$

Total Energies

$$nh = \frac{352 \times 543}{2948} = \frac{191136}{2948} = 65$$

This implies that only 352 questionnaire copies were distributed to respondents. Thus, the study adopted the random sampling techniques. Details of the sample size are provided in Table 3.1 below:

Table 3.1: Study Sample

S/N	Names of Oil and Gas Producing Multinational Companies in Rivers State	Sample
1.	Addax Petroleum Nigeria Limited	28
2.	Chevron Nigeria Limited	71
3.	Nigeria Agip Oil Company	63
4.	Nigeria ExxonMobil	24
5.	Nigeria Liquidified Natural Gas	46
6.	Shell Petroleum Development Company	55
7.	Total Energies	65
	Total	**352**

Source: Researcher's Computation, 2024.

3.4 Validity of the Instrument

Validity of instrument has to do with the capacity of a research instrument to measure what it ought to measure. The study adopted the face and content validity. To achieve this, the questionnaire that was designed for the study was subjected to thorough scrutiny and adjustment by the supervisor and two other experts in Management. Their comments were used to validate the questionnaire items.

3.5 Reliability of the Instrument

The reliability of an instrument is an indication of the firmness and consistency with which the instrument measures the concept and helps to assess the "goodness" of the measure. To test the reliability of the measuring instrument, Cronbach alpha was used to test the internal consistency of the instrument for the study.

3.6 Data collection

A well Structured and validated questionnaire was used to collect data from respondents The research questionnaire was called "Compensation Management Practices and Employee Work Attitude Index" (CMPEWAI). The questionnaire was made up of two sections. Section A was designed to elicit demographic data concerning the respondents. Section B contained the main questionnaire items designed to measure the variables under investigation. The instrument was designed in a modified four (4) point Likert scale with the following response options: Strongly Agreed (SA) = 4; Agreed (A) = 3; Disagreed (D) = 2; and Strongly Disagreed (SD) = 1.

Three Hundred and Fifty-Two (352) copies of the questionnaire were administered to respondents through the help of three independent research assistants. However, two Hundred and Ninety-Two (292) copies were retrieved and used for the analysis

3.7 Method of Data Analysis

Mean and standard deviation were used for the univariate analysis, while the bivariate analysis was done using Spearman Rank Order Correlation with the aid of SPSS Version 23.0. The Spearman Rank Order Correlation Coefficient (Rho) was considered to be the most appropriate for this study as it measures the relationship between two sets of observations. Multivariate analysis was done using Partial Correlation. Thus, Spearman Rank Order Correlation Coefficient was computed using Equation 3.3 below

$$r_s = 1 - \frac{6\sum D^2}{n(n^2 - 1)} \qquad \text{Eqn 3.3}$$

Where;
n = number of pairs of data
d = different between the ranking in each set of data.
$\sum$ = Summation

If our statistical analysis shows that the significance level is Above the cut-off value we have set (which is 0.05), we reject the null hypothesis and accept the alternate hypothesis. Alternatively, if the significance level is above the cut-off value, the null hypothesis was accepted. In testing the hypotheses one to ten, the following rules were upheld in accepting or rejecting our null hypotheses. All the coefficient (r) values that indicate levels of significance (* or **) as calculated using SPSS were accepted and thus our alternate hypotheses were accepted and when no significance was indicated in the coefficient (r) value, we reject the null hypotheses. We set out confidence interval at 0.05 level of significance to test the statistical significance of this study. Both the significance values and the coefficient values were used. For the coefficient values, the following interpretation scheme was applied as stated further: (a) No Relationship = 0, (b) Weak Relationship = 0.1-0.2, (c) Moderate Relationship = 0.3-0.5, (d) Strong Relationship = 0.6-0.7, (e) Very Strong Relationship = 0.8-0.9, (f) Perfect Relationship = 1.

4.0 RESULTS AND DISCUSSIONS

4.1 Results

The result of the instrument reliability test is presented in Table 4.1

Table 4.1: Cronbach Alpha Reliability Test Results

Dimensions/Measures	Items	Alpha
Financial Scheme	4	.863
Job Satisfaction	4	.826
Job Commitment	4	.840
Organizational Culture	4	.962

Source: Survey Data, 2025.

Descriptive statistics of the questionnaire distribution and retrieval from the various companies is presented in Table 4.2

Table 4.2: Administration of Instrument

S/N	Names of Oil and Gas Companies	Copies of Questionnaire Administered	Retrieved Copies	Copies. Not Retrieved	Percentage Retrieved
1.	Addax Petroleum Nigeria Limited	28	26	2	7%
2.	Chevron Nigeria Limited	71	54	17	15%
3.	Nigeria Agip Oil Company	63	50	13	14%
4.	Nigeria ExxonMobil	24	20	4	6%
5.	Nigeria Liquidified Natural Gas	46	44	2	12%
6.	Shell Petroleum Development Company	55	43	12	12%
7.	Total Energies	65	55	10	16%
	Total	**352**	**292**	**60**	**82%**

Source: Researcher's Computation, 2025.

Table 4.2 above shows that a total of Three Hundred and Fifty-Two (352) copies of the questionnaire were distributed to the respondents in the seven (7) Oil and Gas Producing Multinational Companies in Rivers State based on their individual strength. However, Two Hundred and Ninety (290) copies representing 82% of the total number of questionnaires distributed were retrieved

Result of analysis of demographic characteristics of respondents is presented in Figure 4.1. It shows that 190 (65%) of the respondents were male while 102 (35%) were females

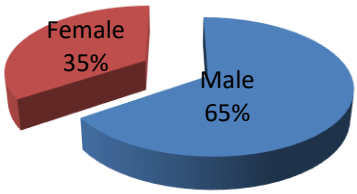


Fig. 4.1: Pie Chart of Gender Distribution (Source: Survey Data, 2025)

The result of the analysis of the Educational Qualification of respondents is presented in Table 4.3

Table: 4.3: Educational Qualification Distributions

		Frequency	Percent	Valid Percent
Valid	First Degree	160	55.0	55.0
	Master's Degree	100	35.0	35.0
	Ph.D	32	10.0	10.0
	Total	292	100.0	100.0

Source: Survey Data, 2025.

The educational qualification status distribution presented in Table 4.3 shows that 160 representing 55% of the respondents have first degree certificate, 100 respondents representing 35% have master's degree certificate, while 32 respondents representing 10% have Ph.D. certificate in the seven (7) Oil and Gas Producing Multinational Companies in Rivers State understudy.

Result of the descriptive statistics analysis of responses on companies financial scheme is presented in Table4.4

Table 4.4: Descriptive Statistics of Financial Scheme

S/N	Items	Responses				Total	Min.	Max.	Mean	Std. Dev.
		SA	A	D	SD					
FS 1	My company pay bonuses when adequately as a way of motivating us.	143	89	41	19	292	1.00	4.00	3.2	1.4
FS 2	Our salary benchmark is reasonable in comparison to sister organizations.	120	100	55	17	292	1.00	4.00	3.1	1.4
FS 3	Salaries are paid on time and bonuses; commissions and incentives are given when due.	182	76	22	12	292	1.00	4.00	3.4	1.5
FS 4	Management of our company disburses wages effectively for workers morale boasting.	132	90	50	20	292	1.00	4.00	3.1	1.5
	Valid N (listwise)	292				Grand		Mean	3.2	

Source: Survey Data, 2025.

Table 4.4 above reveals mean scores of 1point and above across all the response items and grand mean of 3.2. Item 1 with a mean score of 3.2 implies that the respondents believed strongly that their company pay bonuses adequately as a way of motivating them. Item 2 with a mean score of 3.1 implies that the respondents are of the view that their salary benchmark is reasonable in comparison to sister organizations. Item 3 with a mean score of 3.4 indicates that the respondents affirmed that salaries are paid on time and bonuses, commissions and incentives are given when due. Item 4 with the mean score of 3.1 indicates that management of their company disburses wages effectively for workers morale boasting.

Result of the descriptive statistics analysis of responses on employees job satisfaction in the various companies is presented in Table4.5

Table 4.5: Descriptive Statistics of Job Satisfaction

S/N	Items	Responses				Total	Min.	Max.	Mean	Std. Dev.
		SA	A	D	SD					
JS 1	Sometimes, I am allowed to make decision about their work-related issue and this has boasting my intrinsic satisfaction.	90	80	75	47	292	1.00	4.00	2.7	1.2
JS 2	My company makes work easy as they allow us to practice flexible work schedule as a way of supporting our wellbeing.	141	87	45	19	292	1.00	4.00	3.2	1.4
JS 3	We receive positive feedback from our customers to show that they are satisfied due to our product and service quality.	174	67	40	11	292	1.00	4.00	3.4	1.5
JS 4	Our clients are sure of their security in terms of having quality products and services from our company as we adhere to specification.	151	67	47	27	292	1.00	4.00	3.1	1.5
	Valid N (listwise)	292				Grand	Mean		3.1	

Source: Survey Data, 2025.

Table 4.5 above reveals mean scores of 3 points and above across all the response items and grand mean of 3.1. Item 1 with a mean score of 2.7 implies that the respondents believed that sometimes, they are allowed to make decision about their work-related issue and this has boasted their intrinsic satisfaction.

Result of the descriptive statistics analysis of responses on employee's job commitment in the various companies is presented in Table 4.6

Table 4.6: Descriptive Statistics of Job Commitment

S/N	Items	Responses				Total	Min.	Max.	Mean	Std. Dev.
		SA	A	D	SD					
JC 1	I am ready to identify with any goal and policy of my company.	150	78	42	22	292	1.00	4.00	3.2	1.4
JC 2	I have remained in this company because I cannot afford to lose the time and energy I have invested.	112	95	53	32	292	1.00	4.00	2.9	1.3
JC 3	Considering the things I have benefitted from this company; I feel compelled to remain in this organization.	170	100	11	11	292	1.00	4.00	3.4	1.5
JC 4	I have passion for any work I am asked to do in this company.	122	83	66	21	292	1.00	4.00	3.6	1.4
	Valid N (listwise)	292				Grand Mean			3.1	

Source: Survey Data, 2025.

Table 4.6 above reveals mean scores of 2 points and above across all the response items and 3.1. Item 1 revealed a mean score of 3.2 indicates that the respondents affirmed that they are ready to identify with any goal and policy of their company. Item 2 with a mean score of 2.9 implies that they have remained in this company because they cannot afford to lose the time and energy they have invested. Item 3 with a mean score of 3.4 indicates that the respondents affirmed that considering the things they have benefitted from this company, they feel compelled to remain in this organization and tis makes them to be committed to their jobs.

Result of correlation analysis of the relationship between financial scheme and job satisfaction to test hypothesis one is presented in Table 4 .7

Ho_1: There is no significant relationship between financial scheme and job satisfaction in Oil and Gas Producing Multinational Companies in Rivers State.

Table 4.7: Correlations between Financial Scheme and Job Satisfaction

			Financial Scheme	Job Satisfaction
Spearman's rho	Financial Scheme	Correlation Coefficient	1.000	.870**
		Sig. (2-tailed)	.	.000
		N	292	292
	Job Satisfaction	Correlation Coefficient	.870**	1.000
		Sig. (2-tailed)	.000	.
		N	292	292

**. Correlation is significant at the 0.05 level (2-tailed).

Source: Survey Data, 2025.

Table 4.7 above showed r value of 0.870 at a significance level of 0.00 which is above the chosen alpha level of 0.05 for the hypothesis relating financial scheme and job satisfaction. Since the significance value is higher than the alpha level of 0.05, the null hypothesis (Ho_1) which states that there is no significant relationship between financial scheme and job satisfaction in Oil and Gas Producing Multinational Companies in Rivers State was rejected and the alternate hypothesis (Ha_1) was accepted. This implies that there is a very strong positive relationship between financial scheme and job satisfaction in Oil and Gas Producing Multinational Companies in Rivers State.

Result of correlation analysis of the relationship between financial scheme and job commitment to test hypothesis two is presented in Table 4 .8

Ho_2: There is no significant relationship between financial scheme and job commitment in Oil and Gas Producing Multinational Companies in Rivers State.

Table 4.8: Correlations between Financial Scheme and Job Commitment

			Financial Scheme	Job Commitment
Spearman's rho	Financial Scheme	Correlation Coefficient	1.000	.610**
		Sig. (2-tailed)	.	.000
		N	292	292
	Job Commitment	Correlation Coefficient	.610**	1.000
		Sig. (2-tailed)	.000	.
		N	292	292

**. Correlation is significant at the 0.05 level (2-tailed).

Source: Survey Data, 2025.

Table 4.8 above showed r value of 0.610 at a significance level of 0.00 which is above the chosen alpha level of 0.05 for the hypothesis relating financial scheme and job commitment. Since the significance value is higher than the alpha level of 0.05, the null hypothesis (Ho_2) which states that there is no significant relationship between financial scheme and job commitment in Oil and Gas Producing Multinational Companies in Rivers State was rejected and the alternate hypothesis (Ha_2) was accepted. This implies that there is a strong positive relationship between financial scheme and job commitment in Oil and Gas Producing Multinational Companies in Rivers State.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

It is a natural tendency for humans to gravitate towards things that provide them comfort or offer them desired benefits and where they are appreciated. This phenomenon is demonstrated in this study. Motivation is a moral booster to human, hence when people are motivated either by way of financial incentives or any other reward system, they tend to put in their best and get more committed to job assigned to them. This was demonstrated in this study as the findings revealed that financial scheme in oil and gas company has significant positive correlation with their employees' job satisfaction and job commitment.

5.2 Recommendations

Based on the findings, the following recommendations are made:

1. Management of Oil and Gas Producing Multinational Companies should design competitive salary packages that align with industry standards and are communicated transparently.
2. Management of Oil and Gas Producing Multinational Companies should introduce financial incentives such as bonuses, profit-sharing, or stock options tied to individual and organizational performance.
3. Management of Oil and Gas Producing Multinational Companies should conduct periodic reviews of their compensation structures to remain competitive in the dynamic oil and gas industry.

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EARLY LAY CHARACTERISTICS OF LOCAL AND CROSSBRED CHICKEN GENOTYPES BEARING PLUMAGE MODIFYING GENES

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Abstract
This study was conducted to determine the early lay characteristics of local and crossbred chicken genotypes bearing plumage modifying genes. A total of 170 F_1 progenies were generated from the crosses and were used to determine short term egg production traits of the crossbred chickens. All data generated were analyzed using Sas (2004) package. Result obtained revealed that the short term egg production parameters among the genotypes showed that the main crossbred individuals had significantly heavier weight ($P<0.05$) at first egg, and a lower age at first egg (AFE). The Na x E which had the highest WAFE also had higher egg number and egg weight than other genotypes. In conclusion, this study showed a high egg production characteristics, among the main crossbred and reciprocal chicken genotypes having the plumage modifying genes. These improved chicken genotypes is recommended for conservation and incorporation into the Nigerian poultry industry.

1.0 INTRODUCTION

Crossbreeding refers to the crossing of two or more genetically unrelated population or lines that is, it could be different breeds, strains or inbred lines or even different species. It is aimed at combining the gene in both population in the resulting progeny thereby creating greater variability (Adebambo *et al.,* 2006). New combination of genes generally results from such crosses, and favourable ones are used use to bring about improvement. Crossbreeding with the exotic strains increased body weight greatly at 2 weeks of age (Adebambo *et al.,* 2006). Lufadeju *et al.* (1995) and Lamorde (1997) estimated the Nigerian local chicken population at 150 million. However, the Federal Ministry of Agriculture and Rural Development (FMARD) (2008) gave the estimated number of indigenous chicken in Nigeria as 166 million.

These local chicken populations are consisted of mixed varieties of unimproved, unselected and random breeding birds (Udeh, 2010). The growth rate of the local chickens is also generally much slower than that of commercial broilers (Pym *et al.,* 2013). While broilers under typical confinement rearing may reach 2.0kg live weight at five weeks of age, indigenous cockerels birds often weigh no more than 1.0kg at 20 weeks (FAO, 2010), studies have shown that indigenous stock under good conditions, perform marginally better, or under low input and harsh conditions (Singh *et al.,* 2004). The egg production of native chickens have been referred to as low compared to the foreign strains. Nwosu (1979) and Obioha *et al.* (1983) submitted that the egg production for the indigenous bird ranged from 60-80 eggs per annum under extensive system with an average egg weight of 32.75g. Nwosu (1985) reported that there was no major difference in the egg laying performance of Nigeria local chicken of the eastern strain versus Nsukka strain and the Awgu strain.

Peters (2000) also confirmed that normal feather hen laid highest numbers of eggs than the exotics. Horst (1989) reported that the indigenous chickens are abundantly endowed with about 7-9 major genes existing in their genes pool that are generally conserved for special utility in the tropics. The presence of these major genes make them jealous for genetic exploration (Peter, 2000). Research shows that the egg number laid per clutch range from 4 to 14 eggs. Sonaiya and Olori (1990) reported that an average of 9 eggs was laid within the period 12 days. Ikeobi *et al.* (1996) reported that the production of 8 to 9 eggs per clutch was laid within the period of 2 to 14 days during a laying period 32 to 36 weeks. Nwosu and Omeje (1985) evaluated the egg laying performance of indigenous chicken and reported that their production ability is in the range of 40 to 80 eggs, although their genetic potential for egg production is about 125 eggs. Major genes of chicken are believed to confer not only adaptability to the tropical climate, but also resistance to disease (Haunshi *et al.,* 2002).

It is an anxiomatic truth that the potentials of the indigenous chicken has not been fully utilized since there are still growing reports about existing or potential levels of productivity in the strain managed under extensive system (Mathur et al., 1989). Genetic upgrading of native chicken stock is necessary because of its high adaptability to harsh environmental condition of climate and disease compared with the exotic stock (Fitzhugh et al., 1992, Ajayi, 2010). The report of Adedeji et al. (2004) showed a significant improvement in the growth performance of pureline naked neck, frizzle feathered and normal feathered local chickens. This shows an indication that the genetic profile of the chickens can then be upgraded via

different breeding schemes. Thus, this study was carried out to improve on the early lay characteristics of local and crossbred chicken genotypes bearing plumage Modifying Genes.

2.0 MATERIALS AND METHODS

2.1 Location of Study

The experiment was conducted at the Poultry Unit, Teaching and Research farm, Michael Okpara University of Agriculture, Umudike, Abia State Nigeria. Umudike is located on the latitude of 05oC 29'N and longitude 07o33' East.

Management of Base Population

A base population of 35 chicken consisting of 6 frizzle feather females, 6 normal feather females, 6 naked neck feather females, 9 exotic females, 3 frizzle feather males, 3 normal feather males, 3 naked neck feather males, 3 exotic normal feather males, were obtained from local markets in Abia and Imo State of Nigeria. The cocks of these local chicken genotypes were mated to exotic layer strains. The birds were quarantined for about 3 weeks during which they were administered with New Castle disease vaccine (Komarov). The birds were later transferred into a clean deep litter pens fill with wood shavings, Water and commercial layer mash feed was given to them ad-libitum during the period. In the subsequent weeks, calculated amount of feed was given to the birds based on their body weights. Prophylactic antibacterial and anti-coccidial drugs were given to the birds periodically. Thereafter, the birds were allotted into deep litter pens according to the genotypes and mating was done in a ratio of 1 male to 3 females in each genotype.

Mating Schedule of the Base Population and Number of Progenies Generated

Pure line

Male x Female

1. Normal feather (na): na x na
2. Naked neck (Na): Na x Na
3. Frizzle feather (F): F x F

Main crossing

Male x Female

1. Normal feather x Exotic layer: na x E
2. Naked neck x Exotic layer: Na x E
3. Frizzle feather x Exotic layer: F x E

Reciprocal

Male x Female

1. Exotic egg-type strain x normal feather: E x na
2. Exotic egg-type strain x naked neck: E x Na
3. Exotic egg-type strain x frizzle: E x F

Egg collection for incubation

The males and females of each genetic group were allowed to run for two weeks.

The eggs were collected daily, and marked with a permanent ink marker with different

Colors according to their genotypes. All the eggs collected were properly examined for any crack before they were sent to a local hatchery.

Candling and Incubation

The eggs were candled at the 7th day to ascertain their fertility and embryo development. Thereafter, they were also candled at 18th day of incubation before the final hatch at 21st days. However, during this period the relative humidity, temperature conditions were monitored.

Management of F1 Progenies

A total of one hundred and seventy (170) chicks were generated consisting of 37 males and 133 females for the study.

Laying period

During the point of lay (19-20) weeks, Top feed brand layers mash was fed to birds including clean water. Artificial light source was provided to ensure 18 hours of light daily. Clean litter materials were provided every forth nightly. The egg production information were obtained for a period of two months i.e 60 days.

Data Collection

Measurement of Egg Production

Age at first laying: This was calculated as the age (days) at which the hen laid her first eggs.

Body weight at first egg (BWFE): This is the weight of the hen when the first egg was laid.

Weight at first egg (WAFE): The first egg laid on each individual hen was measured and recorded using a sensitive scale.

Egg number: The number of eggs laid by each hen was recorded monthly for a period of two months (60 days) for short term period egg production.

a) **Hen day egg production (% HDP):** This was computed as follows: as;

$$\%\ HDP = \frac{\text{Total egg laid}}{\text{Number of birds alive}}\ x\ \frac{100}{1}$$ (Kwari *et al.*, 2011)

b) **Hen housed egg Production (%HHP):** This is expressed as:

$$\% \, HPP = \frac{\text{Total egg laid}}{\text{No. of birds housed from the beginning of lay}} \; x \; \frac{100}{1}$$

Mortality rate:

$$\frac{\text{No.of dead birds}}{\text{No.of birds at the beginning}} \; x \; \frac{100}{1}$$

Experimental Design and Data Analysis

Data collected from the study was subjected to analysis of variance in randomized complete block design with genetic group as treatment and hatch as block. Significance of means were separated using Duncan Multiple Range test (1955). SPSS (2004) computer application software programme was used for the analysis.

The model of the design is given below;

$$Y_{ijk} = \mu + G_i + B_j + E_{ijk}$$

Where Y_{ijk} = observation of the k^{th} individual in the j^{th} block of the i^{th} genetic group.

μ = population mean

G_i = Effect of the i^{th} genetic group (i = 1, 2 .....9)

B_j = Effect of the j^{th} hatch (j = 1, 2.....9)

e_{ijk} = Random error, assumed to be independently, identically and normally distributed with zero mean and constant variance [(iind) $0\sigma^2$].

3.0 RESULT AND DISCUSSION

3.1 Result

The result for the egg production parameters of pure, main and reciprocal crosses of Normal feather, Naked neck and frizzle feather chicken genotypes are shown in table 2. There were no significant difference (P>0.05) in body weight at first egg (WAFE) for the main crosses of Na x E and na x E which are 1515.0 and 1541.11g, respectively. Significant differences were observed in main-cross, reciprocal cross, and the pure-line genotypes. There were significance differences (P<0.05) in age at first egg (AFE) among the various chicken genotypes. However, the F x F had the highest value of 160.75 days, while the reciprocal cross E x F had the least value of 144.33 days to first egg. There were no significant differences (P>0.05) in weight of first egg but were statistically higher (P<0.05) amongst the main and reciprocal crosses and least in the pure line with the range of 42.82-32.79g respectively. There were significance differences in egg number (EN) amongst the chicken genotypes. However, the main cross na x E had the highest egg number (29.00) among the genotypes. Significant differences were observed in main crosses and as well as the pure-line chicken genotypes investigated.

However, numerically the reciprocal and main crosses individuals had the highest values of the egg weight. There were significance differences in total egg weight (TEW) amongst the chicken genotypic groups respectively except the main cross na x E individual which had highest total egg number of 116.35g. There were also significant difference in hen day production amongst the chicken genotypes. However, at the reciprocal cross E x na had the highest hen day egg production of (70.36%). A similar trend was observed in the hen house production amongst the various chicken genotypes weight; WAFE- Weight of bird at first egg. The superior performance in egg number for the main and reciprocal genotypes could be as a result of selection, increased genetic profile and adequate nutrition given to them.

The highest number of egg production from the crossbred showed genetic introgression from their dam of origin influence, and were similar to the findings of Horst (1991) where higher egg production obtained for the first 100 days of laying in crossbred progenies of the indigenous kadaknath chicken with exotic New Hampshire and white leghorn. The result of this study were not in consistent with the report of sola-ojo and Ayorinde (2011) who obtained total egg number for 100 days of (51 and 53 vs.40) and hen day production of (50.87 and 52.47 vs. 46.05) than the local bred Fulani ecotype, though values from the study were below values obtained from other authors which could be attributed to environmental differences.

The current study was in line with the report of Omeje and Nwosu (1985) who noted that the main cross (GL x LC) and the reciprocal cross (LC x G) had higher egg production than the native chicken counterparts. The higher egg production in this study on na x E, Na x E and E x Na were also in agreement with the findings of Zaman *et al.,* (2004) where improvement in egg production was recorded in crossing indigenous naked neck male with an exotic laying strain female. Egg productions traits were also found to be significantly higher in cross bred between indigenous naked neck cocks and exotic hens (Haque and Howslider, 2000). The higher egg performance characteristics obtained in this study were in agreement with the findings of and Zaman *et al.,* (2004) were an improvement in egg production were obtained in crosses involving indigenous naked neck male and an exotic laying breed female. Significant differences were also observed in the main crosses of Na x E (41.43g), reciprocal E x F (40.92g) and lowest in pure line na x na (34.28g) respectively. The higher egg weight observed in the reciprocal crosses E x na (42.33g), E x Na (41.71g) and main cross of Na x E (41.43g) were due to genetic introgression and modifications which has been encountered on the exotic breeds.

This however, has led to a significant and concomitant improvement of egg weight trait. The lower egg weight of purebred naxna (34.28g) recorded in the study could be attributed to non-selection and dam of origin effect from the parent stock. The values obtained for egg weight in the current study is below

values reported by Sola-ojo and Ayorinde (2011) who reported that the crossbred of (DB x FE) and (FE x DB) had higher egg weight (51.45g and 51.35g). However, the higher egg weight recorded from the pure line and crossbred in this study were in agreement with Horst (1991) who had 39.75 to 47.09 for egg weight in crosses involving local Kadaknah birds and exotic birds, and their crossbred progenies. The results obtained in this study were also not in consonance with the findings of Oluwatosin (2010) who recorded high egg weight in Isa brown and Brown Noiler (56.20, vs 59.99g) and late dry (54.71 vs 56.88gm) season. This might be due to different experimental location and other environmental factors. The increase in egg weight values in this study could be attributed to larger egg size from the exotic dams and maternal influence which are similar to the report of Pandey *et al.* (1986).

Similarly, there were also significant effect of chicken genotype on specific gravity of eggs as reported by Jones *et al.* (2010), and Momoh *et al.* (2010). The current study is in agreement with the the reports of Jones *et al.* (2010) and Niranjan *et al.* (2008). The result obtained showed that the reciprocal crosses of E x Na (144.60 days), E x F (144.33 days) and pure line Na x Na (148.60 days) had lowest age at first egg, respectively. In terms of age and first egg lay, the lowest days of lay recorded for the reciprocal and pure line of Na x Na breeds indicated that they could be utilized for egg production. The higher number of days to first egg encountered by the pure line of F x F, main crosses of na x E, Na x E and reciprocal E x na showed that these genotypes will require higher quantity of feed to sustain this genotype for egg production. The age at first (AFE) from the current study were similar to values reported by Shamina (2011) who obtained the age at sexual maturity 182, 153, and 151 days in synthetic, white Plymouth Rock and Aseel x RIR crossbred birds.

Our findings were similar with the observation of Rahman (2005). The age at first egg in these findings were in consonance with the findings of Fayeye *et al.,* (2005). The lower age at first egg reported for reciprocal and pureline namely E xna, and E x F and Na x Na corresponded with the report of Singh *et al.,* (1992) where lower age at sexual maturity was reported for white leghorn chickens and their reciprocal crosses. The present findings do not agree with the ages at sexual maturity for indigenous birds whose values were above the present study as reported by Kantule (1992) who had 195 days. the lower values of 155-168 days were reported for the Nigeria local chickens (Mary, 2006). This variation is could be due to genetic divergence between indigenous and exotic chicken genotypes. The lowest age at sexual maturity in reciprocal and main crosses genotypes were as a result of gene flow from the local chickens which were in conformity with the report of Dunnington and Siegel (1991) crossing tends to moodify some measures of fitness including age at first egg, which was reported among the BW and WB reciprocals. The pure lines had low first egg weight because these hens have not undergone genetic selection and therefore maintain the inbred dams of origin effect.

The result on first egg weight in the crossbred was in conformity with the findings of Munisi *et al.* (2015) who reported (53.2g) for broiler stock, (43.49g) for black Australorp, 39.7g and 35.5g respectively for warm and cool ecological zones. Egg weight for indigenous chicken from this study were in line within the range of 37.4 and 49.5g reported by Katule (1998), and slightly higher than the weight of 36.8g obtained in Nigeria indigenous chicken and 42.5g for Tanzania indigenous chicken (Msoffe *et al.,* 2006). Egg weight from F x E and Na x E were within the values reported by Singh *et al.* (2009) for the same genotype. These variations are largely explained by the differences in the body weights among genetic stocks similar to what was earlier reported by Bharambe and Garud (2012).

The study also confirmed significance on the hen day production in the reciprocal crosses of En x N (70.36%), maincross of Na x E (65.61%) and reciprocal of E x F (64.09%) and lowest in pureline of na x na (50.05%).The superior performance exhibited by the reciprocal and main crosses over their pure line counterparts could be due to their genetic profile and the introgression of genes from the exotic dam which has impacted heavier body weight on these hybrids egg-type chickens. Higher hen housed egg production recorded for the reciprocal crosses of E x na, pure line F x F, reciprocal cross of E x Na and least for Na x Na were in the range of 70.15%, 51.495, 46.73% and 37.43% respectively. The pure line of F x F genotype excellent performance could be due to the effect of the frizzle single major gene action which has manifested in exploitation of the environmental factors under which the study was carried out.

Table 1: Egg production parameters of pure, main and reciprocal crosses of normal, naked neck and frizzle feather chicken genotypes

Parameters	Purebreds			Maincross			Reciprocal cross			SEM
	Na×Na	na×na	F×F	F×E	na×E	Na×E	E×na	E×Na	E×F	
WAFE (g)	1102.00^{cd}	1055.00^{d}	1140.00^{bcd}	1438.00^{ab}	1541.11^{a}	1515.00^{a}	1316.67^{a} ^{bcd}	1402.00^{abc}	1223.33^{a} ^{bcd}	40.14
AFE/days	148.60^{b} ^{c}	152.80^{ab} ^{c}	160.75^{a}	151.80^{a} ^{bc}	156.78^{ab}	152.75^{a} ^{bc}	150.33^{abc}	144.60^{c}	144.33^{c}	1.24
FEWT (g)	35.04	32.79	36.42	42.82	40.57	41.39	41.76	38.92	38.82	1.14
Egg number	15.78^{b}	17.13^{b}	15.25^{b}	17.88^{b}	29.00^{a}	18.56^{b}	15.63^{b}	18.00^{b}	17.86^{b}	0.65
Egg weight (g)	39.83^{c}	34.28^{e}	35.72^{d}	39.51^{c}	39.97^{b} ^{c}	41.43^{ab}	42.33^{a}	41.71^{a}	40.92^{abc}	0.18
Total. Egg Wt. (g)	577.73^{c} ^{d}	141.95^{e}	539.86^{d}	707.18^{b} ^{c}	1170.35^{a}	763.22^{b}	660.71^{bcd}	738.02^{b}	741.67^{b}	36.39
Hen-day (%)	55.85^{cd}	50.03^{de}	51.61^{de}	52.56^{cd} ^{e}	47.67^{e}	65.61^{ab}	70.36^{a}	59.20^{bc}	64.09^{ab}	0.88
Hen-house %	37.43^{c}	40.62^{c}	51.49^{b}	40.76^{c}	42.94^{b} ^{c}	37.27^{c}	70.15^{a}	46.73^{bc}	46.91^{bc}	1.09

^{abcde} Means within the rows with different superscripts differ significantly $P < 0.05$; SEM Standard error of the mean; AFE- Age of bird at first egg; FEWT- First egg weight; WAFE- Weight of bird at first egg

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

In conclusion, the findings of this study showed that there was high egg production characteristics among the main crossbred and reciprocals chicken genotypes bearing the plumage modifying genes.

4.2 Reccommendation

1. Efforts should be collated into improving local chickens for egg and body weight production characters to substitute them for the exotic breeds and commercial reliance.
2. The reciprocal crossbred should be made accessible to the local farmers and as such would help them exploit the genetic potentials of the breeds.

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EFFECT OF FEEDING GRADED LEVELS OF *COSTUS AFER* ON THE SEMEN QUALITY OF MALE RABBITS

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Target Audience: Animal scientist, Rabbit farmers, feed producers

Abstract
This study was carried out to evaluate the effect of feeding graded levels of Costus afer on the semen quality of male rabbits. Thirty-two (32) rabbits of mixed breeds were fed graded levels of Costus afer meal, mixed with concentrate (growers mash) for a period of Eight (8) weeks. Sixteen (16) male rabbits were sampled and divided into four (4) treatment groups T_1, T_2, T_3 and T_4 at 0%, 5%, 10% and 15% of Costus afer in a completely randomized design (CRD). Semen samples were collected with the aid of artificial vagina (AV) and analyzed in the laboratory. Results showed that semen volume was significantly affected by the experimental diet as the semen volume of the control (T_1) was higher than the other treatments. There was no significant difference ($P>0.05$) for motility, normal morphology, abnormal morphology, viscosity, dead cells, semen color, and P^h across all the treatment groups. There was an effect ($P<0.05$) of the experimental diet on the semen volume and sperm count of the rabbit bucks with no effect on other semen parameters. In conclusion, feeding Costus afer at 10% inclusion level is recommended as adequate for natural breeding or artificial insemination.
Key words*:* Rabbits, Buck, *Costus afer*, Semen, Artificial Vagina.

1.0 INTRODUCTION

Rabbits (*Oryctolagus coniculus*) as livestock animals are of utmost importance because they can be raised to obtain several livestock products such as: meat (high protein content), as pets, for their fur and for research purposes (Adams, 1976). Rabbits can be raised on two types of nutritional programs; hay and grain diets or commercial pre-balanced pellet rations. *Costus afer* is a relatively tall, unbranched tropical plant with a creeping rhizome. It is mostly found in shady and moist forests of West Africa and Tropical Africa (Iwu, 2009). Chemically, *Costus afer* contains Diosgenin, a vital raw material used as a precursor in the synthesis of a host of steroid drugs including sex hormones, corticosteroids, oral contraceptives and anabolic agents (Aweke et al., 2007).

The effect of *Costus afer* on reproduction in animals is not clearly defined although, studies have shown that leaf extract of *Costus afer* enhances expulsion of whole foetus at the 3rd trimester stage of pregnancy in guinea pigs (Okoli et al., 2003). The use of *Costus afer* in the synthesis of steroid drugs in male reproduction could have overwhelming implications as it could affect male sex hormones, which may eventually affect other reproductive characteristics. In the same vein, it could affect the semen characteristics as a result of hormonal interference.

Thus, this study was carried out to determine the effect of feeding graded levels of *Costus afer* on the semen quality of male rabbits and their eventual reproductive life.

2.0 MATERIALS AND METHODS

2.1 Experimental Site

This study was carried out at the Rabbit Unit Niger Delta University Teaching and Research Farm.

Processing of the Experimental Diet

The concentrate feed (growers mash) was procured from Jakee feeds in Yenagoa Bayelsa State. *Costus afer* was harvested at the Niger Delta University Teaching and Research Farm. The whole plant was harvested excluding the roots, chopped into bits, sun-dried, and then oven dried at 50^0c and milled, using a local milling machine. *Costus afer* was bagged, and spread on aluminium roofing sheaths, in a dry environment to avoid mould growth.

Experimental Animal and Management

Thirty-two rabbits of mixed sexes/breeds aged 4-5 months, with an average weight of 1.4kg-1.7kg were randomly selected into four treatment groups labelled (T_1, T_2, T_3 and T_4) in a completely randomized design (CRD). Sixteen (16) male rabbits were used for semen collection. The rabbits were pre-conditioned for a period of one week, provided with clean water and fed *ad libitum*. The rabbits were housed in simple conventional wooden hutches (4) with each hutch having four compartments. Four-hundred grams (400g) of growers mash was fed to the rabbits across all treatment groups whereas, *Costus afer* was included in the rabbit diet at 5%, 10% and 15% respectively in T_2, T_3 and T_4.

Construction of Artificial Vagina (AV) and Semen Collection

Construction of artificial vagina for semen collection was carried out using a polyvinyl chloride (PVC) tube at 3.5cm. A rigid plumbing hose with a diameter of 2.7cm representing the smaller tube was inserted into one end of the larger tube (PVC) and allowed up to 6.0cm forming the main part of the artificial vagina. A condom was cut, and used as a liner held at 4.5cm from the bottom and pulled through the narrow of the bottom tube and held with a rubber band 5.0cm in diameter (Ajuogu and Ajayi 2010). Glycerol antifreeze and lubricator (5ml) was poured into the liner and the tube till it is 2/3 filled. The AV was warmed at 40^0c-60^0c in a container prior to semen collection. A non-cyclic doe was used as teaser for the rabbit bucks to collect semen sample. The ejaculate collected from the collecting tube was read directly on the last tube to determine semen volume whereas, other parameters were determined in the laboratory.

Data Analysis

All data collected were analyzed using the analysis of variance (ANOVA) method.

3.0 RESULTS AND DISCUSSION

3.1 Results

The result of the proximate composition of *Costus afer* is presented in Table 1. Moisture content is 14.64%, Ash 15.83%, Crude fibre 58.78%, Fat 0%, Crude protein 10.73% and Carbohydrate 0.38%.

Tables 1: Proximate composition of Costus afer

Constituents	Percentage (%)
Moisture content	14.64
Ash	15.83
Fat	-
Crude fibre	58.78
Crude protein	10.37
Carbohydrate	0.38

The result of the proximate analysis of the control diet is presented in Table 2. Crude protein is 15.10%, Energy is 2115kcal/kg, Calcium is 1.00%, and Phosphorus is 0.43%, Fiber 5.78 %, Lysine 0.90%, Methionine 0.41%, and Fat 3.3%.

Table 2: Proximate composition of the control diet

Constituents	**Composition (%)**
Crude Protein	**15.10**
Energy	**2115kcal/kg**
Calcium	**1.00**
Phosphorus	**0.43**
Fibre	**5.78**
Methionine	**0.41**
Fat	**3.34**

Results on the influence of the treatment on the semen quality of the rabbits are shown in Table 3. There was no significant difference (P>0.05) on the color, ph, viscosity, and motility of the semen across all treatments. The ph remained constant at 8.00 and the viscosity normal across treatment groups. Semen volume for T_1 was higher (P>0.05) than T_2, T_3, and T_4. There was a significant difference (P<0.05) for sperm count in all the treatment groups, with T_3 (135.00±15.00) significantly higher (P>0.05) than T_1 (45.00±2.50), T_2 (87.50±12.50), and T_4 (55.50±15.00)

Table 3: Influence of *Costus afer* on the Semen quality of male rabbits.

Parameters	**T_1 0%**	**T_2 5%**	**T_3 10%**	**T_4 15%**	**significant diff.**
Appearance	**Milky**	**Milky**	**Milky**	**Milky**	**NS**
P^h	**8.00±0.00**	**8.00±0.00**	**8.00±0.00**	**8.00±0.00**	**NS**
Semen volume	**1.75±0.25**	**0.10±0.00**	**0.15±0.07**	**0.10±0.00**	**++**
Viscosity	**Normal**	**Normal**	**Normal**	**Normal**	**NS**
Actively motile	**47.50±2.75**	**62.50±2.50**	**77.50±2.50**	**62.5±7.50**	**++**
Sperm count	**45.00±2.5.0**	**87.50±12.5**	**135±15.00**	**55.00±15.00**	**++**

Means ± S.E.M (standard error of the mean) ++ significant at P>0.05 NS= Not significant.

Results on the effect of treatment on the morphological defects of sperm cells are presented in table 4. Morphological defects observed; Abnormal morphology, Normal Morphology, Dead cells and sluggishly motile, showed no significant difference (P>0.05) across all the treatments. For normal morphology, T_1 =80.00±4.20, T_2 = 72.50±1.80, T_3 = 80.00±0.00 and T_4 =72.50± 7.5. For abnormal morphology, T_1 =50.00±3.00, T_2 =27.50±2.50, T_3 =20.00±0.00, and T_4 =30.00±10.00

Table 4: Effect of treatment on the morphological defect of rabbit semen

Parameters	T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)	Significant diff.
Normal morphology	**80.00±4.20**	**72.50±1.80**	**80.00±0.00**	**72.50± 7.50**	**NS**
Abnormal morphology	**50.00±3.00**	**27.50±2.50**	**20.00±0.00**	**30.00±10.00**	**NS**
Sluggishly motile	**7.50±3.00**	**12.50±2.50**	**5.00±0.00**	**12.50±2.50**	**NS**

SEM (standard error of the mean) ++ significant at P>0.05 NS= Not significant.

3.2. Discussion

In reproduction, the composite quality of the semen ejaculate by an animal plays a vital role for a successful conception. The quality of sperm and the libido is always uniform throughout the life span of an animal but can be altered by several factors such as nutrition, age, health, and environment (Tugun and Egbunike, 2006). Rabbit semen with a uniform appearance is most desirable and weighed to be of good quality (Onuoha 2020). Normal semen should be white or white colour-related, homogeneous and opalescent. The semen color in this study was generally milky across all treatments. This implies that the test diet did not affect (P>0.05) the semen color of the rabbit bucks. The semen P^h was uniform at 8.00±0.00 between the treatments. This shows the rabbit semen has a normal ph value and can be used for breeding programs. Semen volume increased as treatment diet increased showing a remarkable difference (P<0.05) across the various treatments.

There is an obvious drop in the semen volume as the test diet increased across the treatments. The semen volume of the control diet (T_1) proved to be higher ((P<0.05) 1.75±0.25 than the other treatments T_2, T_3 and T_4. It was observed that animals with higher inclusion of the *Costus afer* had lower libido. It was also observed that the viscosity of the semen was normal as the inclusion of the test diet increased. This means the treatment diet did not influence the viscosity of the semen at any level of inclusion of the test diet. Oyeyemi and Okeridan (2007) posited that adequate nutrition with high percentage of protein enhances the motility and concentration of spermatozoa. Feeding graded levels of *Costus afer* meal had no significant (P>0.05) influence on the motility of the semen collected and subjected to laboratory analysis after the feeding trial.

This observation is as a result of the low percentage of protein (10.37%) in the test diet as shown in Table 1. This further strengthens the assertion made by Oyeyemi and Okeridan (2007), that high percentage of protein enhances the motility of spermatozoa. Most proteins are denatured by heat treatment and this might largely be the contributing factor to the low percentage of protein observed from the proximate analysis of the *Costus afer*. Concentration of the sperm cells reduced as the percentage of the test diet increased across treatments. This means the test diet influenced (P<0.05) the concentration of sperm cells in the rabbit semen. This reduction in the concentration of sperm cells is attributed to the phytochemical constituent of *Costus afer* which contains flavonoids that chelate metals such as iron and zinc and reduce the absorption of these nutrients. Feeding graded levels of *Costus afer* had no significant influence (P>0.05) on the normal morphology of the rabbit semen. Abnormal morphology in the control diet (T_1) was higher (P>0.05) than the other treatment groups T_2, T_3, and T_4, but the test diet did not influence the abnormal morphology of the semen.

4.0 CONCLUSION AND RECOMMENDATION

1. In conclusion, one of the main purposes for feeding is to obtain good quality semen that is fertile. The *Costus afer* meal fed at graded levels affected the reproductive life of the male rabbits.
2. The current study revealed that male rabbits fed graded levels of *Costus afer* found it difficult to ejaculate on mounting the teaser rabbits during semen collection.
3. Based on the results from this study, 10% inclusion level of *Costus afer* is recommended in male rabbit diet for adequate semen production, for artificial insemination or natural breeding.

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POLITICAL INFLUENCE AND HUMAN RESOURCE MANAGEMENT (HRM) IN BAYELSA STATE CIVIL SERVICE 2015-2024

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Abstract
Bayelsa State Civil Service has been confronted with several problems which militate against the effective performance of its functions. One of such problems is the politicization of human resource management (HRM) in terms of recruitment, selection and placement, compensation, and promotion/demotion of civil servants. Recruitment practices based on patronage have created redundancy problems in the civil service in Bayelsa State, where stern measures like termination of appointment and suspension of staff are rarely contemplated. In this scenario, those at the echelon of HRM found it very difficult to perform optimally in a politicized working environment. It is against this backdrop that this study examined the influence of politics on human resource management (HRM) in Bayelsa State Civil Service from 2015-2024. This study was anchored on Elite Theory. The study adopted a descriptive survey design. Due to the largeness of the population, the Taro Yamane formula was used to determine the sample size (382) for the study. Data for this study were collected basically from primary sources and complemented with secondary data. Primary data were collected through self-made questionnaires, personal observation, while secondary data were collected from textbooks, magazines and journals. Descriptive statistics (Mean and Standard Deviation) were used to analyze the data to provide statistical basis for answering the research questions, while a t-test was used to test the hypotheses at a 0.05 level of significance. The study revealed that politics has a negative influence on civil servant's compensation, employee recruitment, promotion and demotion of staff in Human Resource Management in Bayelsa State. Based on the findings, the study recommended, among other things, that Civil Service recruitment, compensation, promotion and demotion of staff in Human Resource Management in Bayelsa State should be done without compromise in order to foster maximum output from the civil servants.
Key Words: Politics, Recruitment, Promotion, compensation, Promotion

1.0 INTRODUCTION

1.1 Background of the study

The influence of politics on the management of public organizations is a major concern of both managers and researchers in various fields, such as political science, sociology, law, and administrative sciences. The challenges of public sector management, affected by the external political influence, require a paradigm shift to provide balance to this relationship. These changes are, in fact, the result of unresolved issues such as the political impact on decision-making processes within public institutions or the relationship of interdependence between the degree of political involvement and professionalization of institutions. The government formulates policies from time to time relating to the management of human resources. These policies have to be adhered to by all the sectors of the organizations which are covered by these policies. This process makes human resource management (HRM) an essential task for every organization.

Human Resource is considered as the most vital, most valuable, most complicated, and the least predictable organizational resources. This is because it is the human resource that processes the other resources of the organization so that the goals and objectives of the organization are achieved. Human resource is defined as skills, knowledge, experiences of a population, which could be used in producing goods and services (Ololube, 2019). Civil servants are essential HR that the government cannot ignore. Civil service is a collective term for a sector of government composed mainly of career civil servants hired on professional merit rather than appointed or elected, whose institutional tenure typically survives transitions of political leadership. A civil servant is a person employed in the public sector by a government department or agency or public sector undertaking to provide essential services to the public. The success of every government depends mainly on the extent to which political office holder is able to galvanize the civil servants in the formulation and implementation of policies to enhance the standard of living of the citizenry. This demonstrates that there is a water-tied relationship between the civil service and politics. Therefore, the management of human resources (HR) is very essential for the sustainability of the state.

Politics is one of the major factors influencing the business of HRM in Bayelsa State. Politics is seen as a process of making an authoritative decision for the state. Okoli, (2003) defined politics as the management of statecraft. The process of making decisions associated with HRM is often determined by politics. In this case, the political leaders determine the number of resources to be used in the formulation and

implementation of policies in the state. The most pronounced influence of politics in HRM is in recruitment, compensation, promotion, labour laws, discipline, demotion, and staff development. Politics is felt in all socio-economic sectors. In this context, political activity, along with social and economic activities, strongly influences the individuals, forcing a certain pace and particular direction of HRM in civil service.

Bayelsa State civil service has been confronted with several problems which militate against the effective performance of their functions. One of such problems is the politicization of HRM in terms of recruitment, selection and placement, compensation, promotion and demotion of civil servants. Recruitment practices based on patronage have created problems of redundancy in the civil service in Nigeria where stern measures like termination of appointment and suspension of staff are rarely contemplated. In this scenario, those who are at the echelon of HRM found very difficult to perform optimally in a politicized working environment.

Objectives of the Study

The study aims to investigate the influence of politics on Human Resource Management in civil service in Bayelsa State. Specifically, the objectives of this study are:

1. To determine the influence of politics on civil servant's compensation in Human Resource Management in Bayelsa State.
2. To determine the influence of politics on employee' recruitment in Human Resource Management in Bayelsa State.
3. To determine the influence of politics on promotion and demotion of staff in Human Resource Management in Bayelsa State

Research Questions

1. Does political influence affect civil servants' compensation in Human Resource Management in Bayelsa State?∧
2. Does politics influence employee recruitment processes in Human Resource Management in Bayelsa State?
3. Does politics influence the promotion and demotion of staff in Human Resource Management in Bayelsa State?

Research Hypotheses

1. H_1: Politics has no significant influence on civil servants' compensation in Human Resource Management in Bayelsa State.
2. H_2: Politics has no significant influence on employee recruitment in Human Resource Management in Bayelsa State.
3. H_3: Politics has no significant influence on the promotion and demotion of staff in Human Resource Management in Bayelsa State.

2.0 Theoretical Framework

This study is anchored on Elite Theory. This theory is traceable to Pareto's law of circulation of Elite (1968). Pareto says that people are always governed by elites except short period of time (Dellican, 2019). To him, history of men is the history of the continuous replacement of certain elites as one ascends another decline, such is the real phenomenon, though to us it may often appear under another form (Delican, 2019). The theory posits that a small minority, consisting of members of the economic elite and policy-planning networks, holds the most power and that this power is independent of democratic elections.

Pareto further classified social classes by taking elites as a stickyard. The Elites represent the higher stratum, the others, namely non-elites are thought as the lower stratum. He further emphasizes and divides it into subgroups, because for him, there is no one elite stratum. There are various strata in it and all of them constitute the elite stratum. The main strata in elite stratum are; (a) governing elite that consists of rest of the individuals who directly or indirectly have a considerable role in government, (b) non-governing elite that consists of rest in the elite stratum and, (c) political elite that effectively and particularly, exercise political power (Delican, 2019).

2.0 METHODOLOGY

The study employed a descriptive survey design, which is appropriate since the researcher aims to examine the challenges commonly associated with the Bayelsa State Civil Service Commission, particularly in the areas of political influence on human resource management. The Bayelsa civil service has about 55000 employees (Agency Report, 2020). Therefore, the study adopted Taro Yamene formula to determine the sample size of 382 staff from the Bayelsa State Civil Service. Thereafter, the study adopted random sampling technique to select 382 employees in Bayelsa State civil service for the study. The instrument for data collection was a self-developed questionnaire titled; 'Politics and Human Resource management in Bayelsa State Questionnaire' *(PHRMCRSQ).*

The PHRMCRSQ based on a four-rating scale instrument items that examines the influence of Politics on Human Resource Management among the civil servants in the Bayelsa State. Data for this study were gathered through primary and secondary sources which include, self-made questionnaires, personal observation, text books materials, magazines and journals. Three hundred and eighty-two (382) copies of the instrument were administered to the respondents in various Government parastatals in the State based on

the different Senatorial Districts but only 283 representing (74.08%) 96.3% of the questionnaires were validity retrieved for the study. Descriptive statistics (Mean and Standard Deviation) were used to analyse the data, while t-test was used to test the stated null hypotheses at 0.05 level of significance.

3.0 RESULTS ANS DISCUSSIONS

3.1 Results

This session presents and describes the result of this study according to the research questions and hypotheses of the study.

Research Question One: does politics influence civil servants' compensation in Human Resource Management in Bayelsa State?

Table 3.1: Descriptive statistics of mean and standard deviations of responses of political influence on civil servants' compensation in Human Resource Management in Bayelsa State?
N=382, Criterion=2.50

S/N	Item Statement	VHE	HE	LE	VLE	Mean	Std.	Remark
1.	Workers' salaries are influenced politically.	36	161	69	116	2.31	1.01	**Low Extent**
2.	Incentives are provided to workers based on the good rapport individual have with employer	148	150	60	24	3.10	0.89	**High Extent**
3.	Benefits are provided on the ground of politics	126	206	41	9	3.18	0.71	**High Extent**
4.	Workers are only rewarded by instruction from Godfathers	163	152	50	17	3.21	0.83	**High Extent**
5.	Workers' allowances are paid if only the employers are too pleased with the worker	179	158	10	35	3.26	0.89	**High Extent**
6	There is no health insurance for workers except instructed by Godfathers	146	183	32	21	3.19	0.81	**High Extent**
7	Payment of Pension or gratuity are mostly done on political basis	149	123	94	16	3.06	0.90	**High Extent**
8	Housing allowances are paid on political basis	155	154	41	32	3.13	0.91	**High Extent**
	Grand Mean					**3.05**	**0.87**	**High Extent**

Table 3.1 indicated the extent politics influence civil servant's compensation in Human Resource Management in Bayelsa State. With the grand mean of 3.05 and standard deviation of 0.87. It indicates that politics has influence on civil servants' compensation to a high extent, such that incentives and benefits are provided to workers based on the good rapport individual have with employer. workers are only rewarded by instruction from Godfathers, workers' allowances are paid if only the employers are too pleased with the workers, payment of pension or gratuity, housing allowances are paid on political basis, it was also noted that there is no health insurance for workers except instructed by Godfathers. However, the mean of 2.31, showed that the civil servants disagreed that their salaries are politically influenced.

Research Question Two: Does politics influences employee recruitment processes in Human Resource Management in Bayelsa State?

Table 3.2: Descriptive statistics of mean and standard deviations of responses on political influence on employee recruitment processes in Human Resource Management in Bayelsa State?
N = 382, Criterion=2.50

S/N	Item Statement	VHE	HE	LE	VLE	Mean	Std.	Remark
9	Recruitment of employees is based on God-fatherism	179	136	67	--	3.29	0.75	**High Extent**
10	If you don't know anyone there is no employee for you	156	160	31	35	3.14	0.92	**High Extent**
11	The organisation lacks sufficient man-power because of too much politics	195	141	35	11	3.36	0.77	**High Extent**
12	We would have had a stronger workforce if not for favouritism	217	136	18	11	3.46	0.72	**High Extent**

13	Too many qualified prospective staff are outside not employed because of favouritism	132	`78	37	35	3.07	0.90	**High Extent**
14	Employment is not based on merit and qualification	189	161	17	15	3.37	0.75	**High Extent**
15	Somebody must speak for you before you will be accepted	93	271	--	18	3.15	0.64	**High Extent**
	Grand Mean					**3.26**	**0.78**	**High Extent**

Table 3.2 showed the extent politics influence employee' recruitment in Human Resource Management in Bayelsa State. With grand mean of 3.26 and standard deviation of 0.78, result on the Table showed that politics influence employee' recruitment in Human Resource Management in Bayelsa State to a high extent, in that recruitment of employees is based on God-fatherism. Employment is not based on merit and qualification, the table showed that the resultant effect of this is the organizations lacking sufficient man- power and insufficient/weak workforce, with too many qualified prospective staff outside not employed because of favouritism.

Research Question Three: does politics influences the promotion and demotion of staff in Human Resource Management in Bayelsa State?

N=382, Criterion=2.50

Table 3.3: Descriptive statistics of mean and standard deviations of responses on political influence on the promotion and demotion of staff in Human Resource Management in Bayelsa State?

S/N	Item Statement	VHE	HE	LE	VLE	Mean	Std.	Remark
21	You are entitled to promotion only if you are in good terms with the employer	240	123	--	19	3.53	0.74	**High Extent**
22	Employers promote only those recommended by God-fathers.	228	106	26	22	3.41	0.85	**High Extent**
23	Promotion is based on years of service of employees	22	69	11	280	1.56	0.98	**High Extent**
24	Promotion is not based on merit but employers' recommendation	185	144	38	15	3.31	0.81	**High Extent**
25	There is too much politics in the promotion process	146	183	32	21	3.19	0.81	**High Extent**
26	Promotion is highly politically-influenced	155	154	41	32	3.13	0.91	**High Extent**
	Grand Mean					**3.02**	**0.85**	**High Extent**

Table 3.3 showed the extent politics influence promotion and demotion of staff in Human Resource Management in Bayelsa State. Grand mean of 3.02 and standard deviation of 0.85 showed that politics to a high extent, influences promotion and demotion of staff in Human Resource Management in Bayelsa State, in that employees are entitled to promotion only if they are in good terms with the employer, promotion is based on recommendation by God-fathers, promotion is not based on merit but employers' recommendation.

Hypotheses

Ho_1: Politics has no significant influence on civil servants' compensation in Human Resource Management in Bayelsa State.

Table 3.4: Summary of t-test on significant of pollical influence on civil servants' compensation in Human Resource Management in Bayelsa State

Variable	N	Mean	Std	t-test	Sig.	Remark
Compensation	382	3.05	0.87	0.027	0.978	**Rejected**

Table 3.4 shows that the result of Hypothesis One showed a mean score of **3.05 (SD = 0.87)**, above the criterion mean of 2.50, indicating that compensation is politically influenced. The t-test analysis further revealed a value of **t = 0.027, p = 0.978**, which supports rejecting the null hypothesis. This implies that political

patronage and favoritism significantly shape the distribution of incentives, allowances, pensions, and benefits. This finding aligns with Murphy (2011), who argued that compensation policies in public institutions are often politicized rather than guided by merit.

Table 3.5: Summary of t-test on Politics has no significant influence on employee recruitment in Human Resource Management in Bayelsa State.

Variable	N	Mean	Std	t-test	Sig.	Remark
Recruitment	382	3.26	0.78	0.905	0.366	Rejected

Table 3.5 shows Hypothesis Two, results indicated a mean of **3.26 (SD = 0.78)**, suggesting that recruitment in Bayelsa State Civil Service is heavily influenced by political interference, such as godfatherism and favoritism since the calculated mean is greater than the criterion mean. The t-test produced a value of **t = 0.905, p = 0.366**, leading to rejection of the null hypothesis. This outcome highlights that political interference overrides merit-based selection, which is consistent with Onukwu (2015), who observed that recruitment processes in Nigerian institutions are often shaped by government influence.

Ho_3: Politics has no significant influence on the promotion and demotion of staff in Human Resource Management in Bayelsa State.

Table 3.6: Summary of t-test on significant of Politics on promotion and demotion of staff in Human Resource Management in Bayelsa State.

Variable	N	Mean	Std	t-test	Sig.	Remark
Promotion/Demotion	382	3.02	0.85	0.083	0.934	Rejected

Table 3.6 shows that result of Hypothesis Three yielded a mean score of **3.02 (SD = 0.85)**, showing that promotion and demotion are significantly influenced by politics. The t-test result was **t = 0.083, p = 0.934**, confirming the rejection of the null hypothesis as the calculated mean was greater than the criterion mean. This implies that promotions are often based on loyalty and political recommendations rather than qualifications or years of service. This finding aligns with Chitescua and Lixandrub (2016), who stressed the significant role of political leaders in influencing civil service activities, particularly staff promotion and demotion.

3.2 Discussion of Findings

Research Question One examined whether politics influences civil servant's compensation in Human Resource Management in Bayelsa State. The findings revealed that compensation is politically influenced It also shows that there was no significant difference between the mean responses of the male and female civil servants on the influence of politics on workers' compensation in Human Resource Management in Bayelsa State. Hakim (2020) posit that compensation plays an important role because in general, employees want balanced compensation from the company, also expect guaranteed welfare for themselves and also for their families while they are still actively working and when they reach retirement. With a balanced compensation, employee welfare will be met and it is hoped that employees will get satisfaction so that the organizational commitment of employees to the organization will be high.

Research Question Two examined the political influence on employee' recruitment in Human Resource Management in Bayelsa State. The findings of the study revealed that politics, influences promotion and demotion of staff in Human Resource Management in Bayelsa State to a high extent, in that employees are entitled to promotion only if they are in good terms with the employer. Promotion is based on recommendation by God-fathers and not based on merit. Secondly, there is no significant difference between the mean responses of the male and female civil servants on the influence of politics and staff recruitment in Human Resource Management in Bayelsa State. The above position is in conformity with the view of Onukwu (2015) which revealed that recruitments in the Nigeria tertiaries institutions were being influence by the government in power.

Research Question three examined the extent politics influence promotion and demotion of staff in Human Resource Management in Bayelsa State. The response of the respondents revealed that there was no significant difference between the mean responses of the male and female civil servants on the influence of politics and staff promotion/demotion in Human Resource Management in Bayelsa State. The findings further revealed that promotion and demotion are significantly influenced by politics. These findings align with the work of Chitescua and Lixandrub (2016), who noted that political leaders significantly influence

civil service activities, particularly in the recruitment, promotion, and demotion of staff within state-owned tertiary institutions in Nigeria.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The study investigated the 'Influence of Politics on Human Resource Management in Bayelsa State' civil service, with specific, objectives ranging from determining the influence of politics on civil servant's compensation, employee' recruitment, employee' training and development in Human Resource Management in Bayelsa State. It was found that politics has influence on civil servant's compensation, employee' recruitment, and promotion and demotion of staff in Human Resource Management in Bayelsa State to a large extent.

4.2 Recommendation

Based on the findings of the study, study recommended that;

I. Civil servants in Human Resource Management in Bayelsa State should be adequately compensated as stipulated in the civil service law, in order to ensure efficient and effective output from the employees in the civil service in Bayelsa.
II. Employment in Human Resource Management in the Bayelsa State should be done without the interference of the government in order to get the best and most suitable man-power needed in the Civil Service.
III. Promotion and demotion of staff in Human Resource Management in Bayelsa State should be done without compromise in order to encourage maximum performance from the workers.

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OWNERSHIP STRUCTURE AND EARNINGS MANAGEMENT OF LISTED PHARMACEUTICAL COMPANIES IN NIGERIA

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Abstract
This study examined the relationship between ownership structure and earnings management of listed pharmaceutical companies in Nigeria. Specifically, the objectives of this study were to investigate the relationship between managerial ownership, institutional ownership and block holder ownership (used as measures of ownership structure) on one hand, and discretionary accruals (proxy of earnings management) on the other hand. Using multiple regression analysis with the aid of STATA 16 output as a tool of data analysis, relevant data was obtained from the 2019 to 2023 annual reports of three listed pharmaceutical companies selected as sample size of this study (out of a population size of seven listed pharmaceutical companies). Results of this study indicated that while managerial ownership and institutional ownership have a negative and significant relationship with earnings management, the relationship between block holder ownership and earnings management is positive and significant. Thus, it was concluded that ownership structure has negative and significant correlation with earnings management of listed pharmaceutical companies in Nigeria. On the basis of the findings of this study, pharmaceutical companies are advised to increase both managerial ownership and institutional ownership while at the same time, reduce block holder ownership in order to reduce earnings management tendencies among these companies.
Keywords: Ownership structure, Block holder ownership, Managerial ownership, Institutional ownership, Earnings management.

1.0 INTRODUCTION

Over the years, especially since the collapse of several notable firms such as Enron, WorldCom, Ranx Xerox, Global Crossing, Cadbury Nig. Plc, Intercontinental Bank Nig., among others, the credibility and reliability of the primary objective of external financial reporting has been questioned by many users of financial reports, and that is because of the seemingly indiscriminate way managers and directors of companies tend to manage and report their earnings, an act that has adversely affected the information content of their financial reports. Ekpulu and Omole (2018) opine that due to the surreptitious activities of directors and managers (who act as agents of the principal, the shareholders) who tend to manipulate financial statements by using judgment in financial reporting and shaping financial transactions so as to give a wrong impression of the financial status of their organizations, thereby misinforming concerned stakeholders/ shareholders about the true state of affairs of their businesses, such activities, summarily described as earnings management practices, have been at the centre of current debates, threatening the credibility of both the accounting and auditing functions.

Although Ganiyu and Araoye (2022) maintain that earnings management can be considered legal if the reported earnings are adjusted in line with GAAP guidelines, it can easily turn into a fraudulent activity if it does not comply with the GAAP guidelines and accounting standards. Going further, Ganiyu and Araoye (2022) assert that in as much as earnings management could be a way to manipulate a firm's disclosed financial statement and paint a wrong picture of the true and fair view of the business, ownership structure has been identified as one of the ways by which aggressive earnings management tendencies can be monitored and controlled among companies. In their own opinion, Ali-Momoh and Ahmed (2022) report that the ownership structure of a company could be of critical importance to the effectiveness of oversight mechanisms employed to reduce the likelihood of earnings management practices. As such, it has been argued that an effective mechanism to constrain fraudulent financial reporting is the development of an appropriate ownership structure (Azzoz & Khamees, 2016).

Taking into cognizance the seemingly important role that ownership structure plays in effectively reducing the probability of earnings management practices, Bawa and Isah (2018) argue that developing an appropriate ownership structure is an effective way of reducing fraudulent financial reporting. In light of the importance of ownership structure in checkmating

earnings management practices, Ali-Momoh and Ahmed (2022) suggest that it has become expedient for companies to set up mechanisms and structures that would not only improve or maintain the practice of reporting earnings quality, but also ensure that manipulations of earnings are done within the ambit of generally acceptable accounting practices, and one way to achieve these objectives is through ownership structure (a component of corporate governance). Mwangi and Nasieku (2022) therefore, indicate that with strong ownership structure, the loopholes exploited by top management to manipulate earnings are bound to be effectively sealed and eventually translate to reliable and quality financial reporting.

1.1 Statement of the Problem

Despite the so many improvements that have greeted the practice of the accounting profession via the advancements of accounting standards, which have given rise to improvements in global financial reporting standards, the cases of earnings management seem not to be abating in the slightest. Even in developed economies, accounting manipulations continue to increase by the day, a situation that has led to decline in the market value of companies, as well as massive decline of shareholders' wealth (Kizil & Kaşbaşı, 2018). Developing economies such as Nigeria deemed to still be at infant stages of capital market development and adoption of international standards have also reported numerous cases of earnings manipulation such as the cases of Oceanic Bank, Intercontinental Bank, Cadbury Plc among others.

A report published by Mwangi and Nasieku (2022), as a result of several cases of accounting manipulations being observed among corporate organizations in Kenya, raised questions about the ability or otherwise of corporate boards and auditors in the wake of glaring misstatements of financial reports with respect to reliable and credible financial reporting. Undoubtedly, there are intense cases of earnings management globally that have seen shareholders lose massively. Thus, strong corporate governance structure has been recommended in curbing the rising cases of earnings management, particularly ownership structure has been cited as a critical factor in fostering accountability and transparency in financial reporting (Mwangi & Nasieku, 2022). This study therefore, is aimed at examining the relationship that exists between ownership structure and earnings management.

Notwithstanding that there have been quite a good number of studies highlighting the relationship between ownership structure and earnings management both within and outside Nigeria, a consensus agreement remains elusive. In general, the contradictory results and lack of any distinct and unifying conclusions about the impact of ownership structure on earnings management have made the need for additional research more urgent. Empirical research on the topic of ownership structure and reported earnings management has produced conflicting findings and has not definitively established whether ownership structure has any significant relationship with or impact on earnings management (Farouk & Bashir, 2017). In addition to this, in as much as it has been established that the issue of ownership structure and earnings management has been comprehensively discussed by many Nigerian researchers and authors (Abba et al., 2023; Osibuamhe & Ogwumike, 2023; Musa et al., 2023; Shittu et al., 2022; Ali-Momoh & Ahmed, 2022; Bingilar & Bariweni, 2020; Aondoakaa & Joseph, 2020), to the best of the knowledge of this researcher, only very little study has been conducted in relation to ownership structure and earnings management in pharmaceutical companies in Nigeria, with the exception of Abba et al. 2023.

Due to the highlighted gap in knowledge and literature, this study empirically examines how ownership structure (proxy by managerial ownership, institutional ownership and block holder ownership) correlates with earnings management (proxy by discretionary accruals) of publicly listed pharmaceutical companies in the Nigerian Exchange Group (NXG) between 2019 and 2023. It is on this premise that hypotheses are subsequently expressed and formulated.

2.0 LITERATURE REVIEW

2.1 Conceptual Review

Ownership Structure

According to Kirimi et al. (2022), the concept of ownership carries varying interpretations depending on the angle one is looking at it from. From a legal perspective, owning a business entails the rights to enjoy the benefits of the business and make decisions concerning its operations. These rights include entitlement to the company's income, the surplus value in the event of a sale, the authority to determine the business's functioning, and the ability to sell all or a portion of the business's value (Akinleye & Adebusoye, 2023).

In the opinion of Lyndon and Yalah (2022), the ownership structure is an internal control component that refers to the manner in which representative rights reallocate company capital in one or more individuals or legal entities. Ownership structure is a key element used in the determination of good corporate governance process in a firm. Onuora et al. (2022) note that ownership structure can be regarded as a crucial aspect of internal control that deals with how a company's capital is reallocated in several entities. To Abdul et al. (2021), ownership structure is seen as a part of the ordinary shares of a company held by different parties such as promoters of a business, private corporations, public corporations, individual

and foreign investors. In a similar vein, Alhassan and Mamuda (2020) view ownership structure as a proportion of the ordinary shares of a company held by different parties. These parties are known as the owners of the corporation (otherwise called shareholders), hence ownership structure in one organization differs from that in another organization as a result of differences in either the legal or environmental stability, regulations as well as economy of scale among others. The opinion of Alhaji and Sani (2018) is that ownership structure refers to the percentage of a company's shares owned by a certain number of institutions, individuals or families. On the part of Ironkwe and Emefe (2019), ownership structure mechanism of a firm could have an effective role in reducing the likelihood of earnings management practices. Illustrating the importance of ownership structure, they opined that it plays an important role in corporate dividend policies and minimizing agency problems. According to Alhassan and Mamuda (2020), ownership structure is portrayed by the equity distribution with respect to capital, votes, and the equity owners' identity.

Omorokunwa and Idubor (2020) report that ownership structure, as a corporate governance instrument in facilitating improved efficiency of a company, has been generally believed to have affected company's performance. Affan et al. (2017) view ownership structure as a core measure of corporate governance that drives the productivity or otherwise of an organisation. A wider spread ownership structure could enhance firm profitability. Edirin (2018) points out that ownership structure is deemed significant because the remunerations of management and other staff is mostly a function or outcome of the decisions of the owners of the firm, whereas, staff remunerations significantly influence the productivity and performance of a given workforce, hence it is seen as the classes or group of owners that exercise control over activities of a firm. According to Affan et al. (2017), ownership structure is described by the distribution of equity with respect to votes, capital, and also by the equity owners' identity. It is widely believed by many economic analysts that the type of ownership can also affect corporate performance, control methods of manages as well as the impact of each type of ownership on financial reporting quality and hence, the audit quality (Daniel, Nuraddeen & Ahmed, 2021).

In furtherance to the issue of ownership structure in Nigeria, Ekpulu and Omoye (2018) cited in Ogiriki and Adole (2023) affirm that ownership structure can be categorized into the following: family ownership, institutional ownership, block holder ownership, foreign ownership, managerial ownership, individual ownership, government ownership and controlling ownership. However, in relation to the pharmaceutical companies that are quoted in the Nigerian Exchange Group as at 2024, the forms of ownership structure prevalent are managerial ownership, institutional ownership and block holder ownership. Therefore, the focus of this study is on the forms of ownership structure that are most common in this sector.

i. Managerial Ownership

Meilita and Rokhmawati (2017), in the simplest terms, opine that managerial ownership occurs when the management of the company owns shares in the company, it is measured as the sum of managerial ownership shares divided by the total outstanding shares. Ogiriki and Adole (2023) submit that managerial ownership shows the ownership portion or stake in a firm that is owned by managers, and it is not only intended to enlarge the capital of the company but also to serve as inducements to managers to support managers' interests with the interests and needs of the company. Meanwhile, the perspective of Omorokunwa and Idubor (2020) on this subject matter is that managerial ownership is represented by natural logarithm of equity shares held by managers as shareholders of the firm, hence it refers to an ownership fraction or stake in a firm that is held by managers. Edirin (2018) views managerial ownership as the fraction of equity shares held by insiders and promoters, whereas Alhassan and Mamuda (2020) suggest that it is the proportion of director's equity ownership which includes their deemed interest.

Not differing from earlier submissions, Alsmady (2018) documents that managerial ownership is the percentage of a firm's ordinary shares owned by the Chief Executive or Managing Partner, while Mudi (2017) views it as the percentage of shares owned by firm's management that is, the composition of board members, CEO and top management. Lending credence to the perspectives shared by previous researchers, Aliyu et al. (2015) view managerial ownership as the percentage of ordinary shares owned by the directors, executive directors and independent directors. On their own part, Lawal et al. (2018) argue that managerial ownership is not only meant to increase the equity of the organization but also to serve as incentives to managers to align managers' interests with those of the interests of the organization. They further posit that managerial ownership is measured by natural logarithm of equity held by managers as shareholders in a firm.

ii. Block holder Ownership

Onuorah et al. (2022) define a block holder as an individual or organization that owns a substantial amount of a company's shares or debt. In terms of shareholding, these owners are often able to influence the company with the voting rights awarded with their holdings. A block holder is thus

regarded as an influential shareholder because of the significant block of the company's stock or bonds that he/she owns. Generally, there is no specific number of shares that defines a block holder. In addition to the opinion of Onuorah et al. (2022), Nguyen et al. (2020) assert that block holder ownership can be regarded as the number of shares that individuals, who are not necessarily family members of the owner of the company, own, and it is measured as the sum of ownership shares by block holders divided by the total outstanding shares. Meanwhile, Racha and Demyana (2019) report that block holder ownership is the type of ownership structure where a large number of shares is owned by outsiders (external shareholders). As such, they maintain that it is measured by counting owners/investors with the large block of shares (5%) in an organization.

iii. Institutional Ownership

Omorokunwa and Idubor (2022) assert that institutional ownership refers to an ownership fraction or stake in a firm that is held by large financial organizations, pension funds or endowments. Institutions generally purchase large blocks of a firm's outstanding shares and can exert considerable influence upon its management. Therefore, institutional shareholders are usually professionals and they normally use their expertise in monitoring the management in ensuring that their interests align with those of the organization's interests. Shohreh et al. (2015), on their own part, postulate that institutional ownership shows the ownership portion of a firm that is held by large organizations, financial firms, endowments, pension funds etc. Institutions normally purchase big blocks of a company's outstanding shares and can apply substantial influence on its management.

Thus, institutional shareholders are usually professionals and they generally apply their expertise in supervising the management to ensure that their interests support those of the company's interests. Institutional ownership is represented by natural logarithm of equity held by different institutions as investors in the company. Paramitha and Firnanti (2018) opine that the ownership of shares by companies and financial institutions in a company is called institutional ownership. The measurement of institutional ownership, according to Reyna (2018), is the sum of institutional ownership shares divided by the total outstanding shares. Institutional ownership is the ownership of company shares by institutions (pension funds, investment companies, banks and others). Institutional ownership is measured by natural logarithm of equity held by various institutions as investors in the firm.

Earnings Management

Several definitions have been given for earnings management. One the definitions is that it is a purposeful intervention in the external financial reporting process with the intent of obtaining private gain (Racha & Demyana, 2019). Another definition is that, according to Saleem (2016), is that earnings management is a situation where managers use judgment in financial reporting and in structuring transactions so as to modify financial reports to either mislead stakeholders about the underlying economic performance of the company or to influence contractual outcomes that depend on reported accounting numbers.

In the opinion of Ogiriki and Adole (2023), earnings management is the strategic manipulation of a company's financial statements, often within the boundaries of accounting rules and regulations, with the primary intent of influencing reported earnings figures to achieve specific financial goals or to portray a desired image of the company's financial performance, thereby potentially affecting investor perceptions, stock prices, and stakeholder confidence. At its core, earnings management revolves around the art of influencing reported earnings, which are a key measure of a company's profitability and performance.

According to Farouk and Bashir (2017), earnings management can be described as the managers' intentional act to manipulate the reported earnings by relying on specific accounting methods in order to make changes that favour their respective interest. Alexander (2019) states that earnings management can be regarded as a practice in which managers/ directors of an organization compile transactions in financial statements in such a way as to misguide stakeholders, thereby bringing about deviations from the company's actual financial performance. However, earnings management could also be defined as the process of taking purposeful steps within the limits of Generally Accepted Accounting Principles (GAAPs) in order to bring about a desired level of reported income (Parveen et al., 2016). Bingilar and Bariweni (2020) submit that on one hand, earnings management is considered to be legal if an entity makes adjustments in earnings disclosed according to generally acceptable accounting principles (GAAP) guidelines and standards.

On the other hand, earnings management may be considered to be fraudulent and illegal if adjustments are made without complying with GAAP guidelines and accounting standards. Towing a different angle, Wati and Gultom (2022) reveal that there are several reasons that could lead to earnings management practices, including avoiding debt requirements, influencing stock prices and fulfilling analysis expectations. The most common practice of earnings management, however, is the changing of accounting

methods and policies. However, Ekpulu and Omoye (2018) note that earnings management consists of accounting earnings management and real earnings management. Accounting earnings management (AEM) includes the way accounting standards are applied to record given transactions and events, whereas real earnings management (REM) changes the timing or the structuring of actual transactions.

Approaches to Earnings Management

i. Discretionary Accruals Management: Dechow, Sloan, and Sweeney (1995) cited in Ekpulu and Omoye (2018) assert that the analysis of earnings management (EM) often focuses on management's use of discretionary accruals. There are several accrual-based models for detecting earnings management. Ekpulu and Omoye (2018) estimate discretionary accruals using a two-step process. First is the estimation of nondiscretionary accrual by scaling the mean of total accruals by lagged total assets from the estimation. Second is the measurement of discretionary accrual by the difference between current year total accrual scaled by lagged total assets and estimated nondiscretionary accruals. Some EM models decompose total accruals into nondiscretionary and discretionary accruals. These models first estimate non-discretionary accrual, then subtract the estimated non-discretionary accruals from event year total accruals to yield discretionary accruals (Ekpulu & Omoye, 2018). The Jones (1991) model was modified by Dechow et al. (1995) by decomposing total accruals into non-discretionary and discretionary accruals and also taking into cognizance the change in receivables over total change in revenue.

ii. Real Earnings Management (REM): Roychowdhury (2006) cited in Ekpulu and Omoye (2018) states that REM involves real activities manipulation suggesting departures from normal operational practices, motivated by manager's desire to mislead at least some stakeholders into believing that certain financial reporting goals have been met in the normal course of operations. It is important to know that the departure from normal operational accounting practices do not necessarily contribute to firm's value even though they enable managers to achieve reporting goals. Interestingly, Ekpulu and Omoye (2018) maintain that financial executives indicate a greater willingness to manipulate earnings through real activities rather than accruals. There are at least two possible reasons for avoiding earnings manipulation outside real activities. First, accrual manipulation is more likely to draw auditor or regulatory inspection than genuine decisions about pricing and production. Second, relying on accrual manipulation alone involves a risk of losing investors' confidence on financial reports.

Theoretical Framework

Agency Theory

On a general note, the discourse on ownership structure and earnings management has been anchored on the agency theory, as this is the theory that highlights the contractual agreement between owners of a business and the parties saddled with the responsibility of managing the business. Therefore, the agency theory establishes the relationship between the principal (owners) and the agents (managers/ directors). The agency theory, initially developed by Berle and Means (1932) and later expounded by Jensen and Meckling (1979), explains the relationship that exists between the principal or owner and the agent or manager in the business. The separation of ownership from management in a modern organization, provide background designed for the functions of agency theory.

Contemporary corporations have generally isolated ownership, in the form of shareholders, who are not more often than not involved in the management of their entity. The argument surrounding the impact that governance mechanisms (which included ownership structure) has on earnings management should be equally be considered from the perspective of the agency problem arising from the ownership and control separation, creating interests' asymmetries between managers and shareholders. When a company is not owned by managers or directors, self-interest becomes their overriding motivation, hence they tend to satisfy their own desires and objectives to the detriment of the objectives and desires of the organization, and consequently, the interests of the shareholders or owners (Musa et al., 2023). In view of this, agency theory suggests that a separation between ownership and control often results in manager and owner having divergent opinions and interests., which brings about conflicts of interest.

2.2 Empirical Review

Musa, Gugong and Abdullahi (2023) scholarly reviewed the impact of ownership structure on earnings management of listed deposit money banks in Nigeria. While they used managerial ownership, institutional ownership, foreign ownership and ownership concentration as measures of ownership structure, earnings management was proxy using the discretionary loan loss provision. The population size of the study was fourteen (14) deposit money banks listed on the Nigerian Exchange Group (NXG) as of December, 2020 out of which twelve (12) banks were purposively selected as sample size for the study. Data collected from the published annual reports and accounts of the sampled banks were analyzed using the multiple regression as technique of analysis with the aid of STATA 16. Findings revealed that while managerial ownership and ownership concentration

had significant impact on earnings management, institutional ownership and foreign ownership had no significant impact on earnings management of listed deposit money bank in Nigeria. on this note, the study recommended that the financial reporting council of Nigeria (FRCN) should define the range of managerial ownership proportions that deposit money banks should maintain so as not allow greater control of investors wealth by agents (managers).

Using selected quoted healthcare companies in Nigeria, Abba, Hanga, Kakanda and Babarabi (2023) empirically looked at the effect ownership structure has on earnings management. Based on their thorough annual reports, seven (7) of the ten (10) stated companies were particularly selected for the study (2012–2021). The collected data were examined using multiple regression analysis, while the research design adopted was ex-post facto research design. The results of the study indicated that institutional ownership has a major negative impact on earnings management, whereas block-holder ownership and foreign ownership have positive and significant impact on how the healthcare companies managed their earnings. The study consequently suggested that listed healthcare businesses in Nigeria should be discouraged from applying block holder and foreign ownership due to their tendency to encourage earnings management, while institutional ownership should be supported, as this would help to reduce the practice of earnings management in Nigerian healthcare organizations.

Ogiriki and Adole (2023) conducted a study to examine how ownership structure correlates with earnings management of selected manufacturing companies in Nigeria. Using data panel data regression to examine the relationship between block holder ownership and controlling ownership (measures of ownership structure) and discretionary accruals (proxy of earnings management). Relevant data were gathered from the annual reports of selected 11 consumer goods manufacturing companies quoted on the Nigerian Exchange Group from 2013 to 2022, and results showed that both block holder ownership and controlling ownership will decrease the incidence of earnings management activities among manufacturing companies in Nigeria. The study therefore, recommended that companies should endeavour to improve block holder ownership and controlling ownership so as to fortify the monitoring mechanism that could restrain earnings management.

The study of Ganiyu and Araoye (2022) examined the effect of ownership structure on earnings management of listed oil and gas companies in Nigeria. The study employed the use of ex-post facto research design. Data were obtained from annual financial reports and accounts of selected eight oil and gas firms listed on the Nigerian Stock Exchange Market as at December 31, 2020 covering the period 2011-2020. A descriptive statistics and pooled regression tools were used to analyze the data collected. The findings revealed that ownership structure has a positive and significant influence on earnings management of the listed oil and gas companies in Nigeria. Specifically, the OLS (robust) revealed that except controlled variable of firm size, explanatory variables of the study have a positive and significant influence on earnings management. The study concluded that ownership structure has effect on earnings management and recommended that management should pay attention to the ownership structure when making policies pertaining to earnings management in order to reduce aggressive earnings management.

3.0 METHODOLOGY

3.1 Research Design

Ex-post facto research design was adopted for this study because all the data relating to both the independent and dependent variables were obtained from the annual reports and financial statements of the pharmaceutical companies selected. From the website of the Nigerian Exchange Group (www.nxggroup.com), it was discovered that the number of pharmaceutical companies in the healthcare sector is seven as at September, 2024. This therefore, represented the population size, while the sample size used for this study is three. The reason for selecting three pharmaceutical companies out of the available seven is that although four companies are considered to be listed, one of these four companies was listed in November 7, 2023. As such, this company (Mecure Industries Plc) does not have the relevant data for the period under study (that is, 2019-2023).

Therefore, the selected sampled companies are: Fidson Healthcare Plc, May & Baker Nigeria Plc and Neimeth International Pharmaceuticals Plc. The measures of the independent variables adopted are managerial ownership, block holder ownership and institutional ownership, while the measure of dependent variable is discretionary accruals developed by Jones (1991) and modified by Dechow et. al. (1995). The method of data analysis employed in this study was multiple regression with the aid of STATA 16 as a tool of data analysis.

3.2 Model Specification

The relationship between ownership structure and earnings management that tracks the impact of the independent variables and dependent variables of the study is hypothesized using the ordinary least square regression model. The regression model for the study is thus, stated as follows:

$DACCit = \beta_0+\beta_1 MOit + \beta_2 IOit + \beta_3 BOit + \mu it.$

Where:

$DACC_{it}$ = Discretionary accruals of firm i time t.

MO_{it} = Managerial ownership of firm i time t.

IO_{it} = Institutional ownership of firm i time t.
BO_{it} = Block holder ownership of firm i time t.
β0 = is constant
β1 – β3 = are the coefficients μit = is the error term

4.0 RESULTS AND DISCUSSION

Descriptive Statistics

The descriptive statistics is presented in Table 1 where minimum, maximum, mean, standard deviation, skewness and kurtosis of the data for the variables used in the study are captured.

Table 1: Descriptive Statistics

Descriptive Statistics of the Variables

Variables	Mean	Std. Dev	Min	Max	Skewness	Kurtosis	Obs
DACC	0.228	0.143	0.004	0.611	0.433	2.477	15
MO	0.108	0.077	0.003	0.030	0.508	2.576	15
IO	0.026	0.015	0.003	0.072	0.867	2.911	15
BO	0.208	0.161	0.007	0.731	1.252	4.421	15

Source: STATA 16 Output, 2024.

Table 2 shows that the measure of earnings management (DACC) of selected pharmaceutical companies listed in the Nigerian Exchange Group as at 2024 had an average value of 0.228 with a standard deviation of 0.143, and minimum and maximum values of 0.004 and 0.611 respectively. This implies that, on the average, discretionary accruals of the selected firms during the period of this study was 0.228. This suggests that the dispersion of the data from the mean is not too wide because the standard deviation is a little bit lower. The peak of the data is indicated by the kurtosis value of 2.477, indicating that most of the values are higher than the mean, hence the data did not meet a normal distribution assumption. The skewness of 0.433 implies that the data is positively skewed (that is, most of the data are on the right side of the normal curve), hence the data does not meet the symmetrical distribution assumption.

More so, the Table indicates that the mean value of managerial ownership (MO) is 0.108 with standard deviation of 0.077, the minimum and maximum values is 0.003 and 0.030 respectively. The implication of this is that on average, MO of sampled companies during the period of study was 0.108 and the data deviates from both sides of the mean by 0.077. This suggests that a wide dispersion of the data from the mean because the standard deviation is far from the mean. The peak of the data is indicated by the kurtosis value of 2.576, suggesting that most of the values are higher than the mean and the data does not meet a normal distribution assumption. The coefficient of Skewness of 0.508 implies that the data is positively skewed (that is, most of the data are on the right side of the normal curve), hence the data does not meet the asymmetrical distribution assumption.

Similarly, the Table shows an average institutional ownership (IO) of 0.026 with standard deviation of 0.015, the minimum and maximum values is 0.003 and 0.072 respectively. This implies that, on average, IO of listed pharmaceutical companies during the period under study was 0.026 and the data deviates from both sides of the mean by 0.015. This suggests that a wide dispersion of the data from the mean because the standard deviation is far from the mean. The peak of the data is indicated by the kurtosis value of 2.911, implying that most of the values are higher than the mean and the data does not meet a normal distribution assumption. The coefficient of Skewness of 0.867 indicates that the data is positively skewed (that is, most of the data are on the right side of the normal curve) thus, the data does not meet the asymmetrical distribution assumption.

In the same vein, the Table indicates an average block holder ownership (BO) of 0.208 with standard deviation of 0.161, the minimum and maximum values is 0.007 and 0.731 respectively. This suggests that, on average, BO of sampled firms during the period of this study was 0.208 and the data deviates from both sides of the mean by 0.161, an indication that a wide dispersion of the data from the mean because the standard deviation is far from the mean. The peak of the data is indicated by the kurtosis value of 4.421, which implies that most of the values are higher than the mean and the data does not meet a normal distribution assumption. The coefficient of Skewness of 1.252 implies that the data is positively skewed (that is, most of the data are on the right side of the normal curve) thus, the data does not meet the asymmetrical distribution assumption.

Correlation Matrix

Table 2: Correlation Matrix

Correlation Matrix of the Dependent and Independent Variables

Variables	DACC	MO	IO	BO
DACC	1			
MO	0.1240 (0.2009)	1		
IO	0.1315 (0.1751)	0.1110 (0.2275)	1	
BO	-0.0535 (0.5823)	-0.1346 (0.1427)	-0.0759 (0.4100)	1 (0.3526)

P-values in parentheses.

Source: STATA 16, Output 2024

The result in Table 2 shows the degree of association between earnings management (EM) and all pairs of independent variables coefficients and significant values individually as well as among themselves and cumulatively between with the dependent variable (earnings management) of the study in listed pharmaceutical companies in Nigeria. The Table presents a positive relationship between discretionary accruals and managerial ownership (MO) from the correlation coefficient of 0.1240 which is not statistically significant. This relationship implies that as managerial ownership decreases, the earnings management of listed selected pharmaceutical companies also decrease.

Table 2 also shows that the relationship between institutional ownership (IO) and discretionary accrual of listed companies under study, which indicates that there is a positive correlation between both of them. From the correlation coefficient of 0.1315, there is an indication that the correlation is also not statistically significant. Therefore, this relationship shows that as institutional ownership decreases, earnings management of listed pharmaceutical companies also decrease.

In addition, the Table indicates a negative association between block holder ownership and discretionary accruals of listed selected pharmaceutical companies in Nigeria. This is evident from the correlation coefficient of -0.0535 which is statistically significant at all levels of significance. This implies that, as proportion of shares held by block holders decreases, the earnings management of the listed firms increases.

Test of Hypotheses

This section presents the regression results of the dependent variable (EM) and all the independent variables of the study. It follows with analysis of the association between dependent variable and each independent variable individually and cumulatively. Hence, the summary of the regression result obtained from the model of the study.

Table 3: Regression Analysis

Regression Results (Random Effect Model)

Variables	Coefficients	Std. Err.	Z-Values	P-Values
Intercept	-0.101	0.121	-0.83	0.404
MO	-3.226	0.898	-3.59	0.000
IO	-0.081	0.402	-0.20	0.840
BO	0.769	0.041	18.97	0.000
R^2 overall	0.8092			
Wald chi2	377.91			
Prob>chi2	0.0000			

Source: STATA 16, Output 2024

The cumulative R^2 (0.8092) which is the multiple coefficients of determination gives the proportion or percentage of the total variation in the dependent variable as explained by the independent variable jointly. Hence, it signifies 81% of total variation in earnings management of listed selected pharmaceutical

companies is caused by the collective effort of managerial ownership, institutional ownership and block holder ownership. This results further indicates that the model is fit, variables properly selected, combined and used in the study. This statistically supported by the Probability value of (0.0000).

The regression result in Table 3 revealed that managerial ownership as measured as proportion of shares owned by managers to total shareholding has a z-value of -3.59, coefficient value of -3.226 and is significant at 1% level of significance. This signifies that managerial ownership is negatively, strongly and statistically related with earnings management of listed selected pharmaceutical companies in Nigeria. This implies that an increase in the proportion of shares held by managers would mitigate against earnings management discretionary accrual by sampled firms. Therefore, the null hypothesis regarding managerial ownership and earnings management is rejected in favour of the alternative hypothesis, hence it can be concluded that there is no significant relationship between ownership structure and earnings management of listed selected pharmaceutical companies in Nigeria.

Also, the Table shows the statistical relationship between institutional ownership and earnings management. The result revealed a coefficient of -0.081, Z-values of -0.20 and p-value of 0.840, which implies that the relationship between institutional ownership and earnings management of sampled pharmaceutical firms in Nigeria is not statistically significant. This connotes that an increase in the proportion of institutional shares held by institutions would mitigate against earnings management. This study therefore, rejects the null hypothesis and concludes that there is no significant correlation between institutional ownership and discretionary accruals of listed selected pharmaceutical companies in Nigeria.

Finally, block holder ownership showed a constant coefficient of 0.769, z-values of 18.97 and p-value of 0.000. This shows that block holder ownership statistically and significantly influences the discretionary accruals of listed selected pharmaceutical companies in Nigeria at 1% level of significance. This implies that a 1% decrease in block holder ownership of the listed sampled companies in Nigeria equally leads to a decrease in earnings management by 77%. The implication of this is that a decrease in the proportion of shares held by one or few individuals would minimize earnings management tendencies, while an increase in block holder ownership would bring about a corresponding increase in earnings management practices among pharmaceutical companies in Nigeria. This study therefore, accepts the null hypothesis that block holder ownership significantly correlates with earnings management of listed selected pharmaceutical companies in Nigeria.

Discussion of Findings

The regression result in Table 3 revealed that managerial ownership as measured as proportion of shares owned by managers to total shareholding has a z-value of -3.59, coefficient value of -3.226 and is significant at 1% level of significance. This signifies that managerial ownership is negatively, strongly and statistically related with earnings management of listed selected pharmaceutical companies in Nigeria. This implies that an increase in the proportion of shares held by managers would mitigate against earnings management through discretionary accruals by listed selected pharmaceutical companies in Nigeria.

Also, the Table shows the statistical relationship between institutional ownership and earnings management of listed pharmaceutical companies in Nigeria. The result revealed a coefficient of -0.081, Z-values of -0.20 and p-value of 0.840, which implies that the relationship between institutional ownership and earnings management of listed selected pharmaceutical companies in Nigeria is not statistically significant. This implies that an increase in the proportion of institutional shares held by institutions would mitigate against earnings management of listed selected pharmaceutical companies in Nigeria.

Finally, block holder ownership showed a constant coefficient of 0.769, z-values of 18.97 and p-value of 0.000. This shows that block holder ownership statistically influences the earnings management of listed selected pharmaceutical companies in Nigeria at 1% level of significance positively. This implies that a 1% decrease in block holder ownership of listed selected pharmaceutical companies in Nigeria will result in decrease in earnings management of the firms in Nigeria by 77%. In other words, a decrease in the proportion of shares held by one or few individuals would minimize earnings management tendencies.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

It is common knowledge that pharmaceutical companies, just like every other company, engage in earnings management in order to enhance their overall performance, especially given the need to meet with the demands of the owners of the companies. In the same manner, it has been established that the ownership structure of an organization can help to improve its performance because managers are better able to defend corporate control against a market takeover threat. Similarly, the knowledge of ownership structure is of great significance to all parties involved in a business, as it offers valuable perspectives on the company's effectiveness and potential for growth. Thus, it has become expedient to monitor the decisions of the management of these companies so as to assure that not only are the interests

of shareholders protected, but also to ensure reliable and complete financial reporting. From the foregoing, it is evident that the ownership structure of a firm is regarded as a very crucial monitoring mechanism for both owners and managers of a business as it can be used to reduce the incidence of earnings management.

5.2 RECOMMENDATION

On the basis of the findings of this study, it is therefore recommended that:

i. Pharmaceutical companies in Nigeria should be encouraged to monitor managerial ownership so as not allow directors and managers have much control over the affairs of their companies, which will ultimately allow them misappropriate the resources of these companies. In order to do this, the Financial Reporting Council of Nigeria (FRCN) should, through the code of corporate governance and others relevant regulations, define the range of managerial ownership proportions that companies should maintain so as not allow greater control of investors wealth by agents (managers).
ii. Pharmaceutical companies in Nigeria should also encourage greater investment in their shares through institutional ownership because an increase in the proportion of institutional shares will empower these institutions to curtail the unwholesome and inordinate activities of the executives. This can be achieved if government through its regulatory agencies, such as the Security and Exchange Commission, make policies that will encourage investment in the private sector. Without a doubt, investment by institutions will provide greater power for them to indirectly control management opportunistic tendencies.
iii. Furthermore, since findings have revealed that block holder ownership encourages earnings management practices among pharmaceutical companies in Nigeria, the proportion of shares held by one or few individuals should be minimized. This will reduce the controlling power these few individuals have in influencing management decisions especially the ones that would not be of benefits to them.

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TAX INCENTIVES AND FINANCIAL PERFORMANCE OF LISTED AGRIBUSINESS IN NIGERIA

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ABSTRACT
This study investigated the relationship between tax incentives and financial performance of selected Agro-allied manufacturing businesses in Nigeria. The study adopted the ex-post facto research design and used secondary data and analyzed the data with the aid of regression analysis through, the statistical package for social science (SPSS). The study found that capital allowance has a negative but insignificant relationship with net profit margin; capital allowance has a positive but insignificant relationship with return on equity. This study recommended among others, that investment allowance should be increased for the agro-allied sector for it to have more impact on the sector and all agro-allied companies in Nigeria should be conducted in compliance with applicable laws, regulations, supervisory requirements, and procedures governing capital allowance administration as this may lead to better utilization of the capital allowance provision for it to have a desired impact on the net profit margin. In conclusion, it is without any form of doubt that granting tax incentives to companies in the agro-allied sector is expensive on the part of government.
Key Words: Financial Performance, Tax Incentive, Capital Allowance, Investment Credit

1.0 INTRODUCTION

Taxes collected by government are used to run the affairs of the country which in turn contributes to the economic growth of the country. The Nigerian economic system comprises both the public and private sectors, and since most of the tax revenues collected by the Federal Government of Nigeria is from the private sector, the private sector needs to grow more to ensure continuity of operations which facilitates economic growth. The Government therefore has introduced some incentives to manufacturing businesses to encourage them to ensure their continuous participation in the growth of the economy. Among the incentives provided by the Government is tax incentives granted to manufacturing companies in Nigeria. In view of promoting indigenous investment in Nigeria, tax incentives were put in place to encourage the growth of local manufacturing industries, which will in turn reduce the amount of imported goods. Since 1949, there have been fiscal tax incentives in Nigeria, and they are still widely used in government today (Fowowe, 2013).

According to Ndajiwo (2016), in recent times, there seems to be a move towards finding a middle ground between the proponents of tax incentives, usually the organized business sector, and the opponents, the civil society organizations and campaigners. A contentious debate regarding the importance of tax incentives in driving Nigeria's growth took place in March 2018 at a summit of civil society organizations organized by Action Aid Nigeria. Representatives from the organized private sector and the Federal Inland Revenue Service (FIRS) were present despite the meeting's emphasis on the third sector. The meeting's objectives included determining how stakeholders felt about tax incentive concerns, discussing and reaching consensus on a number of topics, and setting a course for future action. Because tax incentives are intended to encourage investment in certain sectors or geographical areas, they are provided with conditions attached. As the United Nations Conference on Trade and Development, (UNCTAD, 2000) noted, very often countries design special incentives regimes which concern tax benefits as well as key restrictions. For instance, these regimes may require that a facility be established in a certain region(s), have a certain turnover, require the transfer of technology from abroad or employ a certain number of individuals.

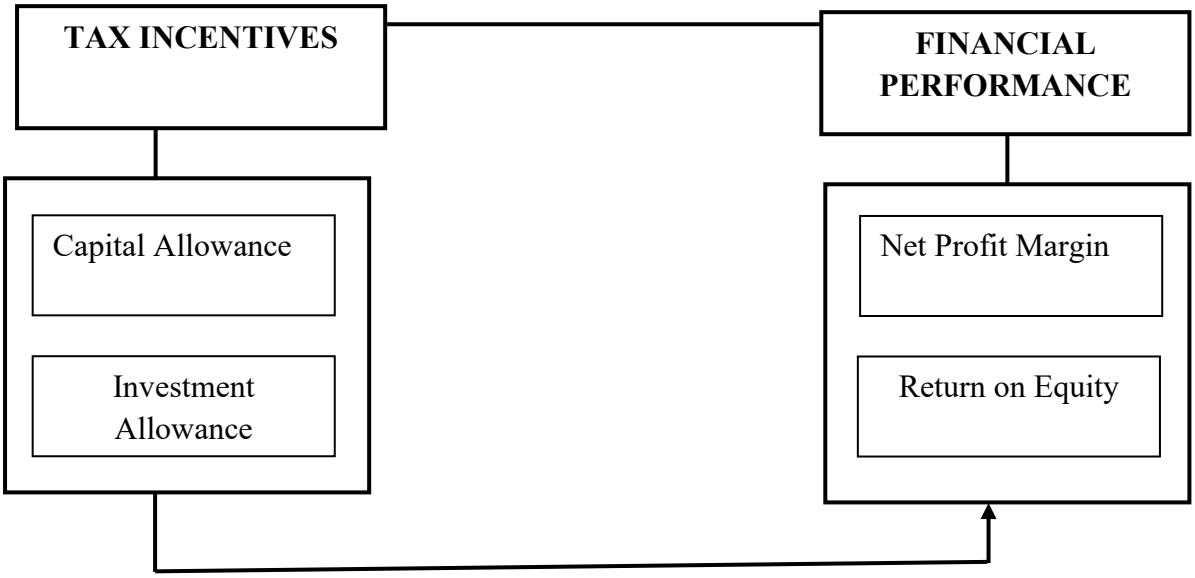
1.2 Statement of the Problem

Good financial performance is the key to the sustenance of a business entity, and a desirable attribute of any organization. It brings about increase in shareholders' wealth, as well as stability and survival of any business. In the same manner, good financial performance indicates the tax liability of companies because the higher the financial performance of a business, the higher its tax liability. In view of this, the incentives that the government gives to companies in relation to tax can affect the financial performance of companies, including the agro-allied sector; this is given the position the agro-allied industry now has in the Nigerian economy. Notwithstanding the relative importance of tax incentives on the financial performance of companies, there are still some contending issues facing the problem of tax incentives. One of such challenges is that several companies tend to take advantage of loopholes in tax administration to either avoid or evade payment of tax outrightly.

With respect to tax incentives and financial performance, there have been several studies conducted by researchers and authors alike with the likes of Agundu and Ohaka (2013), Nwanyanwu

(2018), Olowo, et al. (2020), Omesi and Maccarthy (2022). However, to the best of the knowledge of this researcher, no attention has been drawn to the agro-allied manufacturing companies in recent times to cover between 2014 to 2021. Therefore, this study is conducted to cover the knowledge gap created due to the time gap in the agro-allied manufacturing sector. It is on this basis that hypotheses are formulated and expressed.

Conceptual Framework



Sources: Philip (2018) and Omesi and Maccarthy (2022)

Purpose of the Study

This study intends to evaluate the relationship between tax incentives and financial performance of listed agro-allied manufacturing companies in Nigeria. Specifically, this study intends to:

i. Determine the relationship between Nigerian agro-allied industrial businesses' capital allowance and net profit margin.
ii. Determine the relationship between Nigerian agro-allied industrial enterprises' capital allowance and return on equity.
iii. Investigate the relationship between Nigerian agro-allied industrial businesses' investment tax credits and net profit margin.
iv. Investigate the relationship between investment tax credits and agro-allied manufacturing enterprises in Nigeria's return on equity.

Research Questions

This work will provide answers to the following questions:

i. What is the relationship between capital allowance and the net profit margin of listed agro-allied manufacturing companies in Nigeria?
ii. What is the relationship between capital allowance and the return on equity of listed agro-allied manufacturing companies in Nigeria?
iii. What is the relationship between investment tax credit and net profit margin of listed agro-allied manufacturing companies in Nigeria?
iv. What is the relationship between investment tax credit and return on equity of listed agro-allied manufacturing companies in Nigeria?

2.0 REVIEW OF RELATED LITERATURE

2.1 Conceptual Review

Concept of Tax Incentives

Tax incentives has been defined by various authors and scholars. According to Philip (2015), it can be described as deliberate reduction in tax liability granted by government in order to encourage particular economic units. (e.g., corporate entities to behave in certain desired ways, such as investing more, producing more, employing more, exporting more, saving more, conserving less, polluting less, and so forth). Tax incentives were defined by Okauru (2019) and Aguolu (2019) as an exemption or relief given to a person or a business to lessen the impact of taxation and so promote savings and investment. Well and Allen (2021) conclude that experience strongly suggests that fiscal investment incentives are popular in developing countries yet they have not been effective in making up for fundamental weaknesses in the investment climate.

Forms of Tax Incentives

Capital Allowance

Simply put, capital allowance is a way of reducing tax bill of a person that spent money on certain item used to benefit his business in the long term. The money incurred in procuring the item is termed "qualifying expenditure" (Philip, 2015). Capital allowance is also described as a scheme of allowing a company to tax relief in respect of certain capital expenditures by allowing them to be expensed against the business annual assessable profits (Okauru, 2019). Technically, capital allowance is a form of tax relief granted by the relevant tax authority in accordance to the extant tax laws to a person for incurring a qualifying expenditure on a certain asset used for the purpose of trade or business carried on by it in producing income in the basis period for which that asset was used (Olowo, et al., 2020).

Investment Allowance

Olowo, et al. (2020) reckon that investment allowance is granted on qualifying capital expenditure that is incurred on plant and equipment for the purpose of the business. This incentive comes once a year for the first utilization of such a qualifying capital asset. The rate is 10% of the cost claimable on plant and equipment utilized for agricultural and manufacturing businesses. Kiabel and Nwikpasi (2019) opine that investment allowance is granted on qualifying capital expenditure incurred on new assets on or after 1st of April 1969, an investment allowance of 10% is granted to companies into agricultural and manufacturing businesses only and it is given once in the life of an asset and not also deductible in determining the tax written down value of an asset. Ariwodola (2015) optically states that an investment allowance is granted in the first year of purchase of that asset (plant and/or machinery) engaged in agricultural and manufacturing activities, which is in integration with the customary initial and annual allowances.

Financial Performance

There are several ways to gauge a company's effectiveness, but they should all be combined. Along with total unit sales, line items like operating income, operational revenue, or cash flow from operations might be included (Njeru, 2012). The profitability of an organization may be measured quantitatively using terms like gross margin, net margin, return on sales, return on equity economic value added, return on equity less cost of equity, and return on capital utilized. Other performance indicators include cash flow metrics like free cash flow over sales and growth indicators like historically growing revenue (Agundu & Ohaka, 2013). Traditionally, financial performance can be measured in many different ratios such as profitability ratios which are financial measures of a company's capacity to create revenue in relation to sales, costs, assets, and equity over a certain time span; liquidity ratios which tell a company about its ability to meet its short-term financial obligations; efficiency ratios which tell management how well they are, using its business assets; financial leverage or gearing ratios which tell a firm how sustainable its exposure to long-term debt is; and other investors ratios (Nwanyanwu, 2018).

Net Profit Margin

Nwanyanwu (2018) points out that net profit is that profit which is generated from all phases of the business, including interest and taxes. This is the bottom line that attracts most of the attentions in discussions of a company's' profitability. The net profit margin or net margin, compares net income to sales, a consistently high net margin is often a strong indication that a company has been enjoying one or more competitive advantages. Additionally, a high net margin provides a company with a cushion during unanticipated downturns in its business. Anwaar (2016) describes net profit margin or net profits ratios as the percentage of post-tax and interest profits to sales. It shows how much of the earnings by the company are translated into profits. According to Wilkinson (2013), net profit margin, also known as net margin, is the ratio of net income to total sales that a firm generates. A corporation is more effective at converting sales into actual profit if its net profit margin is larger.

Return on Equity

Tyson and Schell (2018) state that return on equity (ROE) is a percentage determined by dividing profit to equity. i.e., pretax profits from the profits and loss statement and equity or net worth from statement of financial position. Tracy (2018) opines that ROE ratio tells us how much profit a business earned in comparison to the book value of its shareholders' equity. It is useful especially for privately owned business, which is hard to determine the market value of owners' equity.

2.2 Theoretical Framework

Agency Theory

The agency theory was first developed by Berle and Means (1932), and then expounded by Jensen and Meckling (1976) and is characterized through the conflict of interest between the principal (owners) and agents (managers), known as an 'agency problem'. The relationship arises whenever the principal gives control and/or decision-making authority to the agent. Simply, put the agency theory deals with the operational relationship existing between one party, the principal, who delegates work to another party referred to as an agent. The work of Berle and Means (1932), Prias

(1976) and Ross (1973) discussed the extent to which there was a dispersion of shareholding, which consequently led to the separation of ownership and control. In discussing the theory further, Jensen and Meckling (1976) stated that the managers of the company are the agents and the shareholders as the principal. In other words, the directors, who serve as the shareholders' agents, receive daily decision-making authority from the shareholder who serves as the company's owner or principle. The agent is expected to make decisions that will maximize the wealth of the principal, and the act in the best interests of the principal (Solomon, 2004).

Stakeholder Theory

This theory was first described by Dr. F. Edward Freeman (1984). It contends that investors are only one among a number of stakeholders in a corporation, according to a professor at the University of Virginia. The stakeholder ecosystem, involves any one invested and involved in, or affected by, the company; employees, vendors, governmental agencies, and more. The stakeholder theory is the anchor theory of this research. It applies to this research because it focuses on what the government, as stakeholder, does to affect the financial outcomes of companies in the agro-allied sector in Nigeria.

2.3 Empirical Review

Amendola et al (2018) investigated the impact of tax incentives on firm performance in Dominican Republic. The analysis of the data was based on panel data for the period often years from 2006 to 2015 of manufacturing firms in Dominican Republic. The study used both random and fixed effects estimation methods to find out the relationship between tax incentives and firm performance. The findings of the study showed that tax exemptions have a direct effect in firm performance. The study also revealed that firms located in special economic zones were receiving special treatment on tax and they ended up performing better in comparison to other firms in other areas. The study revealed a clear statistical correlation between tax incentives and firm performance. The study recommended that in order to encourage a level playing ground tax incentives should be reduced or totally eliminated. Philip (2018) examined the impact tax incentives have on the Nigerian manufacturing sector growth as a veritable tool in the hands of the government. Investment allowance and pioneer status were used to gauge tax advantages, while Return on Capital Employed (ROCE) measured manufacturing firms' performance. The study employed secondary data and cross-sectional data analysis. The method of analysis adopted was Ordinary Least Square regression technique. The empirical results based on 2016 tax data obtained for 15 quoted manufacturing firms in Nigeria lend support to the objective of the study. The study revealed that investment allowance has a positive significant effect on the ROCE of manufacturing companies. The study recommended that Nigerian businesses receive higher tax breaks in order to draw capital into the industry.

A research on the impact of tax incentives on the financial performance of construction enterprises in Malaysia was undertaken by Iliyas et al. in 2019. The study was carried out in a sample of 138 firms where secondary data was collected for the year 2015 to 2017.The study adopted Ex Post Facto Research Design and ordinary least square estimation and regression analysis was used for the data analysis. The findings of the study indicated that there was no significant difference in the financial performance between the firms which engage in construction of green buildings and the ones which do not. It is recommended that Nigerian businesses receive higher tax breaks in order to draw capital into the industry. Omesi and Maccarthy (2022) investigated on tax incentives and financial results of Nigerian firms that manufacture consumer items listed on. The research adopted ex-post facto design. The population for this study was twenty-one (21) listed consumer goods companies in Nigerian Stock Exchange and a sample size of twenty listed consumer goods companies. The instrument of the study was secondary data obtained from the company's published financial report or statements within the period of eleven (11) years, ranging from 2009-2019.The study's findings showed that listed Nigerian consumer goods manufacturing businesses' return on assets and investment allowance had a positive and substantial link. The study recommended that to continually maintain high return on assets of consumer goods manufacturing industry and foster economic development, the tax authority should consider proportionately increase of annual allowances if the period for a year of assessment happens to be a period of more than one year. This will attract more investors thereby improving the economic growth of the country.

3.0 METHODOLOGY

3.1 Research Design

This research adopted ex-post facto research design. The population for this study was five (5) listed agro-allied manufacturing firms on the floors of Nigeria Exchange Group (NGX) which include: Indorama Fertilizers, Dangote Group, Seedco Nigeria Ltd, Bua Group and Agromallas at 2022 and have consistently submitted their annual reports to the NGX from 2017-2021. This population size equally represented the sample size. The study used secondary data instrument, and data were analyzed using the various data analysis model such as descriptive analysis and regression analysis, which enabled the

researcher present the data in a more meaningful way. The analysis for the distribution for the variables examined the manifestations and distribution of each variable.

4.0 RESULT AND DISCUSSION

4.1 Result

Data Analysis

Table 4.1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
NPM	8	11.51	61.82	25.7259	16.03460
ROE	8	9.61	35.66	19.0020	9.95425
CAL	8	918608711.00	3583304430.00	1773374771.2500	959631077.91769
TXH	8	204094500.00	2190414900.00	801478100.0000	660590316.38557
1NA	8	117910230.00	565784910.00	271449335.5000	159428467.19341
ValidN(listwise)					

Source: Researcher's analysis, 2022

The Table above reveals that the values for the dependent variables are much smaller than those of the independent and variables. Hence there is a need to convert the independent variables to log 10 in order to unify the values before proceeding with the analyses as shown in Table 4.2 below.

Table 4.2: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
NPM		11.51	61.82	25.7259	16.03460
ROE	8	9.61	35.66	19.0020	9.95425
Log10CAL	8	8.96	9.55	9.1986	.21773
Log10TXH	8	8.31	9.34	8.7805	.35187
Log10INA	8	8.07	8.75	8.3718	.24471
Valid N (listwise)	8				

Source: Researcher's analysis, 2022

From the above results, the variance inflation factor results are low for all the predictor variables. The tolerance level is high, close to 1.0. High tolerance level and low variable inflation factor make it clear that there is No high collinearity among the predictor variables. Having passed the diagnostic tests, below are the discussions of the research findings.

Regression Analysis

HO_1: There is no significant relationship between capital allowance and net profit margin of listed agribusinesses in Nigeria.

Table 4.3a: Model Summary on the relationship between capital allowance and net profit margin of listed agribusinesses in Nigeria.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.251[a]	.063	.093	16.76324

a. Predictors: (Constant), Capital allowance

Source: Field Data, 2022

Table 4.3b: ANOVA[a] on the relationship between capital allowance and net profit margin of listed agribusinesses in Nigeria.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	445.611	1	455.611	10.781	.017[b]
	Residual	41.222	27	.871		
	Total	486.833	28			

a. Dependent Variable: Net profit margin

b. Predictors: (Constant), Capital allowance
Source: Field Data, 2022

Table 4.3c: Coefficients[a] on the relationship between capital allowance and net profit margin of listed agribusinesses in Nigeria.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-190.657	63.894		-2.984	.025
	Capital allowance	23.814	7.253	.802	3.283	.017

a. Dependent Variable: Net profit margin
Source: Field Data, 2022

Table 4.3b (ANOVA) and Table 4.3c (Coefficient) reveal that the p-value level as 0.017 which is <0.05 significant level. This shows that capital allowance has a significant positive relationship of 0.802 with net profit margin of listed agribusiness in Nigeria. Therefore, we reject the null hypothesis.

HO_2: There is no significant relationship between capital allowance and return on equity of listed agribusinesses in Nigeria.

Table 4.4a: Model Summary on the relationship between capital allowance and return on equity of listed agribusinesses in Nigeria.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.251[a]	.063	.093	16.76324

a. Predictors: (Constant), Capital allowance
Source: Field Data, 2022

The R-value on Table 4.4a (Model summary) is the correlation between the observed and predicted value of the dependent variable and indicates the proportion of variance in the dependent variable (return on equity) which can be predicted by capital allowance. R-Square was found to be 0.063, this value indicates that 6.3% of the variance in the return on equity can be predicted by capital allowance. Therefore, we accept the null hypothesis as there is no significant relationship between capital allowance and return on equity of listed agribusinesses in Nigeria.

HO_3: There is no significant relationship between investment allowance and net profit margin of listed agribusinesses in Nigeria.

Table 4.5a: Model Summary on the relationship between investment allowance and net profit margin of listed agribusinesses in Nigeria.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.251[a]	.063	.093	16.76324

a. Predictors: (Constant), Investment allowance
Source: Field Data, 2022

Table 4.5a (Model summary) shows the R square value which is .251. This value indicates that the 6.3% of the variable in return on equity can be predicted by investment allowance. This is way too insignificant.

Table 4.5b: ANOVA[a] on the relationship between investment allowance and net profit margin of listed agribusinesses in Nigeria.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	113.722	1	113.722	.405	.548[b]
	Residual	1686.037	6	281.006		
	Total	1799.758	7			

a. Dependent Variable: Net Profit margin
b. Predictors: (Constant), Investment allowance
Source: Field Data, 2022

Table 4.5c: Coefficients[a] on the relationship between investment allowance and net profit margin of listed agribusinesses in Nigeria.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	163.620	216.843		.755	.479
	Investment allowance	-16.471	25.892	-.251	-.636	.548

a. Dependent Variable: Net profit margin
Source: Field Data, 2022

Table 4.5b (ANOVA) and Table 4.5c (Coefficient) reveal that the p-value level as .548 which is >0.05 significant level. Since this research used a 1-tailed test, we divide the 2-tailed result .548 by 2 which is .274. This is still higher than the acceptable significant level of 0.05. This show that investment allowance has no significant impact on Net profit margin. Therefore, we accept the null hypothesis.

HO_4: There is no significant relationship between investment allowance and return on equity of listed agribusinesses in Nigeria.

Table 4.6a: Model Summary on the relationship between investment allowance and return on equity of listed agribusinesses in Nigeria.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.055[a]	.003	-.163	10.73574

a. Predictors: (Constant), Investment allowance
Source: Field Data, 2022

Table 4.6a (Model summary) shows the R square value which is.003. This value indicates that the 0.03% of the variable in return on equity can be predicted by investment allowance.

Table 4.6b: ANOVA[a] on the relationship between investment allowance and return on equity of listed agribusinesses in Nigeria.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2.073	1	2.073	.018	.898[b]
	Residual	691.537	6	.256		
	Total	693.610	7			

a. Dependent Variable: Return on equity
b. Predictors: (Constant), Investment allowance
Source: Field Data, 2022

Table 4.6c: Coefficients[a] on the relationship between investment allowance and return on equity of listed agribusinesses in Nigeria.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.383	138.874		.003	.998
	Investment allowance	2.224	16.582	.055	.134	.898

a. Dependent Variable: Return on equity
Source: Field Data, 2022

Table 4.6b (ANOVA) and Table 4.6c (Coefficient) reveal that the p-value level as .898 which is >0.05 significant level. Since this research used a 1-tailed test, we divide the 2-tailed result .898 by 2 which is .449. This is still higher than the acceptable significant level of 0.05. This show that investment allowance has no significant impact on return on equity. Therefore, we accept the null hypothesis.

4.2 Discussion of Findings

With respect to hypothesis one, the R value of-0.027 indicates a negative relationship. This indicates

that there is a negative but insignificant relationship between capital allowance and net profit margin of listed agro-allied companies in Nigeria. Therefore, we accept the null hypothesis. This finding corroborates the findings of Abdulrahman and Kabir (2017) that the tax incentives granted do not significantly affect profitability as they were not sufficient enough to sustain the desired development for which they were granted.

The result of analysis relating to hypothesis two shows R value to be 0.246. This indicates a positive relationship, hence there is no relationship between capital allowance and return on equity of listed agro-allied companies in Nigeria.

In respect of hypothesis three, the result of the R value of -0.251 indicates a negative relationship. This indicates that there is no significant relationship between investment allowance and net profit margin of listed agro-allied companies in Nigeria.

With respect to hypothesis four, the result of the R value of 0.555 indicates a positive relationship. Therefore, it is concluded that there is a positive but insignificant relationship between investment allowance and return on equity of listed agro-allied business in Nigeria.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This research work centered on the measure of tax incentives which are capital allowance and investment allowance. Net profit margin and return on equity serve as stand-ins for financial profitability. Tax incentives have a considerable positive link with the financial success of specific economic sectors, according to some of the empirical research addressed here. Agro-allied sector plays a major role in the development of most African countries. Thus, inadequate attention paid to the agro-allied sector can hurt the economy of any given country. The government reduces tax rates and offers different tax incentives to encourage investments and economic activity that boosts capacity for production and propels economic growth.

5.2 Recommendations

On the basis of the findings of this study, the following recommendations are hereby made.

Companies in the agro-allied businesses need to carefully manage the savings from capital allowance in productive activities as these have not yet proved impactful on their return on investment.

The government should increase investment allowance for agro-allied companies as this has shown no significant relationship with net profit margin and overall financial performance of the agro-allied companies in Nigeria, or remove others factors that hinder the intended goals of the generous incentives in order to achieve the desired goals.

Investment allowance can be carefully monitored to find out other factors that have been militating against its success since it has shown no statistical relationship with return on equity of the agro-allied companies in Nigeria. Otherwise, it will be another method of starving the government of much-needed funds.

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THE EFFECT OF ACCOUNTING MEASUREMENTS ON THE VALUE RELEVANCE OF FINANCIAL STATEMENTS OF LISTED COMPANIES IN NIGERIA.

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Abstract
This study was conducted to interrogate the effect of accounting measurements on the value relevance of financial statements of listed companies in Nigeria. Specifically, the study intended to investigate how fair value accounting and historical cost accounting affect value relevance of financial statements. Using a cross-sectional data of 20 selected listed companies drawn from both the financial sector and non-financial sector of the Nigerian Exchange Group for the period 2014 – 2023, and analyzing the data obtained from their annual reports and other relevant secondary sources. The data was analyzed via Panel Estimated generalized least squares (EGLS) regression technique. Findings revealed that there is a positive and significant effect of earnings per share (which served as proxy of fair value measurement) and book value per share (which represented historical cost measurement on market value per share (which was the measure of value relevance of financial statement used). It was therefore recommended that stringent rules backed up by legislations that will enhance value relevance of financial statements should be implemented by policy makers in order to enhance accountability and responsibility in the preparation and application of accounting standards which will serve as confidence booster to investors.
Keywords: Fair value accounting, Historical cost accounting, value relevance.

1.0 INTRODUCTION

On a general note, the objective of financial reporting is to provide accountability and decision usefulness of the financial statements, which is done by two major bases of accounting, namely accrual and cash bases. In a related vein, there are several accounting measurements for financial reporting, which include historical cost accounting (HCA) and fair value accounting (FVA), among others.

For centuries, accountants have used the HCA which has been systematically codified as the fundamental basis for measuring, recording and reporting the economic and related activities of firms (Abdullahi & Ma'aji, 2017). Consistent with that, Generally Accepted Accounting Principles (GAAP) financial statements are prepared according to HCA, which requires most assets and liabilities to be measured and reported at their cost of acquisition. The consideration of the range of technical issues to record and report the entity financial performance has been arising.

However, in recent past, it has been argued that HCA has lost its usefulness for user decision making and also lost its value relevance due to the changes in the economy, particularly the high-tech environment, and there have been considerable agitations that a more current measurement approach be adopted by companies in their reporting process (Osazevbaru, 2020). At the forefront of this campaign for a more market-condition friendly measurement approach are the International Accounting Standards Board (IASB) and Financial Accounting Standards Board (FASB). However, there are two schools of thought that have come up with different postulations about which measurement approach is more value relevant than the other, especially in relation to financial statements.
The first school opines that earnings are more value-relevant than the book value of equity, while the other school postulates that book value of equity is more value relevant than earnings according to (Adwan et al., 2020). To buttress this opinion, Mashoka (2022) adds that financial firms (that is, companies that focus on providing financial services and hold high portions of financial assets and investments) rely more on fair value measurements for their financial assets, hence they are more focused on earnings. Therefore, they consider earnings to be more value relevant on the basis of using fair value measurement as their own measurement approach.

On the other hand, non-financial firms (companies that either manufacture and/or sell products or provide non-financial services such as hotels, education, transportation etc.) invest heavily in property and equipment and therefore rely on historical cost accounting to measure their assets. Since they rely on historical cost accounting as their measurement approach, they are of the opinion that book value of equity is more value relevant than earnings. The question that now begs for an answer is: What then is value relevance and how do accounting Figures measure value (Akadakpo & Mgbame, 2018)? Akadakpo and Mgbame (2018) point out that value relevance deals with the usefulness of financial statements information in equity valuation. It deals with issues of how well do accounting Figures measure value and the accounting Figures that are used to

predict value attributes. Thus, value relevance of financial statements information can be measured by its ability to capture or summarize information that affects equity value. Going further, they assert that value relevance of accounting information is not the same as quality of accounting information, but that value relevance concept is one of the fundamental attributes of quality of accounting information.

Tahat et al. (2021) emphasize that studies on value relevance of financial statements are inspired by the fact that listed companies use financial statement as one of the major media of communication with their equity shareholder and public at large. For instance, in Nigeria, Companies and Allied Matters Act (CAMA, 2004) and the subsequent amendments require the directors of all companies listed on the Nigerian stock exchange to prepare and publish annually, the financial statements.

The relative crucial role of measurements in assessing the value relevance of financial statements in Nigerian companies notwithstanding, there has been very little or nothing done in that regard whether in Nigeria or in developed economies, to the best of the knowledge of this researcher. It is imperative to point out that according to Akadakpo and Mgbame (2018), majority of the studies on value relevance and financial statements have been in the developed nations of the world where financial statements are released at the end of the financial period, while there is a dearth of literature on the relationship accounting measurements have with value relevance of financial statements in Nigeria, in particular and the world at large.

This study therefore is concerned with the Nigerian situation with respect to accounting measurements (particularly historical cost measurement and fair value measurement) and to establish if indeed there is a relationship between accounting measurements and value relevance of financial statements of companies listed on the Nigerian Exchange Group. However, the study specificall intends to interrogate: the relationship between historical cost measurement and market value and the relationship between fair value measurement and market value of companies listed on the Nigerian Exchange Group. It is on the basis of these specific objectives that hypotheses are formulated and tested subsequently.To achieve the specific objectives the following hypothesis are formulated and tested.

2.0 LITERATURELiterature

2.1 Conceptual Review

Concept of Value Relevance

There have been several definitions given to the term “value relevance”. According to Francis and Schipper (1999) cited in Mashoka (2022), value relevance is the ability of accounting information to summarize any information that affects stock values. It is concerned with summarizing accounting information that affects stock values in a way as to influence the decision of investors. Abdullahi and Ma’aji (2017) define value relevance as the usefulness of accounting information to enable investors to make informed decisions. To Palea (2019), value relevance is seen as evidence of the quality and usefulness of accounting numbers, hence it can mean the usefulness of accounting data for decision making process of investors and its existence is usually by a positive correlation between market values and book values. In Abuaja and Ukpong’s opinion (2022), value relevance can be regarded as the ability of accounting numbers contained in the financial statements to explain the stock market measures. Accounting numbers such as earnings, book value, dividend, retained earnings are seen to be value relevant if they are significantly related to share price or abnormal return.

According to Mashoka (2022), there are four distinct perspectives that contribute to fully understanding value relevance in different aspects. The first perspective is the fundamental view of the value relevance, which focuses on the usefulness of accounting information in equity valuation. This approach involves finding a firm’s value without using its share price on the stock market. Second is the prediction view of the value relevance, which emphasizes relevant variables that need to be used for valuation purposes and focuses on how to predict relevant variables. Thirdly, the stock market is deemed to be efficient when statistical correlations are used to determine whether investors depend on the accounting information when making investment decisions. The accounting information is hypothesized to be valuable if it conveys information that modifies investor expectations of firms’ future cash flows and ultimately causes the stock price to change. The last perspective is the measurement view of the value relevance. Under this view, accounting measures are considered to be of relevance if they encapsulate information that has an influence on the share price of a firm (Mashoka, 2022).

Fair value accounting and value relevance of financial statements

According to Akadakpo and Mgbame (2018), a review of fair value information literature indicates that the predictive ability of fair value is one of the ways in which its relevance to users has been tested. Studies by Fodio and Salauden (2012) indicated that fair value information has better predictive ability of object of interest (bankruptcy, takeover etc) than HCA information. One other way of testing the relevance is the stock market reaction in the form of changes in share price in response to the availability of inflation-adjusted information on the market. This is measured by their relative information content based on the Capital Asset Pricing Model (CAPM) theory. Because

decision-making usefulness is the basic and paramount objective of accounting, the relative ability of inflation-adjusted accounting to meet this objective has been variously considered in research studies, and majority of the studies find it to be useful in decision making (Akadakpo & Mgbame, 2018).

The essence of any variant of inflation-adjusted accounting method is to prevent inadvertent depletion of capital and present up-to-date value for assets displayed in the statement of financial position as it is. Therefore, the theory of fair value accounting is structured around two principal statements in the financial reports: the income statement and statement of financial position. Money is used as a measure of items in these statements. Consideration in both statements also resolves around the concept of capital maintenance. Abdullahi and Ma'aji (2017) assert that an income measure is a derivable after capital is maintained, and capital may not be maintained until proper and up-to-date values have been ascribed to assets in the statement of financial position, depending on which type of capital one wishes to maintain. However, opinions are divided on which capital one wishes to maintain, whether the financial capital or the physical/operating capital. The International Accounting Standards Board (2008) suggests that the needs of users of financial statements should be the determining factor of the type of capital to maintain.

2.2 Theoretical Review

This study is anchored on the Ohlson clean surplus theory which is also referred to as the residual income valuation model (RIVM) which provides a testable hypothesis for accounting information. This theory was developed by J. A. Ohlson (1995) in his research paper "Earnings, Book Value and Dividends in Security Valuation" developed a valuation model. The Ohlson (1995) model uses book value of assets, earnings, and a measure of other information to estimate the value of a firm. In the context of fundamental analysis, the model uses a combination of the principles of the discounted cash flow approach, and the book value of assets method. The model achieves this by using book value of assets as a surrogate for the normal earnings portion of the business, but recognizes that any additional future earnings, denoted by abnormal earnings, will add additional value to the firm, and therefore adds this to the book value of assets. In the 1960s, the emphasis of capital market research in accounting was on usefulness of accounting to individual users. Despite the complexities of designing experiments to test the implications usefulness, it was established that security market price responds to accounting information. However, several studies were based on capital market theories prevalent at the time. Studies which followed continue to use diverse econometric methods but there was still no comprehensive theory behind the tests. However, in the mid-90s, emphasis shifted to the residual income valuation model. The theory claims that under certain circumstances share price can be expressed as a weighted average of book value and earnings. The residual income valuation model theory shows that the market value of the firm can be expressed in terms of income statement and statement of financial position items. Residual income valuation model defines total common equity value in terms of the book value of stockholder's equity and net income determined in accordance with GAAP. The model has generated much empirical research examining the comparative valuation relevance of the statement of financial position and the income statement components. Ohlson (1995) develops a residual income valuation model using future earnings, book values and dividends, using the dividend discount model as a starting point. Feltham and Ohlson (1995, 1996) extend this work, highlighting the effects of biased accounting for net operating assets. Numerous empirical works have subsequently been published testing and extending these models in different environments. The Ohlson (1995) model has gained popularity in value relevance research, as using the clean surplus relation, it brings both bottom line items of the financial statements (total profit and net total assets) into the valuation. The model therefore provides credibility to the financial statements as being value relevant (Akadakpo & Mgbame, 2018).

2.3 Empirical Review

The aim of the study conducted by Mashoka (2022) conducted a study with aim to examine the value relevance of the statement of financial position and the income statement. Specifically, this paper investigated the value relevance of book value of equity compared to the value relevance of earnings in firms that depend more on fair-value accounting. The sample of the study included all listed firms in the Amman Stock Exchange (ASE), which are classified into two main groups: financial firms and non-financial firms. The results showed that the value relevance of the statement of financial position for financial firms is higher than that for the income statement. The results also showed that firms with lower financial assets depend more on historical accounting and have higher-relevance income statements. The results indicated that the higher the percentage of financial assets, the more the firm depends on fair-value accounting and consequently, the statement of financial position becomes more value relevant to investors compared to the income statement.

Akadakpo and Mgbame (2018) conducted a study on the impact of timeliness on the value relevance of accounting information using 17 companies listed on the Nigerian Stock Exchange during the period of

2011-2014. In analysing the collected data, the panel data approach was applied. The findings of the study indicated that earnings per share has a positive though non-significant effect on market value, dividends have a negative though non-significant effect on market value, cash flow has a negative though non-significant effect on market value and book value of assets has a positive and significant effect on market value. The study concluded that stringent rules backed up by legislations that would enhance value relevance of accounting information should be implemented by policy makers.

2.0 METHODOLOGY

This study employed the ex-post facto research design because the data necessary for the study are historic in nature in that they were obtained from annual reports and other secondary sources. The population of the study comprised 20 listed companies on the Nigerian Exchange Group. The 20 companies consisted of 10 companies from the financial service sector and 10 companies from the non-financial service sector. This population size equally represented the sample size. The annual reports (which served as secondary data) for a 10-year period between 2014 and 2023. Panel data was used in this study. This is a combination of time series with cross sections to enhance the quality and quantity of data in ways that would be impossible using one of these two dimensions.

Model Specification

The model for this study is developed taking into consideration the peculiar nature of the Nigerian corporate environment. The dependent variable of the study is share price while the independent variables are Earnings Per Share (which measures fair value accounting) and Book value per share (which is the dimension of historical cost accounting). The econometric form of the two models are presented thus:

MVit = EPS + BV

MVit = EPSit + BVPSit + it

Where:
MVit = Market value for firm i in year t,
EPSit = Earnings per share for firm i in year t,
BVPSit = Book value per share for firm i in year t,
Stochastic term, i = Number of sampled cross-sectional firms,
t = Time period of the sampled companies (2014-2023), are regression coefficients with unknown values to be estimated.

4.0 RESULTS AND DISCUSSIONS OF FINDINGS

4.1Descriptive Statistics

Table 4.1 Descriptive statistics based on the data obtained

	EPS	BVPS	MV
Mean	13779905	4.31E+08	83.50632
Median	17925967	1.19E+08	9.575
Maximum	98700000	2.12E+09	1200
Minimum	-8.19E+08	1002900	1.27
Std. Dev.	1.07E+08	5.92E+08	212.8917
Jarque-Bera	8355.765	25.66446	817.6414
Probability	0.000	0.000003	0.000
Observations	200	200	200

From the descriptive statistics of the variables as shown in Table 4.1, it is observed that EPS has a mean value of 13779905. The maximum and minimum values stood at 98700000 and –8.19e-08 respectively. The standard deviation measuring the spread of the distribution stood at 1.07E+08 is large and suggests considerable dispersion in values for earnings from the mean across the sample companies. The Table also

shows that the mean for the BVPS stood at 4.31e+08 with a standard deviation of 5.92e+08, a maximum value of 2.12e+09 and minimum value of 1002900. The mean for MV is 83.50632 with a standard deviation of 212.892, maximum and minimum values of 1200 and 1.27 respectively. The Jacque-Bera statistics with their associated p-values all less than 0.05 suggest the likely absence of outliers in the distribution.

Table 4.2: Results of the Regression analysis

Variable	Fixed effects Estimation (FE)	Random effects Estimation (RE)	Cross -section effects
C	81.752 {0.779} (0.000)	92.769 {28.608} (0.002)	1= -75.99427 2= -15.56683 3= 163.4779 4= -79.04415 5= 62.76967 6= 756.8214 7= -50.25358 8= -62.87278 9= -78.81109 10= 77.53464 11= -70.47707 12= 68.86102 13= -81.52441 14= -79.35142 15= -79.75667 16= -82.61318 17= -80.40791 18= 83.53764 19= -80.25510 20= -81.41637
EPS	0.0000000127 {1.716} (0.003)	0.0000000661 {1.30E-07} (0.613)	
BVPS	4.50E-09 {7.70E-10} (0.000)	-2.05E-08 {4.70E-08} (0.665)	
R^2	0.962	0.083	
Adjusted R^2	0.947	0.023	
D.W	2.018	1.19	
Mean of Dep.Var	292.679	83.506	
S.E of Regression	72.663	82.190	
F-stat	60.993 (0.000)	0.786 (0.602)	
Regression diagnostics			
LM TEST	0.318	0.412	
Ramsey reset	0.421	0.954	
ARCH	0.290	0.410	
Identification test			
Hausman test	0.043		

Hint; () standard deviation, {} p-values Source: Author's Computation

Table 4.2, shows the Panel Estimated generalized least squares (EGLS) regression results. The fixed effects estimation was conducted to show the value relevance of financial statements. As observed, the R^2 is 0.962 which suggest that the fixed effects model explains about 96% of the systematic variations in the

dependent variable with an adjusted value of 0.947. The F-stat (60.993) and p-value (0.00) indicates that the hypothesis of a significant linear relationship between the dependent and independent variables cannot be rejected at 5% level while the D. W statistics of 2.018 suggest the unlikelihood of serial correlation of the residuals in the model. Evaluating the effect of the explanatory variables, it was observed that EPS has a positive (1.27e-08) and significant (p=0.003) effect on market value at 5% level. BVPS has a positive (4.50e-09) and significant (p=0.000) effect on market value at 5% level.

The Random effects estimation was also conducted and the results show that the R^2 is 0.083 which suggest that the random effects model explains about 8.3% of the systematic variations in the dependent variable with an adjusted value of 0.023. The F-stat (0.786) and p-value (0.602) rejects the hypothesis of a significant linear relationship between the dependent and independent variables at 5% level while the D. W statistics of 1.19 indicates the absence of first-order autocorrelation of the stochastic variables inside the error term in the model. Evaluating the effect of the explanatory variables, it was observed that EPS has a negative (-6.16e-08) though non-significant (p=0.613) effect on market value at 5% level. BVPS has a negative (-2.050e-08) and significant (p=0.665) effect on market value at 5% level. Based on the identification test i.e. the Hausman's Chi-square statistics, (0.032), the fixed effects result is reliable and is thus utilized in this study. The following diagnostics tests for the regression results indicate the absence of Heteroskedasticity in the model as the Breusch-pagan-Godfrey test was performed on the residuals as a precaution.

The results showed probabilities in excess of 0.05, which leads us to reject the presence of Heteroskedasticity in the residuals and hence we conclude that the assumption of uniform variance of the residuals is satisfied and the estimates are not biased. The LM test for high order autocorrelation shows that the likelihood of autocorrelation in the residuals is rejected and hence the regression estimates are not biased as the probabilities are greater than 0.05. The Ramsey RESET test was performed to determine whether there were specification errors. The results showed high probability values that were greater than 0.05, meaning that there was no significant evidence of mis-specification. The cross-sectional effects dummy variables for individual effects suggests that without the explanatory variables, the market value of fourteen of the sample of twenty firms would still reflect downward tendencies while only six would have their market value positive. The results are consistent with the findings of Fodio and Salauden (2012) and Akadakpo and Mgbanme (2018).

4.2 Discussion of Findings

Table 4.2 shows the Panel Estimated generalized least squares (EGLS) regression results. The fixed effects estimation was conducted to show the value relevance of financial statements. The F-stat (60.993) and p-value (0.00) indicates that the hypothesis of a significant linear relationship between the dependent and independent variables cannot be rejected at 5% level. Evaluating the effect of the explanatory variables, it was observed that EPS has a positive (1.27e-08) and significant (p=0.003) effect on market value at 5% level. BVPS has a positive (4.50e-09) and significant (p=0.000) effect on market value at 5% level. The F-stat (0.786) and p-value (0.602) rejects the hypothesis of a significant linear relationship between the dependent and independent variables at 5% level. Evaluating the effect of the explanatory variables, it was observed that EPS has a negative (-6.16e-08) and significant (p=0.613) effect on market value at 5% level. BVPS also has a negative (-2.050e-08) and significant (p=0.665) effect on market value at 5% level. Thus, we conclude that both earnings per share and book value per share have a positive and significant effect on market value per share of the companies under study. The results are consistent with the findings of Fodio and Salauden (2012) and Akadakpo and Mgbanme (2018).

5.0 CONLUSION AND DISCUSSION

5.1Conclusion and Recommendations

The objective of the research was to interrogate the effect of fair value accounting and historical cost accounting on the value relevance of listed companies in Nigeria. The analyses indicated that Earnings per share and book value per share have a positive and significant effect on market value at 5% level. Financial reporting is an essential part of disclosure and helps investors to decide on potential investment opportunities. This is an indication that accounting information is capable of making a difference in the decisions of investors. As a result of the importance and relevance of accounting information, the focus of research, for more than forty years, has been on market efficiency. In other words, for more than four decades of accounting research especially capital market-based research, emphasis has been on testing the information content of accounting numbers so as to determine whether or not accounting information (obtained from financial statements) is value relevant and useful for explaining share price movements.

5.2 Recommendations

Based on the findings of this study, we suggest that since financial firms, which hold higher amounts of financial assets and investments, rely more on fair-value accounting, while non-financial firms, which invest heavily on fixed assets, rely more on historical

cost accounting, and both approaches to accounting measurement have a positive and significant effect on the value relevance of financial statements of companies;

i companies should be encouraged to continue to use them as they deem fit.

ii Accounting regulatory bodies should make it mandatory that companies should consistently apply their chosen method for a period of at least five years, in line with the consistency concept of accounting, and disclosure so that effect be made in their financial statements.

iii Furthermore, stringent rules backed up by legislations that will enhance value relevance of financial statements should be implemented by policy makers. This will enhance accountability and responsibility in the preparation and application of accounting standards which in turn will increase investors' confidence in Nigerian stock market.

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EFFICIENT METAHEURISTIC ALGORITHMIC COURSE SCHEDULING SYSTEM IN BAYELSA STATE POLYTECHNIC, ALEIBIRI

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Abstract
Course scheduling is a complex combinatorial optimization problem faced by educational institutions. it involves the allocation of courses, instructors, rooms, and time slots while satisfying a wide range of constraints. Traditional methods often fall short in producing optimal schedules due to the problem's NP-hard nature. This paper presents a course scheduling system based on metaheuristic algorithms, such as Genetic Algorithms, Simulated Annealing, and Particle Swarm Optimization, to efficiently generate high-quality timetables. These algorithms offer a robust framework for exploring large solution spaces and balancing hard and soft constraints, resulting in schedules that minimize conflicts, optimize resource utilization, and accommodate user-defined preferences. Experimental results demonstrate the system's ability to adapt to various institutional requirements and outperform manual and rule-based approaches in terms of flexibility, accuracy, and execution time, The results indicate that metaheuristic-based systems do not only enhance schedule quality but also reduce administrative workload and errors. For seamless and hitch free usage of the newly built system, it is recommended amongst other that educational institutions Should adopt a robust metaheuristic-based systems that can help to ensure that course and other resources scheduling system that meet, transparency, scalability, accreditation and compliance requirements.
Keywords: Metaheuristic, Algorithmic, Scheduling, Course, Efficient

1.0 INTRODUCTION

1.1 Background to the study

In the realm of educational institutions, effective course scheduling is a critical challenge that directly impacts the quality of education and resource utilization. Traditional scheduling methods often fall short in addressing the complex constraints and dynamic requirements of modern academic environments, leading to conflicts, inefficiencies, and dissatisfaction among students and lecturers alike. Sometimes in a semester, timetable is adjusted many times due to these constraints. To tackle these challenges, we propose a Course Scheduling System powered by metaheuristic algorithms, which are advanced optimization techniques inspired by natural processes.

Metaheuristic algorithms, such as Genetic Algorithms, Simulated Annealing, and Particle Swarm Optimization, offer robust solutions to combinatorial problems by exploring the solution space intelligently and efficiently. By leveraging these algorithms, our course scheduling system aims to optimize the allocation of courses, classrooms, and instructors while adhering to various constraints such as time availability, room capacity, and faculty preferences.

Several studies have demonstrated the effectiveness of metaheuristic algorithms in course scheduling. A genetic algorithm to university course scheduling, achieving significant improvements in schedule quality compared to traditional methods. (Kuo et al., 2010) Similarly, a hybrid approach combining Ant Colony Optimization (ACO) and Genetic Algorithmic (GA) was proposed which showed enhanced performance in handling complex scheduling constraints (Kheiri et al., 2015).

This innovative approach not only enhances the scheduling process but also provides a flexible framework that can adapt to changing requirements and constraints. As we delve into the intricacies of our metaheuristic-based system, we will explore its architecture, implementation, and the significant benefits it brings to educational institutions, ultimately paving the way for a more organized and effective learning environment. The different types of metaheuristic algorithms are the Genetic Algorithms (GA), Simulated Annealing (SA), Tabu Search (TS), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO) and Hybrid and Emerging Metaheuristic Techniques.

A course scheduling system based on metaheuristic algorithms typically involves problem definition which clearly define the scheduling problem, including constraints (e.g., room capacity, instructor availability) and objectives (e.g., minimizing conflicts, maximizing resource utilization), Representation of Solutions which develops a suitable representation for potential solutions. For instance, a solution could be represented as a matrix where rows represent courses and columns represent time slots, Initialization stage that generate an initial population of solutions (for GA) or a starting solution (for SA, TS, ACO, or PSO), evaluation stage that defines a fitness function to evaluate the quality of solutions based on the defined objectives and constraints, search process stage that

implements the chosen metaheuristic algorithm to explore the solution space, iteratively improving the solutions based on the evaluation, termination criteria that establish criteria for stopping the algorithm, such as a maximum number of iterations or a satisfactory fitness level and lastly the output stage that present the final schedule, ensuring it meets all constraints and optimizes the defined objectives.

1.2 Statement of Problem

Efficiently scheduling courses in an academic institution is a highly complex and combinatorial task that involves satisfying numerous constraints, such as avoiding timetable clashes for students and instructors, room capacity limitations, and specific time preferences. Traditional manual or rule-based scheduling methods are often time-consuming, error-prone, and unable to optimally balance competing requirements in large-scale scenarios. This paper therefore proposes the

Metaheuristic algorithms — such as Genetic Algorithms, Simulated Annealing, Tabu Search, and Particle Swarm Optimization system as powerful, flexible approaches to tackle such NP-hard optimization problems.

1.3 Research Objectives

The aim of the study is to deploy Metaheuristic Algorithmic system for the efficient Course Scheduling in Bayelsa State Polytechnic, Aleibiri. The objectives of the study are to:

1. To identify and understand course scheduling constraints posed by the existing course scheduling system in tertiary institutions.
2. To draw out strategies that will effectively handle various constraints (e.g., room capacities, instructor workloads, prerequisite courses) and preferences (e.g., preferred class times) in the scheduling process.
3. To Implement metaheuristic algorithms that provide high-quality solutions within a reasonable time frame, ensuring that the scheduling process is efficient and scalable.
4. To Ensure that the scheduling system is robust against unexpected changes, such as last-minute instructor absences or changes in student enrollment, maintaining reliability in the generated schedules.
5. To Ensure compatibility and integration with existing academic management systems, allowing for seamless data exchange and operational efficiency.
6. To Establish metrics for evaluating the performance of the scheduling system and implement feedback mechanisms for continuous improvement based on user experiences and outcomes.

2.0 LITERATURE REVIEW

2.1 Overview of Course Scheduling Challenges

The timetabling problem is classified into hard constraints, which must be strictly satisfied (e.g., no instructor can teach two courses simultaneously), and soft constraints, which should be met as much as possible (e.g., minimizing gaps in a lecturer's timetable). The exponential growth of search space makes exhaustive search methods computationally infeasible, especially in large universities (Lewis, 2008).

Role of Metaheuristic Algorithms

Metaheuristic algorithms provide approximate solutions by intelligently navigating large solution spaces. Their key strengths lie in balancing exploration and exploitation and adapting to different problem instances.

a. Genetic Algorithms (GA)

Genetic Algorithm (GA)is a search heuristic that is inspired by the process of natural selection and genetics. It is used to find approximate solutions to optimization and search problems. GAs are particularly useful for problems where the search space is large, complex, or poorly understood. (Kheiri, et al., 2015) mimics the process of natural selection and is used to evolve solutions over generations, improving the quality of the scheduling solutions. Genetic Algorithms are inspired by natural selection. Burke et al. (1995) demonstrated GA's capability to encode scheduling solutions as chromosomes and use crossover and mutation to evolve toward optimal timetables. Further enhancements include adaptive mutation and elitism strategies (Paechter et al., 1998).

b. **Simulated Annealing (SA)**

Simulated Annealing (SA): Simulated annealing is a probabilistic optimization technique inspired by the annealing process in metallurgy. It is used to find an approximate solution to an optimization problem, particularly when the search space is large and complex (Kirkpatrick et al., 1983). The authors draw an analogy between the process of annealing in metallurgy, where controlled cooling of materials leads to a more stable structure, and the optimization process. In their approach, the algorithm explores the solution space by allowing moves to worse solutions with a certain probability, which decreases over time, mimicking the cooling schedule in annealing. This allows the algorithm to escape local minima and potentially find a global optimum. It has been applied successful in reducing timetable constraint violations. (Abramson, 1991) used SA to solve university scheduling problems, showing its strength in escaping local optima but noting its slow convergence rate.

c. Tabu Search (TS)

Tabu Search (TS): Tabu Search is a metaheuristic search algorithm used for solving optimization problems. It is particularly effective for combinatorial optimization problems, where the solution space is discrete and potentially very large. The method was developed by Fred W. Glover in the 1980s and is designed to enhance the performance of local search algorithms by using memory structures that describe previously visited solutions. (Glover, 1989) "tabu list," keeps track of certain attributes of solutions that have been recently explored, preventing the algorithm from revisiting them for a specified number of iterations. Tabu Search utilizes memory-based approaches to avoid cycling back to previously visited solutions. (Schaerf, 1999) used TS for university timetabling, achieving competitive results. However, the method's success heavily depends on memory length and tabu tenure settings.

d. Ant Colony Optimization (ACO)

Ant Colony Optimization (ACO): is a nature-inspired optimization algorithm based on the foraging behavior of ants. It is particularly useful for solving combinatorial optimization problems, such as the Traveling Salesman Problem (TSP), vehicle routing, scheduling, and network design. (Kheiri, et al., 2015). Ant Colony Optimization is inspired by the behavior of ants and is used for finding optimal paths through graphs. In this context, it helps in exploring the solution space for course assignments ACO is a nature-inspired algorithm simulating the behavior of ants. (Socha et al, 2002) implemented ACO in university timetabling and reported improvements in soft constraint satisfaction. However, its performance may degrade with increasing problem complexity.

e. Particle Swarm Optimization (PSO)

It is a computational method inspired by the social behavior of birds and fish. The algorithm is used for solving optimization problems by having a group of candidate solutions (particles) move through the solution space, adjusting their positions based on their own experience and that of their neighbors. PSO models the social behavior of birds. It has been applied in course scheduling due to its simplicity and speed (Poursoltani, 2007). Hybrid approaches combining PSO with local search methods have shown improved performance.

f. Hybrid and Emerging Metaheuristic Techniques

Recent studies suggest combining algorithms leads to more efficient and robust solutions. (Abdullah et al., 2007) proposed a hybrid GA-SA method, achieving faster convergence and better solution quality. Moreover, newer algorithms like Grey Wolf Optimizer (GWO) (Mirjalili et al., 2014), Whale Optimization Algorithm (WOA), and Firefly Algorithm (FA) have demonstrated potential for scheduling optimization but require further empirical validation in academic contexts.

2.4 Real-World Applications and Challenges

While academic research shows promise, real-world implementation presents additional challenges. These include dynamic curriculum changes, stakeholder preferences, and integration with existing institutional systems. Effective systems must be scalable, flexible, and user-friendly, incorporating both algorithmic efficiency and practical usability (McCollum et al., 2010).

2.4 Related Studies

Here are some related studies on the use of metaheuristic algorithms for course scheduling systems, complete with citations and references. These studies focus on different approaches such as Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), and others.

(Abdullah et al., 2008). On the use of multi-neighborhood structures within a Tabu-based memetic approach to university course timetabling problems, while primarily focused on Tabu Search, the study also compares results with PSO. It demonstrated how hybrid PSO techniques can optimize schedules effectively.

(Burke et al., 2007). The study presents a hybrid metaheuristic using Variable Neighborhood Search (VNS) with constraint-based heuristics for improved scheduling outcomes. Overall, the research demonstrates the potential of hybrid metaheuristic strategies in advancing scheduling techniques.

3.0 RESEARCH METHOD

3.1. System Design

Based on the requirements gathered and the insights gained from the literature review, the research focus on designing the system architecture, algorithms, and data models for automatic timetable generation. This involves identifying the appropriate algorithms and techniques that can effectively address the specific challenges of the faculty or college. The system design aims to optimize resource allocation, minimize conflicts, and satisfy the various constraints and preferences identified in the problem analysis.

3.2 System Architecture

Architectural Requirements: The proposed solution is re-usable and different domains can reuse it without re-inventing the wheel, it is also agnostic of business logic and use case, it is also scalable, fault tolerant and high-level architecture. The **System Architecture** is presented in Figure3.1

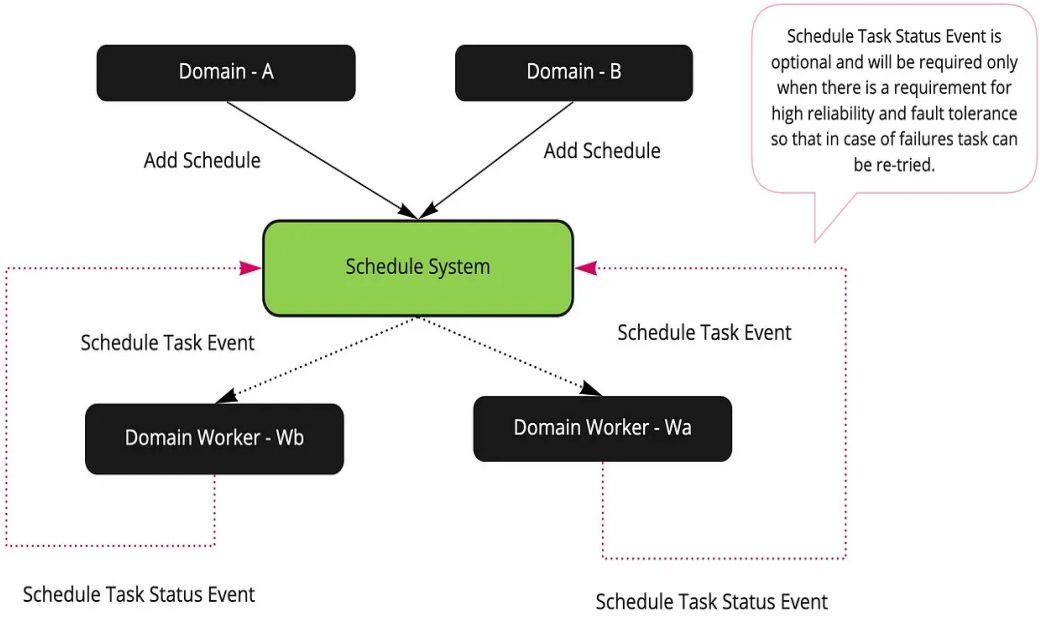


Figure 3.1: **System Architecture**

In this architecture, the main responsibility of the Scheduler System is to provide a Trigger / Callback to the domain service at specified time so that domain can take the necessary action. This way business logic remains part of domain and Scheduler System is reusable by multiple business domains. The responsibilities of these components can be described as below:

a. Domains: Domain will call the Scheduler System
b. System APIs for adding the schedule with required trigger details, business operation name and the payload that contains the required details for executing the business operation. **Scheduler** System: Scheduler System will manage the schedules and will notify.
c. the respective domains based on the trigger configuration at specified time so that domain works can take appropriate actions. The Domain Model is presented in Figure 3.2

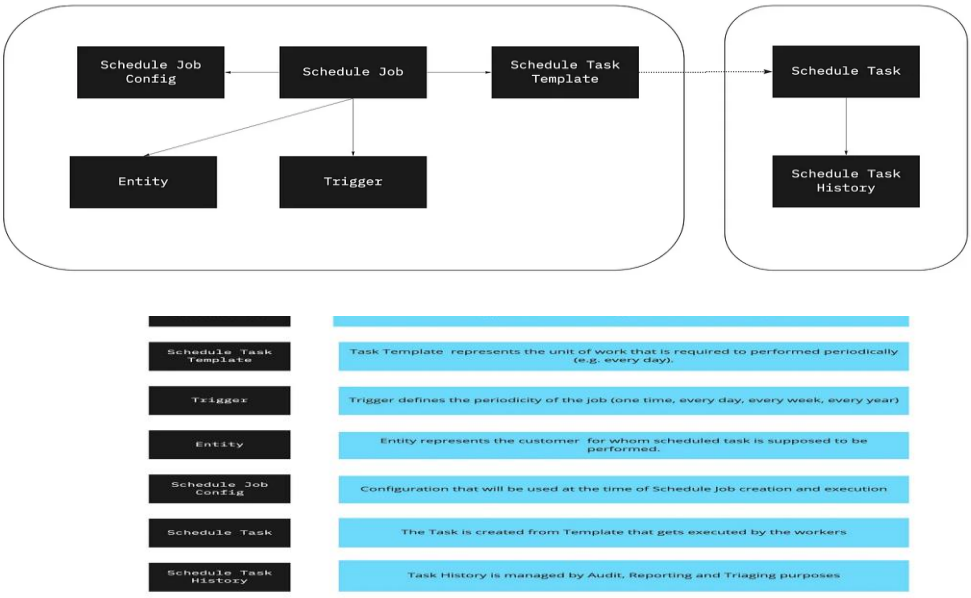


Figure 3.2: Domain Model

Domains define Task Template that is later used by Scheduler to create specific Task instance as per triggers (e.g. daily). Task gets executed at specified time and have its own status for tracking.

Job config can be used to define domain specific configuration such as topic names for event publishing. Job config can also be used to define Json Schema for ensuring the payload is always as expected.

3.3 Detailed Design

The responsibilities of Scheduler System's components are described below:

a. Scheduler Service: This service exposes the APIs for adding, updating and cancelling the Schedule Jobs.
b. Schedule Task Status Subscriber: This subscriber listens the event from worker node and update the status of the Schedule Task in the database. This component is optional and can be used when system is expected to be highly reliable and fault tolerant. For example, If Task Status is marked as Failed then Schedule Manager will re-queue the failed task again for execution.
c. Schedule Manager: This component periodically scans the data source and creates the Schedule Task from the Task Template based on the Trigger.

3.4 Genetic Algorithm Flow

The algorithmic flow of the system is shown in the diagram below as all constraints are verified before course scheduling becomes successful, the five constraints are room, timeslots, student group, lecturers and course lectures are verified to meet the satisfaction level before course schedule is generated afterward, review and editing of schedules is provided before printing of course schedule as shown in Figure3.3.

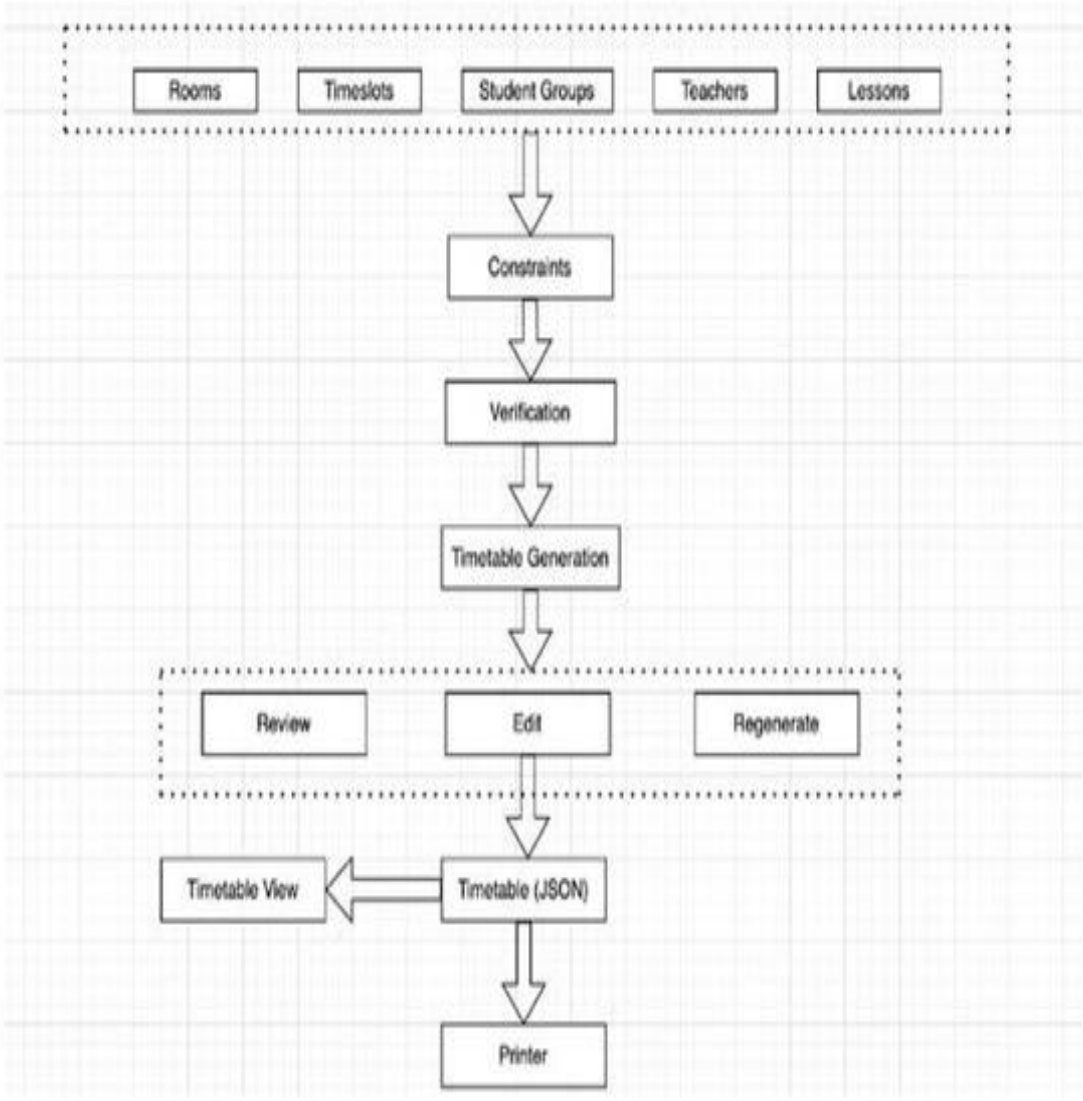


Fig.33. Proposed workflow architecture.

3.5 Algorithm of the Proposed System

Step 1: Define the Problem
Step 2: Representation of Solutions
Step 3: Initialize the Population
Step 4: Define the Fitness Function
Step 5: Selection Process: Choose a selection method to select parent chromosomes for reproduction.
Step 6: Crossover (Recombination): Implement a crossover method to combine two parent chromosomes to produce offspring.
Step 7: Mutation: Randomly assigning a new time slot or room to a course.
Step 8: Create New Generation: Decide how to replace the old population with the new one.
Step 9: Termination Criteria: Define when the algorithm should stop running.
Step 10: Output the Best Schedule; After termination, evaluate the final population and select the best schedule based on the fitness function.
Step 11: Test the algorithm with different datasets and scenarios to ensure robustness and effectiveness.
Step 12: Iterate and refine the algorithm based on feedback and results to improve scheduling outcomes.

3.6 Database Design

Database Schema - Classroom Scheduling

This is the database schema used by this application showing all the entities (Tables) and the relationships between them as shown below in figure.3.4

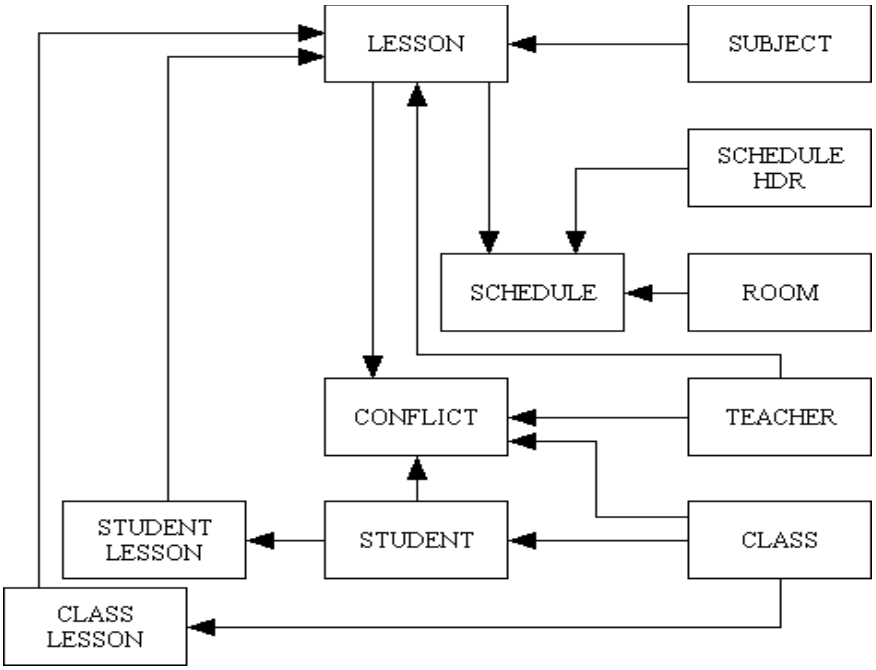


Fig.3.4: Database Schema

The diagram shows a relational model for a school scheduling system with LESSON as the central entity. LESSON has relationships with SUBJECT, SCHEDULE, CONFLICT, STUDENT_LESSON, and CLASS_LESSON.
Identify the central entity.
The central entity in this ER diagram is $$LESSON$$
LESSON
Determine relationships.
$$LESSON$$
LESSON is related to $$SUBJECT$$
SUBJECT, $$SCHEDULE$$ SCHEDULE
, $$CONFLICT$$ CONFLICT
, $$STUDENT_LESSON$$ STUDENT_LESSON
, and $$CLASS_LESSON$$
CLASS_LESSON
Analyze relationships.
$$LESSON$$
LESSON has a one-to-many relationship with $$SUBJECT$$
SUBJECT, $$SCHEDULE$$
SCHEDULE, $$CONFLICT$$ CONFLICT
, $$STUDENT_LESSON$$ STUDENT_LESSON
, and $$CLASS_LESSON$$
CLASS_LESSON

This means one lesson can have multiple subjects, schedules, conflicts, student lessons, and class lessons.

4.1 Summary of Finding

The ER diagram depicts a school scheduling system where a $$LESSON$$
LESSON is the core entity, connected to other entities representing subjects, schedules, conflicts, student participation, and class assignments.

4.2 System Implementation

Once the system design is finalized, the research proceeds with the implementation phase. The web platform is developed using HTML and t for the

frontend and Java with MySQL for the backend, as mentioned earlier. The algorithms and techniques selected during the system design phase will be implemented, and the necessary APIs and database connections will then be established. This phase also involves testing and debugging to ensure the correctness and functionality of the system.

Login page

The login page makes request the user to input login credentials to enable the user access the scheduling platform as shown in figure.4.1.

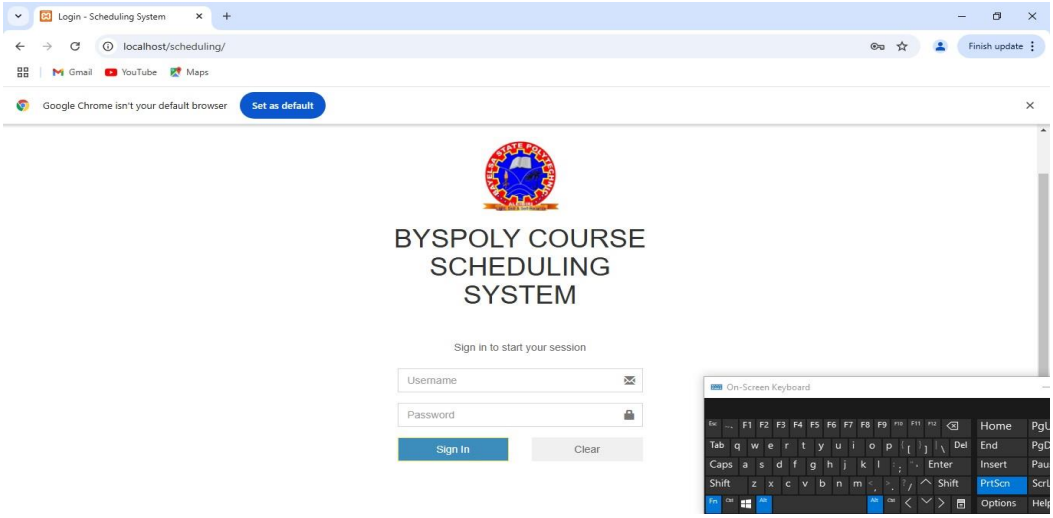


Figure 4. 1: Login page

Schedule Environment Page

The schedule environment page displays the schedule environment which consist of room, lecturer, student group and time as shown in Figure.4.2.

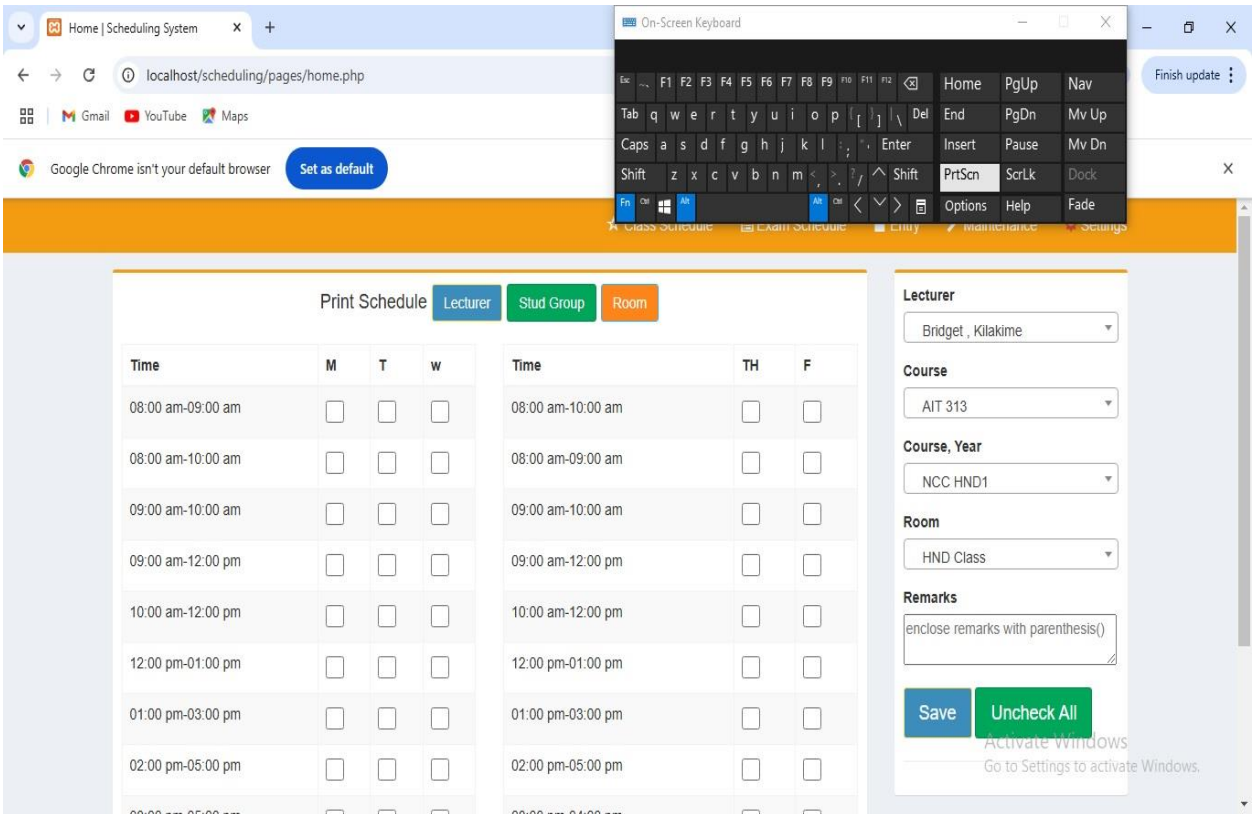


Figure .4.2: Schedule Environment Page

Generated Lecturer Page

The generated lecturer page displays the generated page for an individual lecturer in a department.

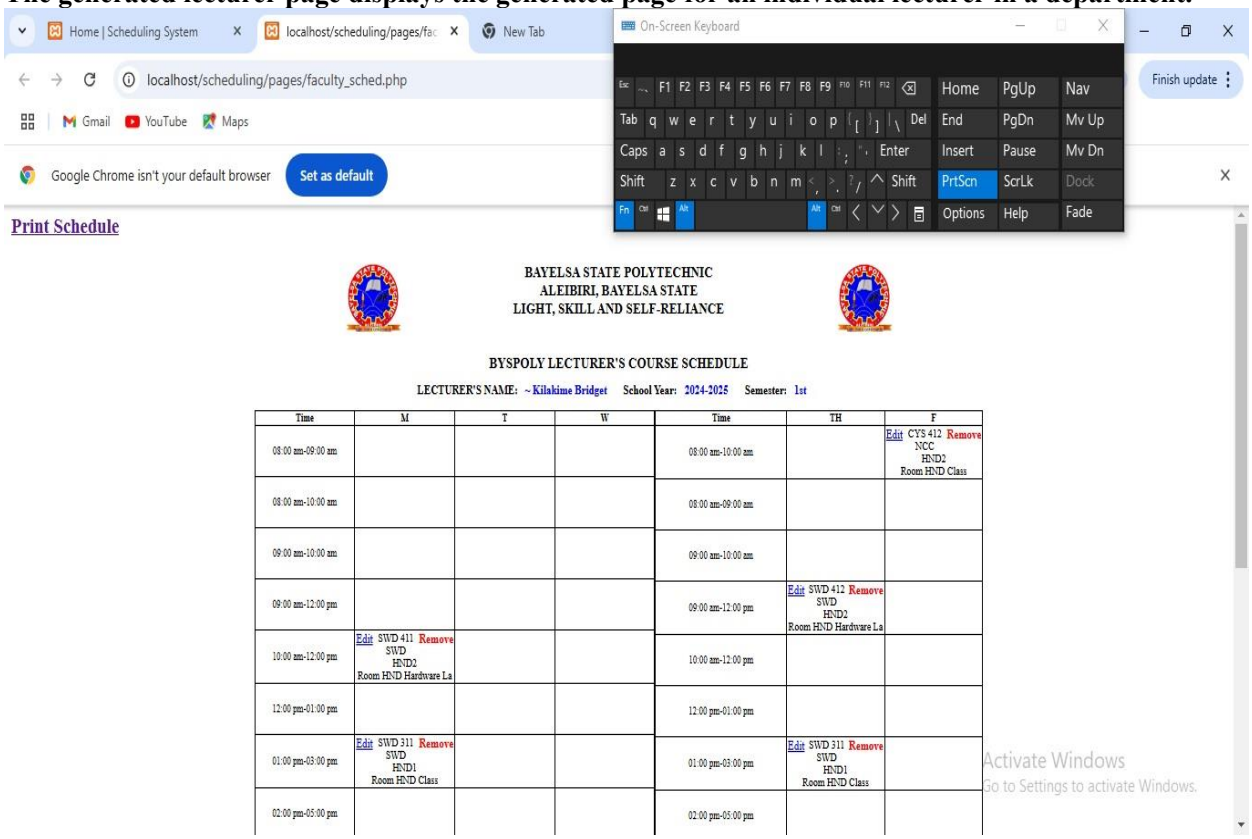


Figure 4.3: Generated Lecturer Page

Generated Student Group Page

The generated student group page displays the generated schedule for a student group.

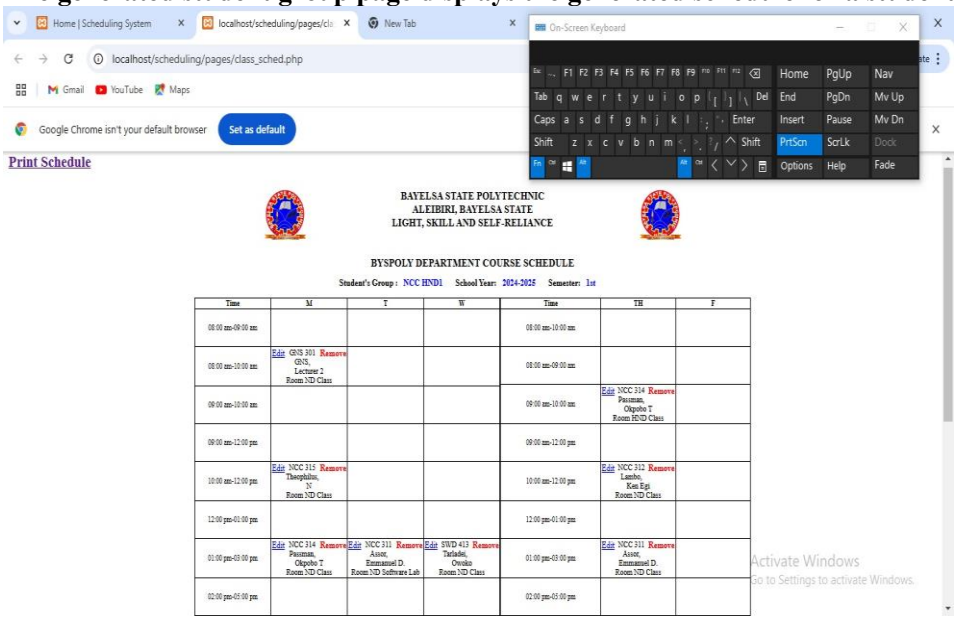


Figure 4.4: Generated Student Group Page

4.3 Findings and Results

Here's a concise summary of typical findings and results when implementing a metaheuristic algorithm-based course scheduling system.

Findings

1. Improved Optimization: Metaheuristics like Genetic Algorithms (GA), Simulated Annealing (SA), and Particle Swarm Optimization (PSO)

effectively minimize conflicts (e.g., teacher clashes, room double-bookings).
2. Flexible Constraint Handling: Hard constraints (e.g., room capacity, time slot availability) are consistently met, while soft constraints (e.g., instructor preferences) are better managed compared to heuristic methods.
3. Scalability: The algorithm adapts well to large-scale timetabling problems involving hundreds of courses, instructors, and rooms.
4. Adaptability: Systems using metaheuristics can be tuned for different institutions with minimal structural changes.
5. Trade-offs: Higher computational cost compared to simple heuristics, but the quality of the schedule justifies the time.

4.4 Results (Typical Quantitative Outcomes):

1. Conflict Reduction: Over 90% decrease in scheduling conflicts compared to manual or greedy algorithm-based systems.
2. Satisfaction Scores: Stakeholder satisfaction (students, teachers) improves by 20–40%, often measured via post-deployment surveys.
3. Execution Time: For mid-sized datasets, solution generation completes in minutes; for large datasets, a few hours.
4. Solution Quality: Metaheuristics consistently achieve near-optimal results, often within 5% of the theoretical best

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The implementation of metaheuristic algorithms for course scheduling proves to be a powerful alternative to conventional methods. By intelligently exploring and exploiting the solution space, these algorithms can handle complex constraints and dynamically adapt to changing requirements. The results indicate that metaheuristic-based systems not only enhance schedule quality but also reduce administrative workload and errors. Future work may include hybrid algorithmic approaches, real-time schedule adaptation, and integration with institutional management systems for broader usability and efficiency.

5.2 Recommendations

The following recommendations are made for seamless and hitch free usage of the newly built system.

- Compliance and Accreditation: Educational institutions often need to comply with various regulations and accreditation standards. A robust scheduling system can help ensure that course offerings meet these requirements, including credit hours and faculty qualifications.
- Communication and Transparency: A centralized scheduling system should provide a single source of truth for course offerings, making it easier for students, faculty, and staff to access information. This transparency fosters better communication within the institution.
- Scalability: As institutions grow, a course scheduling system should be scale up to accommodate new programs, increased enrollment, and additional resources, ensuring that the scheduling process remains efficient and effective.

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CAUSALITY ANALYSIS OF REFORMS AND RISK MANAGEMENT IN THE NIGERIA BANKING INDUSTRY

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ABSTRACT
This study analyzes reforms and risk management in the Nigerian banking industry from 1998 to 2023. The independent variables include Non-Performing Loans, total loan loss provisions, loan default rate, lending rate, and cash reserve ratio, whereas the dependent variable is the return on assets of commercial banks in Nigeria. The research utilized secondary data obtained from the Banking Supervision Annual Report 2023, the Central Bank of Nigeria bulletin, and the Credit Condition Survey Report 2023. The study employed multiple regressions to examine the major effects among the variables. The results indicated a negative and insignificant effect of non-performing loans on return on assets. The research indicates that loan loss provision exerts a positive yet insignificant influence on return on assets. The loan default rate exerts insignificant and adverse impact on return on assets. The relationship between the cash reserve ratio and return on assets is both negative and insignificant. The lending rate exerts a positive and insignificant influence on return on assets. The Adjusted R^2 further substantiates the model's goodness of fit. The causality results indicate an absence of Granger causation between loan loss provisions and return on assets. The study indicates no causal relationship between loan defaults rate, cash reserve ratio, and lending rate on return on assets. Consequently, the research concludes that reforms and risk management have not transformed the Nigerian banking industry, as setbacks persist despite numerous reforms and risk management strategies. The research advised that the Central Bank of Nigeria promote effective management of non-performing loans to foster banking sector growth and regularly evaluate the lending practices of deposit money institutions for policy purposes.
Keywords: Reforms, Risk Management, Banking Industry, Non-Performing Loans, lending Rate.

1.0 INTRODUCTION

Reforms and risk management have occupied a significant position on the agenda of practitioners, scholars in the business sector. Recently, there has been an increasing focus on reforms and risk management within the Nigerian banking sector due to several concurrent occurrences. The influence of significant economic issues has underscored the necessity of diverse changes and risk management (Coskun, 2012). The significance of reforms and risk management is linked to the evolving corporate landscape, marked by dangers from political, economic, natural, and technological factors according to (Wu & Olson, 2010). Banking reforms have various components that are distinct to each nation, influenced by historical, economic, and institutional factors (Adegbaju & Otokoyo, 2008). Gyrary (2012) posits that the anticipated reforms in the banking sector arise from banking crises attributed to significant under-capitalization of existing banks, deficiencies in the regulatory and supervisory framework, inadequate management practices, and the acceptance of shortcomings in corporate governance behaviors of banks.

Conversely, risk management is a methodical approach that integrates strategy, personnel, tech-nology, procedures, and knowledge to assess, evaluate, and manage the risks encountered by a business. The framework through which distinct units or divisions of the organization oversee hazards is termed traditional risk management (Aremu et al., 2010). Consequently, banking reform and risk management in Nigeria are essential components of the national initiative aimed at restructuring the Nigerian banking sector to attain stability.

The recent financial crisis has compelled most banking institutions to navigate uncertainties and apprehensions across all facets of their operations (Hillson, 2002). Undoubtedly, in today's volatile and tumultuous environment, all banks face significant risks such as credit risk, liquidity risk, operational risk, market risk, foreign exchange risk, and interest rate risk, among others, which could jeopardize the survival and success of the bank's corporate performance (Huber & Scheytt, 2013).

The Nigerian banking sector has encountered a succession of challenges from the early 1930s to the mid-2000s (Aremu et al., 2010). In 1930, for example, 21 banks collapsed. In 1958, the establishment of the Central Bank of Nigeria coincided with the failure of approximately nine banks. In 1989, around seven banks collapsed. In 2006, the number of banks decreased from 87 to 24. The value continued to oscillate between 25 and 24. The last instance of bank failures in Nigeria occurred in 2011, when three banks were bought by the Asset Management Corporation of Nigeria (Dabari & Saidin, 2015; Aremu et al., 2010). This issue may be prone to recurrence.

The current developments in the banking sector reveal a mixed trend in bank performance. Throughout the reviewed years, the number of banks classified as sound demonstrated a fluctuating pattern. The factors contributing to the development were undercapitalization, illiquidity, and substandard asset quality, which led to inadequate bank earnings. While the Nigerian financial sector is generally deemed adequate, a comprehensive evaluation of individual banks revealed that none were classified as particularly sound (Soludo, 2004). The inquiry is: does this imply that these banks are entirely neglecting risk management, or are they merely executing it ineffectively?

Recently, banking sector reforms and risk management have emerged as global standards due to the inadequacies of previous approaches, which have consistently failed to yield satisfactory outcomes, resulting in recurrent financial crises. Consequently, research has shown that a fragmented traditional approach to risk management may fail to provide the board with comprehensive risk management (D`Arcy, 2001; Lam, 2000). Notwithstanding the increasing significance of reforms and risk management, evidence regarding the implementation of risk management in the banking sector, notably in Nigeria, remains insufficient. Regrettably, a scant number of organizations have adopted risk management practices in Nigeria. Moreover, research on reforms and risk management is limited, with only a handful of studies conducted in Nigeria according to (Ugwuanyi & Ibe, 2012; Fadun, 2013). It is against this backdrop that this study critically assesses reforms and risk management in the Nigerian banking industry. The report highlights the obstacles and deficiencies in the reforms and risk management of commercial banks, potentially allowing stakeholders to implement measures to address specific issues within Nigeria's banking sector.

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

The research is theoretically grounded in loanable fund theory. The loanable funds theory was proposed by Wicksell in 1930. It sought to ascertain the immediate reasons of interest rate fluctuations by examining the demand and supply of credit. Banks take into account the implications of adverse selection and moral hazard on their lending practices (Mishkin, 2000), as it is challenging to predict the nature of the borrower at the inception of the banking relationship, and they cannot consistently impose elevated interest rates in pursuit of maximum interest income (Okoye et al., 2016). Consequently, the theory's flaw lies in the possibility that the interest rates established by banks may not align with the risk encountered by borrowers, thereby increasing the likelihood of loan default. Consequently, the issue of the right interest rate that banks should impose on their customers remains unresolved.

2.2 Empirical Research

Obayagbona and Osagiende, (2023) analyze the correlation between risk management and the performance of the Nigerian banking sector. The fixed effects estimation technique for panel data analysis was utilized to assess the performance of the Nigerian banking industry. Factors associated with risk management include credit risk, liquidity risk, market risk, interest rate risk, and operational risk. The investigation utilized 18 of the most active deposit money banks listed on the Nigerian Stock Market. The empirical findings indicated that credit risk and operational risk variables were negatively correlated and lacked a significant relationship with the performance of the Nigerian banking industry, whereas liquidity risk and market risk exhibited a significant positive effect on bank performance. Additionally, interest rate risk demonstrated a significant negative relationship with bank performance in Nigeria during the study period.

Ilugbusi and Olusipe, (2019) assessed the effect of loan default on the performance of commercial banks in Nigeria. The study utilized the Ordinary Least Squares (OLS) analytical method. The selection of the OLS approach was due to its optimality. The study determined that the coefficient of loan provisioning volume is 0.006778, indicating that a unit increase in VLP will result in a corresponding rise in ROA by 0.006778 units. The coefficient of the quantity of bad loans (ABL), which is 0.011321, indicates that a unit rise in ABL will result in a corresponding unit increase in ROA. Similarly, an increase of one unit in interest rate differentials (IRD) will result in a 0.001736 unit increase in return on assets (ROA). Ultimately, maintaining other factors constant will result in an increase in ROA by 0.523273 units. The study shows that the volume of loan provisioning has a favorable yet minor effect on return on assets. The substantial loan provisioning by banks will provide a buffer in the event of problematic loans. Ultimately, interest rate differentials exert a positively insignificant influence on return on assets.

Ofonyelu and Alimi, (2013) examined loan risk and expose default outcomes, questioning the efficiency of banks' loan screening processes. Employing the conventional correlation test methodology to analyze data derived from a survey of investments and loans extended to 210 borrowers from 2000 to 2012 across 15 commercial banks in Nigeria. The analysis reveals that the banks' screening criteria were constrained by knowledge asymmetry. Adverse selection and moral hazard were noted to continue in the loan market.

Ntiamoah, et. al., (2014) investigated the loan default rate and its effect on the profitability of

financial institutions. Their study employed both qualitative (case study) and quantitative methodologies, respectively. Financial institutions were chosen to collect data, which was gained from responses to administered questionnaire and through interviews. The study's hypothesis was examined by correlation and regression analysis. The results indicate a strong positive association between the constructs of loan default rate and the profitability of various microfinance institutions. The statistical analysis indicated that effective management of client loans will result in increased profitability for the firm.

Obuya and Olweny, (2017) investigated the impact of banks' lending practices on loan losses among publicly traded commercial banks in Kenya. The research utilized a descriptive survey design. The target population included 11 registered commercial banks in Kenya. The research constituted a census of registered commercial banks in Kenya. An elementary OLS model was employed to ascertain the causal association between lending behavior and loan losses of publicly traded commercial banks in Kenya. The results indicated that the overall amount of client loans and the quality of those loans significantly influenced loan losses. The impact of lending rates, loan growth, and loan portfolio diversification on loan losses was not statistically significant. The study concluded that banks' lending behavior significantly affects loan losses, as indicated by a p-value below the significance level in the ANOVA analysis. The report advises the management of publicly traded commercial banks to evaluate their total customer loans and loan quality when establishing reserves for potential loan losses.

Caporale et al., (2018) analyzed data from a panel of over 400 Italian banks from 2001 to 2015 to investigate the primary determinants of loan loss provision (LLP), categorized as either discretionary (income smoothing, capital management, signaling) or non-discretionary (associated with the business cycle). The potential consequences of the double-dip recession occurring from 2008 to 2009 and from 2011 to 2015 were also analyzed. The findings indicated that LLP in Italian banks was countercyclical, with non-discretionary elements and macroeconomic disturbances exerting considerable influence. Furthermore, LLP was less cyclical for local banks due to their loans being more collateralized and their operations being more significantly influenced by regulatory oversight.

Fadare, (2010) examined the influence of banking sector reforms on economic growth in Nigeria from 1999 to 2009. The Ordinary Least Squares (OLS) regression method was utilized to analyze the correlation between economic growth and banking sector changes. This delineated economic growth as the rate of increase in real GDP per capita following the empirical methodology of Tuuli (2002). It utilized interest rate margin, private sector credit, and parallel market premium as indicators of banking sector reforms. The inflation rate was incorporated into the OLS model as a macroeconomic variable. The results indicated that the total capital of the banking sector was appropriately signed and statistically significant in elucidating economic growth. It advocated for the utilization of more sophisticated statistical estimate techniques and time series data encompassing an extended duration.

3.0 RESEARCH METHODOLOGY

3.1 Research Design

Research design is the structured plan employed to derive solutions to a research topic. It constitutes the framework and methodology of the inquiry. Research design establishes the foundation for identifying solutions to the topic being investigated. This study utilized an *ex-post facto* design to establish the cause-effect link. The investigation will encompass the years 1998 to 2023.

Model Specification

According to Fadare, (2010), the formulation of an econometric model will rely on economic theory and any pertinent information regarding the issue under investigation. The study delineates the examination of reforms and risk management within the Nigerian banking sector.

The models' functional form for estimation is shown as follows:

$$ROA = F(NPL, LLP, LDR, CRR, LR) \quad (1)$$

The model's econometric specification is as follows:

$$ROA = \beta 0 + \beta_1 NPL + \beta_2 LLP + \beta_3 LDR + \beta_4 CRR + \beta_5 LR + \mu \quad (2)$$

Where:

ROA=	Return on Asset
NPL=	Non-Performing Loan
LLP=	Loan Loss Provision
LDR=	Loan Default Rate
CRR=	Cash Reserve Ratio
LR=	Lending Rate
μ =	The Error Term

Where $\beta 0>0$, $\beta 1>0$ $\beta 2>0$ $\beta 3>0$ $\beta 4>0$ $\beta 5>0$

$\beta 0$, $\beta 1$- $\beta 5$ = Constant Parameters.

$\beta 0$, encapsulates the influence of all factors calculated from the equation, whereas $\beta 1$, $\beta 2$-$\beta 5$ denote the impact of variations in the dependent variable due to independent variables.

Granger Causality Model

The research utilized a causality test to determine the impact of reforms and risk management in the Nigerian banking sector and to identify the direction of causality. The Granger causality equation, obtained from equations 1 and 2, illustrating the connection

between reforms and risk management (ROA), is shown in equations 3, 4, 5, 6, 7, and 8.

Consequently, the model is articulated as follows:

$$ROA_t = \beta 0 + \beta_1 NPL_t + \beta_2 LLP_t + \beta_3 LDR_t + \beta_4 CRR_t + \beta_5 LR_t + \mu \quad (3)$$

$$NPL_t = \beta 0 + \beta_1 ROA_t + \beta_2 LLP_t + \beta_3 LDR_t + \beta_4 CRR_t + \beta_5 LR_t + \mu \quad (4)$$

$$LLP_t = \beta 0 + \beta_1 ROA_t + \beta_2 NPL_t + \beta_3 LDR_t + \beta_4 CRR_t + \beta_5 LR_t + \mu \quad (5)$$

$$LDR_t = \beta 0 + \beta_1 ROA_t + \beta_2 NPL_t + \beta_3 LLP_t + \beta_4 CRR_t + \beta 5 LR_t + \mu \quad (6)$$

$$CRR_t = \beta 0 + \beta_1 ROA_t + \beta_2 NPL_t + \beta_3 LLP_t + \beta_4 LDR_t + \beta_5 LR_t + \mu \quad (7)$$

$$LR_t = \beta 0 + \beta_1 ROA_t + \beta_2 NPL_t + \beta_3 LLP_t + \beta_4 LDR_t + \beta_5 CRR_t + \mu \quad (8)$$

4.0 RESULT AND DISCUSSIONS

4.1 Results

Table 4.1:Summary of Descriptive Statistic

	ROA	NPL	LLP	LD	CRR	LR
Mean	2.113591	50.49955	578.0834	2.261818	16.56500	17.27227
Median	2.599500	50.35000	83.64000	2.110000	16.32500	16.90500
Maximum	4.090000	91.58000	5283.000	4.230000	32.50000	24.85000
Minimum	-9.820000	13.36000	34.45700	-0.230000	1.000000	11.48000
Std. Dev.	2.857637	21.20654	1214.349	1.204166	7.941204	2.890935
Skewness	-3.495777	0.264017	3.044483	0.126080	-0.160531	0.387103
Kurtosis	15.23523	2.529814	11.71556	2.395526	2.758144	4.008283
Jarque-Bera	182.0341	0.458238	103.6168	0.393226	0.148111	1.481361
Probability	0.000000	0.795234	0.000000	0.821508	0.928620	0.476789
Sum	46.49900	1110.990	12717.83	49.76000	364.4300	379.9900
Sum Sq. Dev.	171.4879	9444.065	30967503	30.45033	1324.317	175.5076
Observations	22	22	22	22	22	22

Source, Author Computation from E-view Output 2025

Table 4.1 presents the count of observations for all variables, together with their mean and standard deviation. It also displayed the lowest and maximum values that can be achieved by these variables. The average return on assets was found to be 2.113591%. Additionally, the non-performing loan, loan loss provision, loan default, cash reserve ratio, and lending rate are expected to be 50.49955, 578.0834, 2.261818%, 16.56500%, and 17.27227%, respectively. The values of skewness, kurtosis, and standard deviation being equal to or near zero convey significant insights into the symmetrical characteristics of the distributions. Kurtosis quantifies the peakness or flatness of a distribution, with mesokurtic referring to a normal distribution characterized by a kurtosis of 3. Table 4.1 indicates that non-performing loan, loan default, cash reserve ratio and lending rate utilized in the study are normally distributed, as confirmed by the Jarque-Bera probability test, which demonstrates normal distribution at the 5% significance level, with the exception of return on assets and loan loss provision, which are not normally distributed.

Table 4. 2: Regression Model
Dependent Variable: LnGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.442483	5.345041	0.269873	0.7907
NPL	-0.014289	0.037007	-0.386110	0.7045
LLP	0.001069	0.000840	1.272545	0.2214
LD	-0.945141	0.621924	-1.519706	0.1481
CRR	-0.020463	0.099279	-0.206119	0.8393
LR	0.188247	0.272892	0.689824	0.5002
R-squared	0.170148	Mean dependent var		2.113591
Adjusted R-squared	0.169181	S.D. dependent var		2.857637
Prob(F-statistic)	0.000000	Akaike info criterion		5.250294

Source: Author Computation from E-View Output, 2025

Table 4.3: Pairwise Granger Causality Tests

Null Hypothesis:	F-Statistic	Prob.
NPL does not Granger Cause ROA	0.25267	0.7798
ROA does not Granger Cause NPL	14.0313	0.0003
LLP does not Granger Cause ROA	0.46642	0.6391
ROA does not Granger Cause LLP	0.28907	0.7545
LD does not Granger Cause ROA	0.19987	0.8205
ROA does not Granger Cause LD	0.04891	0.9524
CRR does not Granger Cause ROA	1.31532	0.2917
ROA does not Granger Cause CRR	1.56273	0.2353
LR does not Granger Cause ROA	0.26130	0.7728
ROA does not Granger Cause LR	0.02272	0.9776

Source: Author Computation from E-View Output, 2025

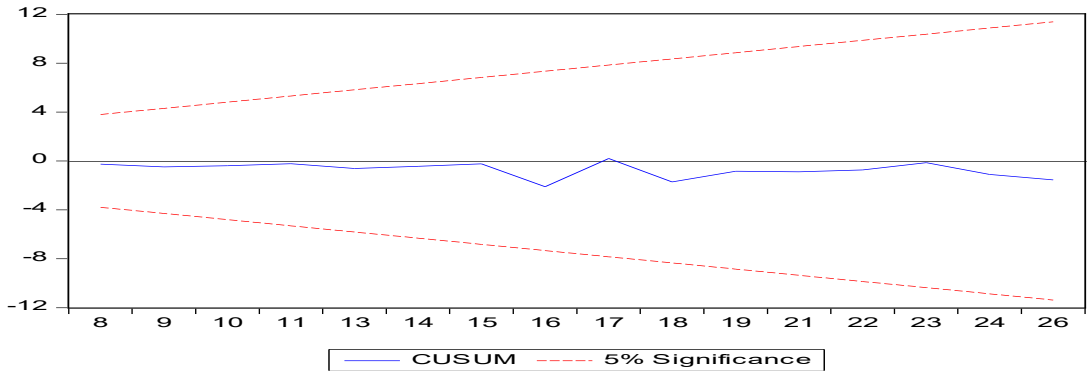


Figure 4.1: CUSUM TEST

4.2 Discussion

Following the descriptive analysis presented in Table 4.2, the study proceeds to explore methods for evaluating the impact of reforms and risk management within the Nigerian banking sector, employing the regression approach to estimate the effect between the dependent and independent variables.

Table 4.2 indicates a negative and insignificant effect on non-performing loans and return on assets. The nonperforming loan on return on assets contributed -0.014289. The implication is that for each unit change in non-performing loans, there is a corresponding negative shift of -0.014289 in return on assets. The study aligns with the research conducted by Ofonyelu and Alimi (2013) regarding perceived loan risk and ex post default outcomes: Are the banks' loan screening criteria efficient? Employing the conventional correlation test methodology to examine data acquired from a survey of investments and loans extended to 210 borrowers from 2000 to 2012 across 15 commercial banks in Nigeria. The analysis reveals that the banks' screening criteria were constrained by knowledge asymmetry. Adverse selection and moral hazard were noted to continue in the loan market and non-performing loans in Nigeria.

Table 4.3 further illustrates that loan loss provisions exert a positive yet insignificant effect on return on assets. The loan to deposit ratio on return on assets contributed 0.001069. This indicates that for each unit change in loan loss provision, there is a corresponding increase of 0.001069 in return on assets. The research corroborates the findings of Caporale et al. (2018), who analyzed data from a panel exceeding 400 participants. The findings indicate that loan loss provisions in Italian banks were countercyclical, with non-discretionary elements and macroeconomic disturbances exerting an insignificant influence.

The loan default rate adversely and significantly impacts return on assets. The loan default rate has negatively impacted on return on assets by -0.945141. The implication is that for each unit increase in the loan default rate, there is a corresponding decrease of 0.945141 in return on assets. The study aligns with the research conducted by Dong, et al., (2012), who reviewed and analyzed the evolution of the nation's loan loss provision system and examined the relationships between commercial bank loan loss provisions, earnings management, and capital management through empirical investigation. Empirical findings indicate a significant negative correlation between the loan default rate and corporate profitability.

Table 4. 2 indicates a negative and insignificant relationship between the cash reserve ratio and the return on assets of commercial banks in Nigeria. The cash reserve ratio on gross domestic product contributed -0.020463. The implication is that for each unit change in the cash reserve ratio, there is a corresponding negative change of -0.020463 in the return on assets of commercial banks in Nigeria.

The lending rate exerts a positive yet insignificant influence on the return on assets of commercial banks. The lending rate demonstrates a positive impact on the return on assets of commercial banks in the short term. The lending rate on return on assets of the commercial bank contributed 0.188247. The implication is that for each unit change in the lending rate, there is a corresponding positive change of 0.188247 in the return on assets of commercial banks in Nigeria. This study aligns with the findings of Fadare, (2010) which also concentrated on banking reforms in Nigeria. The study indicated that a substantial profile of bad debts or high lending rates adversely affects economic performance.

Table 4.3 indicates that the coefficient of determination R^2 is 0.170148, suggesting that the explanatory variables collectively account for over 17.01% of the total variation in the dependent variable, gross domestic product. The remainder is elucidated by other variables not incorporated in the model. Simultaneously, the Adjusted R^2 further substantiates that the model exhibits a satisfactory goodness of fit. The Granger causality results in Table 4.3 indicate a unidirectional causality from return on assets to non-performing loans. There is no causal relationship between non-performing loans and return on assets. The causality results indicate no Granger causality between loan loss provisions and return on assets. The study additionally indicates no causal relationship between loan default, cash reserve ratio, lending rate, and return on assets.

The CUSUM tests in Figure 4,1 indicate model stability, as the chart plots remain within the critical bounds at the 5% significance level. The null hypothesis suggests that the regression equation is accurately specified; thus, we cannot reject the null hypothesis if the plots of these statistics fall within the critical boundaries at the 5% significance level, indicating that the model is generally appropriate.

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study aimed to elucidate the impact of reforms and risk management within the Nigerian banking sector. The research employed time series data from 1998 to 2023. This study presented multiple findings. The study concludes that reforms and risk management exert minimal or no impact on the Nigerian banking sector. The study reinforces the multitude of empirical research indicating that reforms and risk management have not transformed the Nigerian banking industry, as setbacks persist despite numerous initiatives.

5.2 Recommendation

Based on the findings of the study, we recommend that:

the Central Bank of Nigeria should ensure effective management of non-performing loans to foster banking sector growth and, for policy purposes.

Central Bank of Nigeria Should regularly evaluate the lending practices of deposit money banks in Nigeria. The discretionary management of banks in allocating substantial amounts for loan loss provisions should be scrutinized and curtailed to improve the performance of banks in Nigeria.

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SKILL IMPROVEMENT NEEDS OF UNIVERSITY LECTURERS OF WOODWORK TECHNOLOGY IN INSTRUCTIONAL DELIVERY IN ENUGU STATE: IMPERATIVE FOR SOCIO-ECONOMIC DEVELOPMENT AND GLOBAL RELEVANCE

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Abstract
The study identified the skill improvement needs of university lecturers in woodwork technology instructional delivery in Enugu state, Nigeria. A descriptive survey research design was adopted for the study. Two research questions guided the study and two null hypotheses were formulated and tested at 0.05 level of significance. The population for the study was 92 respondents comprising 32 university lecturers and 60 workshop technologists. The population was of a manageable size, hence no sampling. The instrument used for data collection was a 33-item questionnaire derived from literature reviewed. Three experts validated the instrument. Cronbach alpha was used to determine the reliability of the instrument and a reliability coefficient of 0.87 was obtained. The data collected was analyzed using mean and t-test. The findings revealed that all the items were required as the skill improvement needs of university lecturers in woodwork technology instructional delivery in Enugu state, Nigeria. The study concluded that there is need for regular skill improvement programmes for woodwork lecturers in Universities in Enugu state. The study recommends amongst other things that skill improvement programs should constantly be organized for lecturers on use of latest technologies for academic activities.
Keywords: Woodwork Technology, Skill, Improvement Needs, Instructional Delivery and University Lecturers.

1.0 INTRODUCTION

Woodwork technology is the activity or skill of making items from wood, which include cabinet making, joinery and general carpentry. Markarfi, (2014) stated that woodwork technology is the art of incorporating technology in producing objects or things from wood in buildings or rooms such as doors, windows, roof, bed, cupboards, chairs, and tables. Woodwork Technology is one of the practical-based programme in Universities which offer vocational education courses. Woodwork according to National Policy on Education (Federal Government of Nigeria [FGN], (2013) comprises machine woodworking, carpentry and joinery, upholstery and furniture making. Woodwork technology basically deals with the use of wood. Wood is a material cut from complex living organism called tree. Trees are first felled before cutting into logs.

Waltan, (2011) stressed that these logs are thereafter converted or sawn into various sizes, making it suitable for building and constructional purposes. Woodwork technology includes timber technology, safety rules in the workshops, tools and classification of materials such as nails, adhesives, fitting and their uses, preparation of timber, classification, construction of joints, forestry and product of trees, woodturning, repairs, and maintenance of tools and equipment are practical aspect of woodwork (Mohammed, 2008). Woodwork technology requires some special skills and University lecturers must possess these skills in order to effectively impart the knowledge and basic skills to the students.

Skill is the ability to do something well, usually gained from experience. Uga (2005), stated that skills are well established norms and practices needed for performing certain tasks in work situation., because skills are practical activities which individual perform for work to be done effectively. Stone (2011) defined skills as the art of directing and coordinating human and material resources throughout the life of a project by using modern management techniques to achieve predetermined objectives of scope, cost, time, and quality. Skill is the capacity, systematic and sustained effort to smoothly and adaptively carry out complex activities or job functions involving ideas. Lecturers in woodwork technology are required to possess the basic knowledge and skills in order to effectively impart the knowledge to the students. Agbatogun, (2006) stressed that in most cases, lecturers are required to go for in-service training, re-training for skill improvement or upgrade. Students in woodwork need to acquire skills in order to be employable in woodwork establishments. Such skills in woodwork would assist the student in employment.

According to Barlaw (2001), employability prospects of woodwork graduate depends largely on the acquired work skills whether in self or paid employment. However, Bukar (1994) noted that the process of skill acquisition and development, as it cuts across the three domains of educational objectives is cumbersome, tedious, and time consuming. This calls for enormous skills improvement for teachers of practical based course like woodwork technology especially in the Universities.

Skill improvement need is a process of learning a new skill or refreshing a certain skill of a particular job function in order to enhance the job performance. Skill improvement needs are ways of developing new work skills that can assist in job performance or in carrying out a task while performing a given job, (Boyd, 2007). Ezekiel, and Usoro, (2009), stated that the University woodwork lecturers with varying qualification, knowledge and skills need to update their knowledge and skills through regular training, in order not to be obsolete. This informed the introduction of Technical Teachers Training Programme (TTTP). The programme was principally designed for improvement of technical teachers' knowledge and skills. There is need to first find out the areas the teachers lack required skills and need for improvement in their performance before embarking on any training or re-training of technical teachers, thus the need for improved instructional delivery.

Instructional Delivery combines the complexities of teaching with institutional expectations and student demand for quality instruction. Instructional delivery is a teacher's personal approach to teaching based on his/her own professional identity, helping to create a unique classroom culture, (Nassazi, 2013). Ekpo-Eloma, (2008) stressed that teachers' ability to use a variety of instructional materials and a combination of teaching methods and the ability to manage group learning is at the core of effective instructional delivery in woodwork technology. This means that the teacher understands the need for careful preparation of lessons and schedules and that he/she is able to organize teaching and learning around a variety of learning modes such as individual and group learning materials. Practical projects in woodwork can be taught with the use of instructional materials on how to handle woodwork hand tools and machine tools, (Oruabena, et'al 2017).

Some common skill needed in woodwork technology are shaping and wedging, fitting table top, fitting and hinging doors, woven tops for chairs, stools and so on. Some technical staff and lab technicians are not all that capable to operate machines and available equipment, so the few institutions that have them are unable to use them effectively, which could results to inability of the teachers to put across the concepts to the students. This could contribute to poor performance of students in practical projects. There is therefore the need to provide regular skill improvement programmes for woodwork lecturers in Enugu State Universities.

1.1 Statement of the Problem

There is the general impression that the quality of education has fallen and knowledge imparted by the teachers and that imbibed by students have considerably declined. This is caused by inadequate provision of skilled lecturers and lack of skill improvement programmes for lecturers in the universities necessary for teaching and learning practical courses such as woodwork technology. Skills improvement/development programmes are rarely organized for the lecturers on the use of latest technologies for academic activities. Most universities Lecturers lack training on new technologies developed which can be used in facilitating teaching and learning in woodwork technology, (Winterton et'al, 2006). The graduates of such universities are then looked upon as unemployable, because they lack skills required for good quality performance in industries. Also they could not create jobs for themselves due to lack of skills. This has been traced to poor practical and workshop activities while in training.

Available literature revealed that effective staff development is essential for the success of any educational programme. This implies that lecturers' development is critical for the improvement of educational standards (Nassazi, 2013). Based on this and the assertion made by educational planners in Nigeria that no education system can rise above the quality of its teachers, the National Policy on Education (FGN, 2013) states that continuous training in all educational institutions shall be encouraged. Universities are established to produce technical manpower for the nation's industrial and socio-economic development and that can only be achieved when skilled manpower especially lecturers and lab technicians are recruited and trained on a continuous basis. The training and development of lecturers and lab technicians would enable them to perform their duties of teaching and research effectively (Yakubu, 2010). The quality of lecturers has a direct impact on the learning outcomes of students and the quality of education.

Therefore, investment in the development of lecturers is imperative for promoting quality education. Lecturers are expected to grow continuously through exposure to induction, mentoring, conferences, seminars, workshops and higher education training. If a lecturer fails to keep himself in touch with rapid changes in the world, his knowledge could become obsolete which could render the lecturer ineffective in discharging his duties. Hence, this study seeks to find out skill improvement needs of university lecturers for instructional delivery in woodwork technology.

1.2 Purpose of the Study

The purpose of the study is to determine the skill improvement needs of university lecturers in woodwork technology instructional delivery in Enugu state. Specifically, the study determined:

1. The general skills required for improvement by university lecturers for instructional delivery in woodwork technology.

2. The practical skills required for improvement by university lecturers for instructional delivery in woodwork technology.

Research Questions

1. What are the general skills required for improvement by University lecturers for instructional delivery in woodwork technology.
2. What are the practical skills required for improvement by University lecturers for instructional delivery in woodwork technology.

Hypotheses

1. There is no significant difference in the mean responses of lecturers and workshop technologists on the general skills required for improvement by University lecturers for instructional delivery in woodwork technology.
2. There is no significant difference in the mean responses of lecturers and workshop technologists on the practical skills required for improvement by University lecturers for instructional delivery in woodwork technology.

2.0 METHODOLOGY

2.1 Research design

The study adopted the descriptive survey research design. The study was conducted in Enugu State, Nigeria comprising 4 Universities; University of Nigeria, Nsukka, Godfrey Okoye University, Caritas University and Enugu state University of Science and Technology. The population for the study was 92 respondents made up of 32 university lecturers and 60 workshop technologists in woodwork technology in Enugu State, Nigeria. Due to the manageable size of the population, there was no sampling.

2.2 data collection

The instrument used for data collection was a 33-item questionnaire developed from review of related literature. The questionnaire was structured on a five-point Likert's type scale of: Very Highly Required (VHR) – 5; Highly Required (HR) – 4; Required (R) - 3; Moderately Required (MR) -2; and Not Required (NR) -1. The instrument was subjected to face validation by three experts, one from the Department of Vocational and Technical Education and one each from Test and Measurement, Enugu State University of Science and Technology and Godfrey Okoye University both in Enugu State. The suggestions and corrections of the experts were used to produce the final version of the instrument used for this study.

The reliability of the instrument was determined by administering the instrument on 10 University lecturers and 20 workshop technologists in Benue State. Cronbach Alpha was used to establish the internal consistency of the items in the instrument. The reliability coefficient of 0.87 was obtained. The instrument was administered with the help of five research assistants. All the 92 copies of the questionnaire were duly completed and returned after two weeks. This gave a 100% return rate. Mean was used to answer the research questions while t-test was used to test the null hypothesis at 0.05 level of significance. Any item with a mean value of 3.00 and above was regarded as required while any item with a mean value below 3.00 was regarded as not required. Using the t-test statistic, the null hypothesis was rejected when the t-calculated value was greater than the t-critical but retained when the calculated value is less than t-critical value of 1.95.

3.0 RESULTS AND DISCUSSIONS

3.1 Results

Table 1: Mean Responses and t-test Analysis of Lecturers and Workshop Technologists of Woodwork Technology on the General Skills Required for Improvement by University Lecturers for Instructional Delivery in Woodwork Technology. N= 92

S/N	General skills:	X_G	SD_G	X_1	SD_1	X_2	SD_2	t-cal	Sig (2-Tailed)	Rmks RQ Ho
1	Basic academic skills in reading, writing and computation	4.99	1.16	4.99	1.13	4.98	1.19	0.03	HR	NS
2	Good communication skills including listening and speaking	4.13	0.92	4.14	0.91	4.11	0.93	0.13	HR	NS
3	Creative thinking and problem solving	4.44	0.62	4.47	0.60	4.40	0.63	0.46	VHR	NS
4	Self-esteem, motivation and goal setting	4.49	0.90	4.54	4.44	0.97	0.97	0.48	HR	NS
5	Personal and career development skills	4.49	0.57	4.49	4.48	0.57	0.57	0.07	HR	NS
6	Interpersonal/negotiation skills and teamwork	4.56	0.50	4.56	4.55	0.50	0.50	0.05	HR	NS
7	Organizational effectiveness and leadership	4.37	0.73	4.38	4.37	0.74	0.74	0.05	VHR	NS

8	Ability to assign responsibilities and motivate others	4.37	0.89	4.40	4.33	0.96	0.96	0.34	VHR	NS
9	Ability to Identify the right time to get things done	4.44	0.50	4.43	4.44	0.50	0.50	0.50	VHR	NS
10	Ability to apply basic mathematical principles in solving problems	4.47	0.76	4.49	4.44	0.80	0.80	0.27	HR	NS
11	Ability to adapt to change and Learn new things	4.28	0.84	4.31	4.25	0.85	0.85	0.28	HR	NS
12	Ability to Prepare estimate and budgets for jobs	4.60	0.56	4.61	4.59	0.57	0.57	0.16	VHR	NS
13	Ability to apply ICT skills in teaching and learning	4.63	0.56	4.63	4.62	0.56	0.56	0.15	VHR	NS
14	Ability to Lead others without supervision	4.31	0.66	4.33	4.29	0.66	0.66	0.23	HR	NS
15	Ability to Procure and use materials effectively	4.41	0.63	4.42	4.40	0.63	0.63	0.09	HR	NS
	Grand X_t and SD_t	**4.47**	**0.77**							

Note: X_t= Total mean; SD_t = Standard deviation total; X_1=mean of lecturers; SD_1= Standard deviation of lecturers; X_2 = mean of workshop technologists; SD_2 =Standard deviation of workshop technologists; N_1 = Number of lecturers (32); N_2 = Number of workshop technologists (60).

Table 3.1 revealed that all the 15 items had their mean values ranging from 4.14 to 4.99, which were above the criterion mean of 3.00, indicating that the respondents agreed that all the 15 items are general skills required for improvement by university lecturers for instructional delivery in woodwork technology. The grand mean of 4.47 with standard deviation of 0.77 suggested that skills in most of the items were perceived as very highly required for improvement by university lecturers for instructional delivery in woodwork technology. The t-calculated values of all the items ranged 0.03 to 0.66 were lower than the t-critical value of 1.96 at an alpha level of .05. The result therefore indicated that no significant differences exist in the mean response of two groups of respondents. It was therefore concluded that there is no significant difference in the mean responses of lecturers and workshop technologists on the general skills required for improvement by university lecturers for instructional delivery in woodwork technology. The hypothesis was retained.

Table 3.2: Mean Responses and t-test Analysis of Lecturers and Workshop Technologists of Woodwork Technology on the Practical Skills Required for Improvement by University Lecturers for Instructional Delivery in Woodwork Technology. N= 92

S/N	Practical skills:	X_G	SD_G	X_1	SD_1	X_2	SD_2	t-cal	Sig (2-Tailed)	Rmks RQ Ho
i	**Maintenance skills**									
16	Ability to dismantle, remove functional parts of hand tools/machines and reassemble them.	4.31	0.46	4.34	4.45	4.28	0.46	0.46	VHR	NS
17	Ability to effectively lubricate and clean parts of the woodwork tools and machines.	4.25	0.57	4.26	0.48	4.24	0.66	0.54	HR	NS
18	Ability to Repair parts of woodwork tools and machines	4.30	0.57	4.20	0.62	4.40	0.52	0.08	HR	NS
19	Ability to identify, select and use various wood working hand tools correctly	4.36	0.56	4.30	0.59	4.42	0.66	0.54	VHR	NS
20	Ability to demonstrate the safe use of machines	3.89	0.52	3.90	0.43	3.88	0.61	0.35	HR	NS
21	Ability to operate portable power tools and make use of hand tools.	3.85	0.69	3.99	0.72	3.71	0.66	0.44	HR	NS

22	Ability to maintain hand tools and carry out simple maintenance of machines.	4.38	0.55	4.35	0.65	4.40	0.45	0.56	VHR	NS
	Cluster $\bar{X}$ and SD	**4.29**	**0.59**							
ii	**Safety Practice Skills**									
23	Ability to Observe and demonstrate safety rules, regulations and precautions to prevent accident.	4.27	0.52	4.25	0.59	4.29	0.45	0.68	VHR	NS
24	Ability to Identify sources of worksite accidents, when handling and using hand tools, machines, portable power tools.	4.50	0.49	4.40	0.48	4.60	0.49	0.09	HR	NS
25	Ability to identify and demonstrate the safe use of machines and hand tools.	4.33	0.55	4.42	0.56	4.23	0.54	0.46	HR	NS
26	Ability to Apply first aid when necessary.	4.35	0.55	4.42	0.56	4.23	0.54	0.46	VHR	NS
27	Ability to store hand tools in the appropriate place and keep the woodwork machines in good working conditions.	4.11	0.44	4.14	0.43	4.08	0.45	0.75	HR	NS
	Cluster $\bar{X}$ and SD	**4.19**	**0.56**							
iii	**Construction principles and techniques**									
28	Ability to Measure wood to desired sizes	4.93	0.54	4.90	0.52	4.95	0.56	0.43	VHR	NS
29	Ability to Demonstrate the principles and sequence of cutting timber to various sizes	4.91	0.57	4.89	0.56	4.93	0.58	0.24	HR	NS
30	Ability to Plane wood surfaces and edges to flatness and squareness with face and edge marks.	4.94	0.57	4.89	0.60	4.98	0.54	0.45	HR	NS
31	Ability to produce and interpret simple working drawings of wood projects.	4.85	0.57	4.80	0.51	4.89	0.62	0.13	VHR	NS
32	Ability to identify and make woodwork joints	4.18	0.70	4.i4	0.75	0.65	0.54	0.59	HR	NS
33	Ability to design and produce furniture items and projects to a given specification for functionality.	4.45	0.59	4.56	0.66	4.52	0.51	0.20	VHR	NS
	cluster $\bar{X}$ and SD =	**4.32**	**0.06**							
	Grand $\bar{X}$ and SD =	**4.55**	**0.78**							

Table 3.2 revealed that all the 18 items had their cluster mean values ranging from 4.19 to 4.32, which were above the criterion mean of 3.00 indicating that the respondents agreed that all the 18 items are practical skills required by lecturers and workshop technologists on the practical skills required for improvement by university lecturers for instructional delivery in woodwork technology. The grand mean of 4.55 with standard deviation of 0.78 suggested that the practical skills in most of the items were perceived as highly required for improvement by university lecturers for instructional delivery in woodwork technology.

The t-calculated values of all the items ranged .03 to 1.90 were lower than the t-critical value of 1.96 at an alpha level of .05. The result therefore indicated that no significant differences exist in the mean responses of two groups of respondents. It was therefore concluded that there is no significant difference in the mean responses of lecturers and workshop technologists on the practical skills required for improvement by university lecturers for instructional delivery in woodwork technology. The hypothesis was retained.

3.2 Discussion of Findings

The findings of this study in Table 3.1 revealed that the 15 areas of general skills identified are required for improvement by University lecturers for instructional delivery in woodwork technology. This is in line with the findings of Suleiman, (2015) who conducted a study on the impact of staff development programmes on the job performance of federal polytechnic lecturers in Nigeria and found that 25 general skills are required by federal polytechnic lecturers for self-improvement. Earlier, Markarfi, (2014) carried out a study on the strategies for improving practical projects in woodwork in colleges of education (technical) in north-western states of Nigeria and reported that technical college teachers and graduates need seven basic general skills to successfully make impact in developing nations. Among these skills that need to be acquired are oral

communication skills, problem solving skills and creative thinking skills. This implies that technical college teachers and graduates are expected to understand their customers and colleagues' feelings and also attend to them with integrity and respect to enhance employability.

The findings in Table 3.2 revealed that there are 18 practical skills required for improvement by university lecturers for instructional delivery in woodwork technology. This finding corroborates with the findings of Yakubu, (2010) on the safety practice skills needed by students of technical colleges in woodwork which include safety practice skills in using hand tools, operating portable power tools, operating machines, handling wood materials, and observance in the use of instructional operating guides. The findings of this study also align with Efuwape, (2018) on the Skills Development Needs of Technical Education Lecturers in use of Technology Facilities and Social Media for Instructional Activities in Nigeria where they found that lecturers of technical colleges needed training in preliminary skills, production of blocks by hand, mix mortar by hand, laying of blocks up to lintel level, cavity construction, construction of semi-circular arch using bricks, rendering walls and wall tiling; and that the technical college graduates could not perform the competency items to the level needed in Blocklaying and Concreting works.

The implication of this is that there are students who graduate from technical colleges without being properly trained for sustainable employment. Yusuf, (2005) earlier posited that many lecturers teaching in the universities do not possess the needed competencies required to teach practical skills; which is the reason why in most cases the lecturers lay more emphasis on theory rather than practical.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The study concludes that all the areas where University lecturers require general and practical skills identified in the study are necessary for improved instructional delivery in woodwork technology. Based on the findings of this study, the following recommendations are made.

4.2 Recommendations

I. Adequate screening exercise should be conducted for employing competent lectures who possess the general and practical skills needed in teaching woodwork technology in the universities.

II. University managements should plan orientation for new staff in such a way that it is well structured, monitored, evaluated and the programme made compulsory for new lecturers as soon as they resume duty.

III. University managements should incorporate mentoring into the administrative workload of senior lecturers. Experienced lecturers within a department should be identified and made to guide and assist new staff members in skill development.

IV. The University managements should allocate more funds and time to lecturers to enable them participates in staff development programmes. Skills development training programs should be organized to train lecturers in the use of new technology facilities in other to improve their skills in woodwork technology.

V. Skills development programs should constantly be organized for lecturers on use of latest technologies for academic activities. Lecturers should be trained on each new technology developed which can be used in facilitating teaching and learning.

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IMPACT OF CLOVE SEED (*SYZYGIUM AROMATICUM*) EXTRACT ON SEMEN METABOLITES OF POST PUBERTAL MALE RABBITS

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Abstract
This study was carried out to investigate the impact of Clove seed (Syzygium aromaticum) extract on semen metabolites of post pubertal male rabbits. A total number of sixteen (16) post pubertal male rabbits were randomly allocated into four groups, of four (4) rabbits per group tagged T_1, T_2, T_3 and T_4 with each group further divided into 2 replicate of 2 animals per replicate.T_1 was the control group (0ml) T_2 (5ml), T_3 (10ml) and T_4 (15ml). Artificial vagina (AV) was used to collect semen from the bucks at the end of the treatment period of 4weeks (28 days) and the specimens analyzed. Semen Metabolites parameters examine were Total protein (TP), Albumin (ALB), Globulin (GLO), Urea (UR), Creatinine (Cr), Total bilirubin (TB), Conjugated bilirubin (CB).From the results obtained, it was revealed that Total protein (TP) was significantly different ($P<0.05$) across the treatment groups having the values; T_1 (53.50±3.53a), T_2 (49.5± 0.71b), T_3 (48.00± 0.00c) and T_4 (48.5± 2.12c). There were no significant differences ($P>0.05$) observed for Albumin (ALB) across all the treatments with T_4 having the highest value and T_3 the lowest. Globulin (GLO) result also showed significant difference across the treatment groups having T1 (23.00 ±2.83a), T_2 (21.5 ± 0.71b), T_3 (13.50± 0.71c) and T_4 (13.50± 0.71c) respectively. The present study revealed the presence of semen metabolites which were influenced by the Clove seed extract. It is recommended that Clove seed extract is administered at 5ml for adequate production and functioning of the rabbit semen.
Keyword: Rabbit, Clove seed, Artificial Vagina, Semen, Metabolites

1.0 INTRODUCTION

1.1 Background

Rabbit (*Oryctolagus cuniculus*) is a micro livestock species appearing to be one of the cheapest and fastest means of producing high quality animal protein and fast growing livestock (Vietmeyer, 1985). Rabbit (*Oryctolagus cuniculus*) is currently being recommended for countries with low meat production as important meat source. Aduku and Olukosi (1990), reported that rabbit production has a lot of benefits among which includes its high adaptability, easiness to handle and manage, high growth rate, high efficiency in converting forage to meat, short gestation period and very high prolificacy. Cloves are the dried flower buds of Syzygium aromaticum, (Chomchalow, 1996).

The clove oil contains approximately 10% acetyleugenol and small quantities of gallic acid, sesquiterpenes, furfural, vanillin and methyl-n-amyl ketone. Other constituents include flavonoids, carbohydrates, lipids, oleanolic acid, rhamnetin and vitamins. In addition, the bud contains a tannin complex, gum and resin and a number of glucosides of sterols (Chaiebet et al., 2007). Semen metabolites plays a vital role in energy production, motility, protection, ph control and regulation of metabolic activities (Bieniek and Drabovich 2016). Thus, this study was carried out to examine the effect of clove seed on semen metabolites of post pubertal male rabbits.

2.0 MATERIALS AND METHODS

2.1 Experimental site

The experiment was conducted at the Faculty of Agriculture Teaching and Research Farm, Niger Delta University, Wilberforce Island, Bayelsa State. Located at the heart of the rain forest zone having latitudes 4°51" North and 5°23 south and longitude 5°22 west and 6°45"East. It exhibits a humid equatorial climate with an average annual rainfall of 2000mm to 4000mm. Temperature records of maximum mean range is 29°-31°c and a relative humidity ranging between 55 to 90%.

Preparation of Clove Seeds (*Syzygiumaromaticum*) extract

Dried clove seeds were purchased from the market at Amassoma. They were washed and boiled with 1liter of water for 5 minutes, allowed to cool, then filtered, and turned into plastic bottles.

Management of experimental animals

A total of sixteen (16) male rabbits of mixed breeds; Chinchilla, New Zealand white, Dutch, Simonaire aged 4 to 5 months were sourced from a commercial farm at the Federal University of Agriculture Abeokuta (FUNAAB). The rabbits were housed in a single-tier hutches constructed with wood and wire-mesh cages, and tagged according to experimental groups/replicates for proper identification.

Construction of Artificial Vagina (AV), Semen Collection and Evaluation

Construction of artificial vagina for semen collection was carried out using a polyvinyl chloride (PVC) tube at 3.5cm. A rigid plumbing hose with a diameter of 2.7cm representing the smaller tube was inserted into one end of the larger tube (PVC) and allowed up to 6.0cm forming the main part of the artificial vagina. A condom was cut, and used as a liner held at 4.5cm from the bottom and pulled through the narrow of the bottom tube and held with a rubber band 5.0cm in diameter (Ajuogu and Ajayi 2010). Glycerol antifreeze and lubricator (5ml) was poured into the liner and the tube till it is 2/3 filled. The AV was warmed at 40^0c-60^0c in a container prior to semen collection. A non-cyclic doe was used as teaser for the rabbit bucks to collect semen sample. The ejaculate collected from the collecting tube was read directly on the last tube to determine semen volume whereas, other parameters were determined in the laboratory. The ejaculate was analyzed for semen metabolites; Creatinine (CR), Total protein (TP), Albumin (ALB), Total Bilirubin (TB), Conjugated Bilirubin (CB), Urea (UR), and Globulin (GLO).

2.2 Experimental design

Sixteen (16) post pubertal male rabbits within the age of 4-5 months were randomly assigned to four treatment groups (T1T2T3T4) in a completely randomized design (CRD). Each treatment group had 4 rabbits with 2 replicates. Treatment T1 served as the control group while animals in T2, T3, and T4 with clove seed (Syzygiumaromaticum) extracts were added as additive in their drinking water at graded level of 5ml, 10ml, and 15ml respectively.

Statistical Analysis

All data collected on semen parameters were subjected to analysis of variance (ANOVA) according to Steel and Torrie (1980) and differences between the means were indicated. Duncan's Multiple Range test (Duncan, 1955) was used to separate the means.

3.0 RESULT AND DISCUSSIONS

3.1 Result

The result for the semen metabolites of the rabbits is shown in table 1. The result for Total protein (TP) was significantly different ($P<0.05$) across the treatment groups having the values; T_1 (53.50 ± 3.53^a), T_2 (49.5 ± 0.71^b), T_3 (48.00 ± 0.00^c) and T_4 (48.5 ± 2.12^c). There were no significant differences ($P>0.05$) observed for Albumin (ALB) across all the treatments with T_4 having the highest value and T_3 the lowest. Globulin (GLO) result also showed significant difference across the treatment groups having T_1 (23.00 ±2.83a), T_2 (21.5 ± 0.71b), T_3 (13.50± 0.71c) and T_4 (13.50± 0.71c) respectively. It was also observed that there was a decline in globulin levels as the aqueous extract of the Clove seed increased. No significance differences ($P>0.05$) were observed for Urea across the treatment groups, and the values obtained in this study were lower than the normal physiological range. The result for Creatinine (Cr) showed significant difference ($P<0.05$) in T_1 (1.54± 2.12), T_2 (1.4± 3.54), T_3 (1.68± 14.85), and T_4 (1.67± 36.80) respectively. Total Bilirubin (TB) showed significant difference ($P<0.05$) across the treatment groups with T_1 (11.60± 0.14c) and T_2 (10.8± 0.49c) within the normal range, while T_3 (13.10± 2.26a) and T_4 (12.40± 4.10b) recorded higher values above the normal range.

Table 1. Impact clove seed extract semen metabolites of male rabbits

Parameters	Normal range	T_1 (0ml)	T_2 (5ml)	T_3 (10ml)	T_4 (15ml)
TP (µmml/L)	54-83	53.50 ± 3.53^a	49.5 ± 0.71^b	48.00 ± 0.00^c	48.5 ± 2.12^c
ALB (µmml/L)	24-46	30.50 ± 0.71	27.5 ± 0.71	25.500 ± 5.65	35.0 ± 2.83
GLO(µmml/L)	15-28	23.00 ± 2.83^a	21.5 ± 0.71^b	13.50 ± 0.71^c	13.5 ± 0.71^c
UR (µmml/L)	13-32	10.50 ± 0.14	9.50 ± 0.71	11.65 ± 1.90	11.25 ± 4.31
Cr (µmml/L)	44-221	54.10 ± 2.12^a	44.21 ± 3.54^b	38.65 ± 4.85^c	36.16 ± 3.50^c
TB (µmml/L)	0-12	11.60 ± 0.14^b	10.8 ± 0.49^c	13.10 ± 2.26^a	13.4 ± 4.10^a

[abc] Means on the same row with different superscript are significantly different, ($P>0.05$) means on the same row with same superscript are not significantly different.

3.2 Discussions

Metabolites is the intermediate end-product of metabolism that occur naturally within the cell. Semen metabolites involves in the maintenance of the semen; pH control, motility, reproduction, development, regulation of metabolic activities, etc. (Bieniek and Drabovich 2016). The metabolites as observed in this study helps to maintain the integrity of the semen in the rabbits used in this study. From the result of this study, it was observed that Total Protein (TP) was highest in T1. But the values obtained in this study fell within the normal reference range of 54-83mmol/L it was observed that T_2, T_3 andT_4 values are less than that of T_1. This might be an indication of ill-health of rabbit or abnormality in the rabbit semen. Rabbits fed Clove

seed extract faired favorably well with the control group for semen Albumin and was within the normal range. This implies that there was minimal damage to the rabbit semen as semen albumin is responsible for semen protection. According to Fink et al., 1989, seminal proteins are an important stimulator of post-ejaculation sperm motility. Globulin as a component of seminal plasma reduced significantly as the Clove seed extract increased across the treatments. This is an indication that the Clove seed extract reduced the sex steroid hormone carrying capacity of the rabbit semen and probably the semen motility of the rabbit bucks.

The urea obtained in this study was not within the normal physiological range (13-32 µmml/L) for healthy rabbits. In a report by Elsevier 2013, urea is one of the most abundant organic metabolites found in seminal plasma. Urea is one of the end products of protein metabolism during sperm maturation. Hence the urea level obtained in this study showed that increased Clove seed extract affected the development of the rabbit semen as semen metabolites influence semen development. Creatinine in this study decreased and was not within the normal physiological range with increasing concentrations of the clove seed.

This result is in agreement with the report of Nasrallah et al., 2020 that low semen Creatinine is associated with reduced sperm motility. This implies that creatinine levels affected semen motility of the rabbits. This shows that administration of Clove seed extract above 5ml is not safe to production and functioning of creatinine in rabbit semen. The Total bilirubin increased across the treatment groups as the clove seed extract increased. Chen 2022, have reported the absence of bilirubin as a semen metabolite but have rather reported a direct relationship between serum total bilirubin and semen quality. The result of the present study might be an indication that the clove seed extract increased the serum total bilirubin as it was higher than the control. According Chen 2022, the highest quartile of serum total bilirubin was associated with decreased sperm motility and normal morphology. This implies that higher levels of the clove seed extract decreased the motility and morphology of the rabbit semen.

4.0 CONCLUSION AND RECOMMENDATION

1. Semen metabolites play a vital role in semen pH control, motility, reproduction, development, and regulation of metabolic activities.
2. The present study revealed the presence of semen metabolites which were influenced by the Clove seed extract.
3. It is recommended that Clove seed extract is administered at 5ml for adequate production and functioning of the rabbit semen metabolites.
4. Further studies on the use of Clove seed on rabbit reproductive life should be encouraged.

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EVALUATION OF VULNERABILITY TO FLOODING OF COMMUNITIES ALONG EPIE CREEK IN YENAGOA METROPOLIS OF BAYELSA STATE, NIGERIA

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Abstract
The study on the vulnerability to flooding of communities along the Epie Creek in Yenagoa Local Government Area of Bayelsa State was investigated. The study considered some physical factors which can expose inhabitants of an area to flooding. Hence, data on flood height reached on buildings and the elevation above MSL as well as the spatial variation in the dimension of flood waters around residential houses with reference to the stream channel (Epie Creek) was evaluated using inferential and descriptive statistics. The results of the analyses showed that areas within Ekeki, Amarata and Onopa are more at risk of flooding due to the height of flood waters reached on buildings. But the results of the elevation of the area slightly differs as areas within Yenezue-Epie-Okaka and Etegwe-Okutukutu are found to be relatively lower (9.5m) than other areas and are expected to be more vulnerable to flooding. Thus, there was no significant correlation between flood height and the elevation of the area above MSL. Hence, the flood height reached on buildings at different location is not directly caused by elevation. On the flood dimension in the area, the study revealed that 'proximity' is a major factor that exposes the inhabitants of Epie Creek to flooding especially for those whose dwellings are located close to the Creek. Hence, the study recommends the total relocation of people living very close to the Epie Creek to allow for better planning of the area.
Keywords: Risk, Vulnerable, Proximity, Expose, Flooding.

1.0 INTRODUCTION

Flood is a common natural disaster which can occur anywhere with associated hazard which is mostly endemic where water flows such as along the banks of rivers, lakes and other forms of water flow. Epie communities situated along the Epie Creek in Yenagoa town have being experiencing flooding in recent times during the raining season. The flood usually causes environmental havoc to lives and properties. The flooding menace in this area destroys farms, damage properties, displaces residents from the homes and sometimes causes death.

Flood as a natural disaster has been described to occur when the volume of flowing water along a defined path such as river channel, exceeds its confinement thereby overflowing the banks to cover the adjacent lands (Digha & Obiene, 2012). Hence, Liao (2012) described flood as natural hazards which possess challenges to towns and cities located along rivers. The scholar went further to state that despite the fact that most cities in developed cities like Bangkok, Thailand, New Orleans, e.t.c, have built strong flood protection structures but are yet to escape from the effects of the hazard due to their location.

Umeuduji (2017), reported that it is obvious that people living close to source of water (such as rivers and lakes) are mostly at risk to flooding despite the lots of opportunities opened to those that inhabits such environment. Thus, it is expedient that those who live close to rivers to prepare to adapt to flood hazard. But studies have revealed that hazard is contextual. That is to say, it differs from place to place and even within a particular environment; the vulnerability of people differs from one point to another point, depending on the capacity of those who are exposed to the hazard (Kelman, 2007; Adelekan, 2010).

Vulnerability has been defined as the degree to which a system (or part of it) reacts adversely to the occurrence of a hazardous event (Proag, 2014). The term has also been viewed to mean the propensity (ability/capacity) of an exposed element such as human beings; their livelihood(s) and assets to suffer adverse effects when impacted upon by hazardous event (Cardona, et al, 2012). Thus, from the definitions above, it is obvious that, an element or a system can be vulnerable to a particular hazard when its capacity or ability to cope with the hazard is not enough and thereby resulting to a collapse of the system. Lungren and Johnson (2012), described the term 'vulnerability' to mean the capacity of the elements or are unequally distributed in the environment.

Viewing in the perspective of the above explanations, one can comfortably state that, vulnerability is a measure of a system's ability or capacity to anticipate the presence of a hazard (potential disaster), ability to cope with the hazard when disaster strikes and; the ability or capacity to recover or recuperates from the effect(s) of the disaster. Therefore, once a system's ability to anticipate or predict potential disaster is high, it would enable it prepare to withstand the effects that may arise.

It is worthy to note that man cannot be completely free from one form of a hazard or the other because; every location on the earth's surface has a unique type of hazard that may pose difficulties within that environment. For instance, those living in mountainous areas are mostly exposed to landslides and other erosion effects. Those living close to the seashores are

exposed to ocean surge, tsunami, and hurricane and so on. In the same way, those who live within floodplains of rivers are exposed to flooding and other erosion and depositional effects.

People's vulnerability to hazard have been said to differ from person to person and from location to location which depends on the 'resilience' of the people being affected. Thus, the resilience of a system has been defined as the measures adopted by the system to enable it adapt or survive in the hazard prone area. According to Adelekan, (2010) vulnerability indicators to flood hazards can be grouped into; (i) physical rainfall characteristics, landscape of the area, etc.; (ii) Social/economic (income level, land-use, resident type, etc.), (iii) resilience preparedness, coping/recovery ability etc.

Most studies have focused on the various indicators of vulnerability e.g (Digha & Obiene, 2009; Kenji, 2004; Efobi & Christopher, 2013; Collins, 2014), but much attention has not been given to the contributions of the physical landscape and the proximity of peoples' residence to the source of water. Thus, the aim of this study is to identify those physical factors that exposes the communities situated along Epie Creek to flooding and the flooding vulnerability of these communities.

2.0 METHODOLOGY

2.1 The study Area

The study area comprises communities along Epie Creek which is located within the Yenagoa Metropolis. The area is situated between Latitude 4^0 50^1N to 5^0 05^1N and 6^0 15^1E to 6^0 30^1E (Izonfuo & Bariweni, 2001). The Epie Creek is drained partly by the Orashi River and the Tailor Creek. The Epie Creek flows across 16 communities and empties into the Ekole River. Historically, like other bigger towns and cities worldwide, all the communities of Epie descent are located linearly along this channel (Epie Creek). Before now, the major occupation of the people in the area was farming and fishing due to the presence of water and the fertile lands adjacent to the stream channel. Because of the annual flooding usually experienced in the area, major crops cultivated in the area include; cassava, water yam, cocoyam, maize and vegetables.

Just like other areas within the central Niger Delta of Nigeria, the study area is flood prone due to the presence of the river channel (Epie Creek) and its tributaries. The tributaries of Epie Creek are found to connect the back-swamps which are located a few distances from the main channel.

The geomorphology of the study area is naturally sculptured to drain excess water from the strip of land inhabited by the people (which is not normally submerged by water) thereby keeping it safe from being flooded. Hence, all those who first occupied this area were relatively safe from the effects of flood. This remained the situation of the area until few years after the creation of Bayelsa state when development started creeping into the deep swamps due to urbanization. Today, urbanization has encroached major parts of the back-swamps thereby disconnecting the link between the natural reservoirs and the main stream channel (Epie Creek). This situation couple with other urbanization challenges has led to the silting of the main trunk which has exacerbated the flood situation of the area. The Map of the study area is presented in Fig, 2.1

1aac992db558429aee8bf925b1f171e03f9680a6ba0198cec441d8dd8d66dba9.0 (PNG Image, 850 × ... file:///C:/Users/MIKIROSE/Desktop/BLUETOOTH/1aac992db558429aee8bf925b1f171e03f96

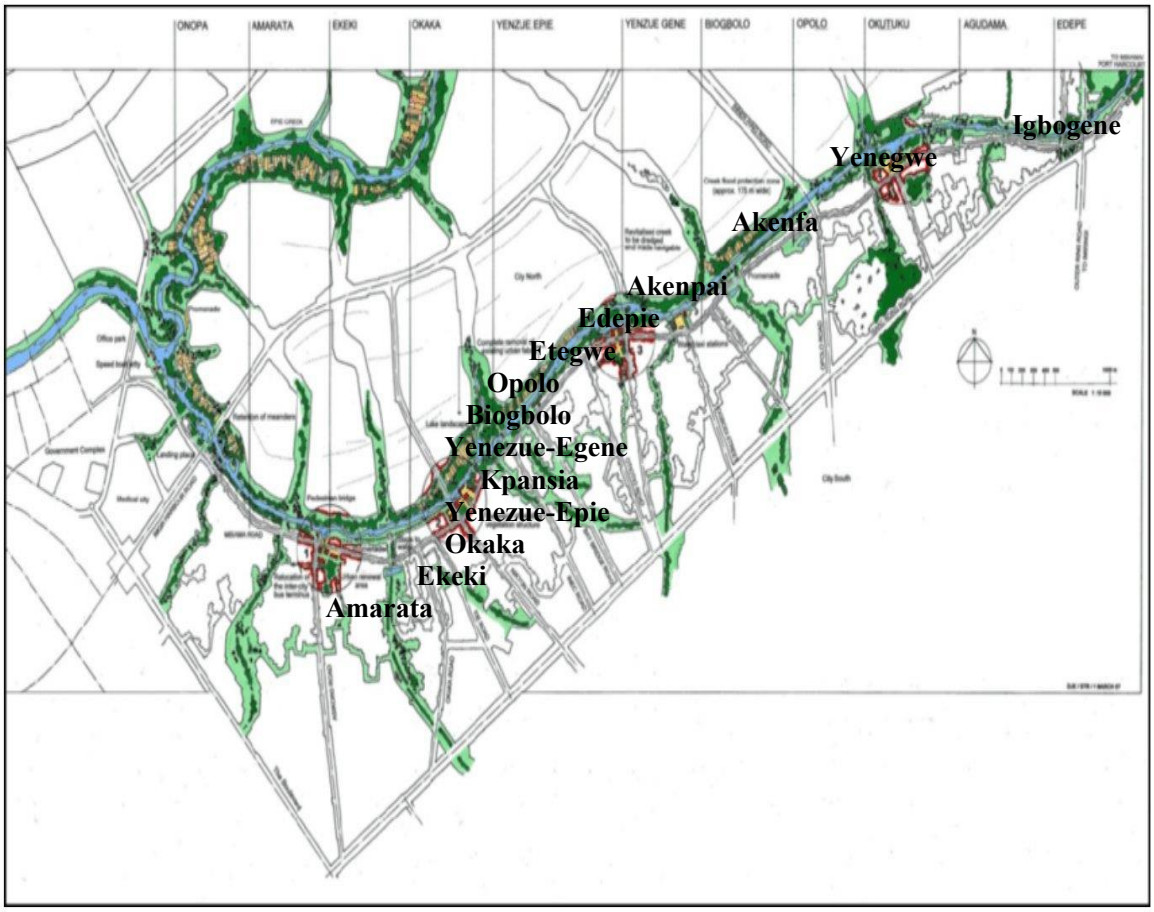


Fig. 2.1: Map Showing Communities along Epie Creek

2.2 Data Collection

Since Vulnerability is contextual, this study has carried out investigation on the level of vulnerability at different location taken reference from the main stream channel. The study focused on the flood extent and depth at the different location and how the inhabitants are able to cope with the effect of floods during and after the event. This was investigated through careful observation and the use of a well-structured questionnaire design to sample opinion from 857 inhabitants covering the 16 communities across the study area.

2.3 Data analysis

Data collected were analyzed by means of product moment correlation technique whereby product moment coefficient (r_{xy}) was evaluated. By this, data on the flood height reached on buildings during the 2022 flood and that of elevation of the area above Mean Sea Level (MSL) were correlated. (r_{xy}). This was carried out by adopting the formula suggested in Aguwa and Onyenaobiya (2014) as presented in equation 1;

$$r_{xy} = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{\{n\sum X^2 - (\sum X)^2\}\{n\sum Y^2 - (\sum Y)^2\}}} \quad 1.$$

(***Where; X=Height of flood reached on buildings, and Y=Elevation of the area***)

3.0 RESULTS AND DISCUSSIONS

3.1 Results

The results of the determination of the height of flood water on buildings during the 2022 flood and ground level elevation above sea level in the study area are presented in Table 3.1. It shows that the flood height ranges between 1.6m and 3.2m. While MSL in the area range between 9.50M and 13M

Table 3.1: Flood Height Reached on Buildings and Elevation above MSL of Communities along Epie Creek

Community	Igbogene/ Yenegwe	Akenfa/ Agudama	Akenpai/ Edepie	Etegwe/ Okutukutu	Opolo/ Biogbolo	Yenezue-gene/ Kpansia	Yenezue-Epie/ Okaka	Ekeki/ Onopa
Flood height on building (m)	2.01	2.15	2.18	1.62	2.82	2.20	2.28	3.16
Elevation above MSL (m)	13.00	12.00	10.50	9.50	11.50	10.50	9.50	10.60

(Source: Author's Fieldwork, 2024)

Height of flood water on buildings during the 2022 is further presented graphically in Figure 3.1 for a better scientific illustration and understanding

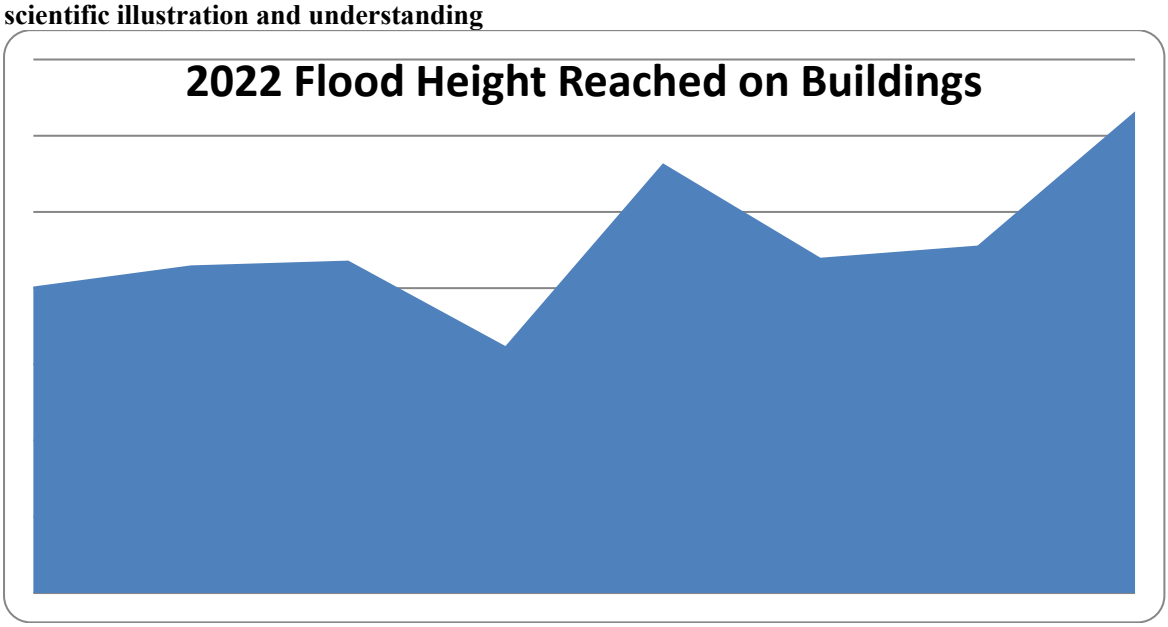


Figure 3.1 Flood Height Reached on Buildings in Communities along Epie Creek During 2022 Flood (Author's Fieldwork).

The ground level Elevation above mean sea level of Communities located along the Epie Creek is presented graphically in Figure 3.2. It shows that the area stands between 9m and 12m above MSL. The areas within Yenezue-Epie-Okaka and Etegwe-Okutukutu are found to be relatively lower (9.5m) than areas within Igbogene-Yenegwe which have above mean sea level of (13m),

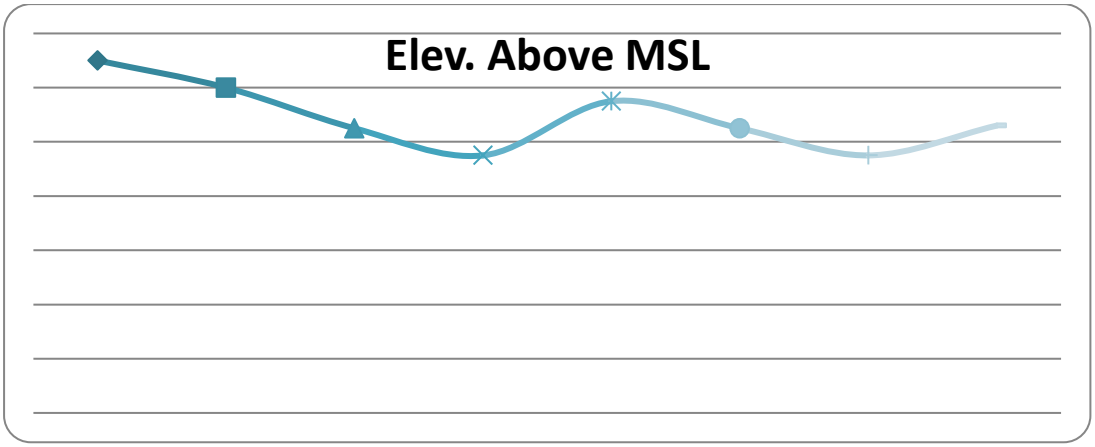


Figure 3.2: Elevation above mean sea level of Communities located along Epie Creek. (Source: Author's Fieldwork, 2024).

The results of the response of respondents to questionnaire to assess the vulnerability of four (4) categories of inhabitants with reference to the proximity to the river channel (Epie Creek) is presented in Table 2.2. It shows the total number of respondents are 857, about 69% of the respondents lives close to the channel (Epie Creek) while only about 31% were located far from the channel.

Table 3.2: Location of Respondents at Distance to the Epie Creek.

Proximity	Very Close	Close	Far	Very Far	Total
No. of Respondents	243	351	143	120	857
% Response	28.3	41.0	16.7	14.0	100

Results of assessment of Peoples' opinions on the degree of occurrence of flood in the area were sampled and results are presented in Table 3.3 It reveals that about 75% of inhabitants of the area who lives close to the river channel reported to experiencing flooding '*very often'* while only about 25% of inhabitants who lives far from the river channel reported that flooding in their area occurs *'very often'.* Again, those who reported to experience flooding 'often"; about 64% lives close while 35%lives far from the channel.

Table 3.3: Proximity and Flood Frequency Around Buildings Along Epie Creek.

Proximity to Channel	No. of Respondents (%)	Very often (%)	Often (%)	Not too Often (%)	Cannot Explain (%)
Very Close	243 (28.30%)	69 (33.17%)	102 (27.13%)	41 (25.32%)	31 (27.93%)
Close	351 (41.00%)	87 (41.83%)	177 (47.07%)	61 (37.65%)	26 (23.42%)
Far	143 (16.70%)	34 (16.35%)	54 (14.36%)	28 (17.28%)	27 (24.32%)
Very Far	120 (14.00%)	18 (8.7%)	43 (11.44%)	132 (19.28%)	27 (24.32%)
Total	857	208	376	162	111
%	100	24.28%	42.87%	18.90%	12.95%

Source: Authors' Fieldwork (2024).

Proximity and extent of flood water around buildings within the study area was also assessed from respondents' opinions and the results are presented in Table 3.4. It shows that out of the 34.19% of those who reported that flood waters surrounds the whole premises (buildings); about 65% lives very close and close to the river channel (Epie Creek), while only 35% lives far and very far from the Creek. For those who reported that flood waters covers two-third of their premises; 60% of them live close and very close to the channel while the remaining 35% lives far and very far from the channel.

Table 3.4: Proximity and Flood Extent around Buildings along Epie Creek

Proximity to Channel	**No. of Respondents (%)**	**Surrounds whole Building (%)**	**Surrounds 2/3 Building (%)**	**Surrounds 1/2 Building (%)**	**Surrounds only small portion (%)**
Very Close	243 (28.30%)	83 (28.33%)	74 (25.0%)	48 (30.97%)	38 (33.63%)
Close	351 (41.00%)	109 (37.20%)	135 (45.61%)	70 (45.16%)	37 (32.74%)

Far	143 (16.70%)	53 (18.09%)	50 (16.89%)	21 (13.55%)	19 (16.81%)
Very Far	120 (14.00%)	48 (16.38%)	37 (12.50%)	16 (10.32%)	19 (16.81%)
Total	857	293	296	155	113
%	***100***	***34.19%***	***34.54%***	***18.09%***	***13.18%***

Source: Authors' Fieldwork (2024).

The results of the assessment of proximity and flood duration around buildings are presented in Table 3.5. It shows that out of the 38.86% of those who reported that flood water lasts for a period between one to two months; more than 80% of them live very close and close to the channel (Epie Creek) while, less than 20% live far and very far from the channel. For those who reported that flood water resides within a space of one month; more than 70% live very close and close to the channel while, less that 30% live far and very far from the channel.

Table 3.5: Proximity and Flood Duration around Buildings along Epie Creek

Proximity to Channel	**No. of Respondents (%)**	**1-2 Month (%)**	**Within 1-Month (%)**	**Less than 1-Month (%)**	**Unknown (%)**
Very Close	243 (28.30%)	105 (31.53%)	84 (33.20%)	40 (20.10%)	14 (19.44%)
Close	351 (41.00%)	166 (49.85%)	94 (37.15%)	63 (31.66%)	28 (38.89%)
Far	143 (16.70%)	32 (9.61%)	47 (18.58%)	45 (22.61%)	19 (26.39%)
Very Far	120 (14.00%)	30 (9.01%)	28 (11.07%)	51 (25.63%)	11 (15.28%)
Total	857	333	253	199	72
%	***100***	***38.86%***	***29.52%***	***23.22%***	***8.40%***

Source: Authors' Fieldwork (2024).

3.2 Discussion

Vulnerability of the inhabitants of the area.

i). Flood height/Elevation of the Area: two factors were considered which include; *flood height reached during 2022 flood event and the elevation of the area above mean sea level (MSL)* as shown in table3.1. Results showed that the flood height ranges between 1.6m and 3.2m. Thus, areas within Ekeki, Amarata and Onopa were found to be more at risk of flooding followed by areas within Opolo to Biogbolo due to the relatively higher level of flood water than other areas (See Figure 2.1). On the elevation, results show that the area stands between 9m and 12m above MSL where as areas within Yenezue-Epie-Okaka and Etegwe-Okutukutu are found to be relatively lower (9.5m) than areas within Igbogene-Yenegwe (13m), Akenfa-Agudama (12m) and Opolo Biogbolo (11.5m) above MSL. But on the whole, the elevation of the area has been shown to decrease downstream from Igbogene to Onopa as shown in figure 3.2. The results of the study have shown that elevation above mean sea level is a major factor that exposed the communities along Epie Creek to flooding. This is because, the areas with higher record of flood height depicts areas with lower elevation above MSL.

The results of the correlation analysis showed a positive relationship (r_{xy} ***=0.098)*** between the two sets of variables X and Y. A test of significance relationship using the t-test (tcal= r***√n-2/1-r)*** showed a no significant correlation between the two sets of variables (X, Y). This result further showed that the elevation of the area does not decrease or increase down /up the stream but alternates. This can be confirmed from the figure 3.2 where, the surface elevation of the area was seen to decrease from Igbogene to Etegwe but elevation starts to rise from Opolo and drops back within Yenezue-Epie/Okaka. The same scenario was observed for the data on the height of flood water on buildings where, the flood height was found to be relatively constant but drops within Etegwe/Okutukutu area but increases within Opolo but drops again within Yenezuegene to Okaka area. This further implies that,

the level of flood (height) in the area is not directly determined by the elevation of the area above MSL.

This means that the vulnerability to flooding of the area (in terms of flood height) is not directly caused by the low surface elevation with reference to MSL but other intervening variables may be responsible. Thus, while both variables can influence the vulnerability of inhabitants of the area to flooding, one may not directly be the cause to the other.

ii) Dimension of flood waters around buildings located at distance to Epie Creek.

The vulnerability to flooding of communities along Epie Creek was also measured in terms of the dimension of flood waters usually found around residence of inhabitants of the area. Thus, the frequency of occurrence, the extent of spread and the duration (resident period) of flood waters around dwellings of inhabitants were assessed. Hence, peoples' opinion were sampled using well-structured questionnaire to assess the vulnerability of four (4) categories of inhabitants with reference to the proximity to the river channel (Epie Creek) namely, those whose dwellings are located *very close, close, far*, and *very far* from the channel. Table2.2 shows the number of respondents (857) used for the analyses and their location with reference to the river channel. Results from Table 3.2 show that about 69% of the respondents' lives close to the channel while only about 31% were located far from the channel. This shows that greater percentage of the inhabitants of the area choose to live closer to the river channel owing to numerous benefits that may be derived from the source of water as suggested in Umeuduji (2017).

Flood Frequency within and around Buildings

Peoples' opinions on the degree of occurrence of flood in the area were sampled and results are presented in Table 3.3. From the responses; about 75% of inhabitants of the area who lives close to the river channel reported to experiencing flooding '*very often'* while only about 25% of inhabitants who lives far from the river channel reported that flooding in their area occurs *'very often'*. Again, those who reported to experience flooding 'often"; about 64% lives close while 35%lives far from the channel. Meanwhile, for those who reported to be experiencing flooding 'not too often'; 63% of them lives close and very close while about 37% of those who lives far reported that they experience flood not too often. Lastly, of the 13% of those who cannot explain the flood situation in the area, 51% lives close and very close while about 49% lives far and very far from the channel. Therefore, it is expedient to note that, proximity to the channel is a major factor that exposes the inhabitants of Epie Creek to flooding where, people whose building are located closer to the channel (Epie Creek) are expected to be more at risk of flooding than those living far. See Table 3.3.

Proximity and Flood Extent around Buildings.

This was measured in terms of coverage of flood waters around premises. The Table 3.4 showed that out of the 34.19% of those who reported that flood waters surrounds the whole premises (buildings); about 65% lives very close and close to the river channel, while only 35% lives far and very far from the channel. For those who reported that flood waters covers two-third of their premises; 60% of them live close and very close to the channel while the remaining 35% lives far and very far from the channel. Again, for those who reported that flood water covers half of their premises, more than 75% of them live very close and close to the channel while only less than 25% of them live far and very far from the channel. Also, for those who reported that flood water covers only a small portion of their surroundings; more than 60% lives very close and close to the channel while less that 30% lives very far and far from the channel. This scenario indicates that although, there is variations in the spread of flood waters even amongst those who live close to the river channel; the results have shown that proximity to the channel is a major determinant that exposes the inhabitants of the area to flooding. Thus, those whose surroundings are located close to the channel are expected to be more at risk of flooding with regards to the spread of flood waters within their surroundings than those whose buildings are located far from the river channel.

Proximity and Flood Duration around Buildings

The duration of flood waters in terms of the resident period of water within the premises of inhabitants long the Epie Creek has been assessed from opinions of residents with reference to their location with distance from the channel. Thus, out of the 38.86% of those who reported that flood water lasts for a period between one to two months; more than 80% of them live very close and close to the channel while, less than 20% live far and very far from the channel. For those who reported that flood water resides within a space of one month; again, more than 70% live very close and close to the channel while, less that 30% live far and very far from the channel. Also, for those who reported that flood water resides for a period of less than one month; about 52% of them live close and very close to the channel while, about 40% lives far and very far from the channel. Also, out of about 8.4% of those who reported that the water resident period is not well known; about 59% live very close and close to the channel while, about 41% live far and very far from the channel. With the results presented in table 3.5, it is imperative to state that proximity to Epie Creek is another factor that contributes to the flood vulnerability of the people living in the area.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The results of the study on the vulnerability to flooding of communities along Epie Creek has shown that though, the area is generally prone to flooding, but the elevation above MSL has been found to contribute less to the inhabitants exposure to flooding. Instead, the peoples' *proximity* to the channel has been identified as a key factor that exposes the people to flooding. Thus, since vulnerability is contextual, the results of the study have shown that people whose buildings are located close to the Epie channel are more exposed to flooding than those whose dwellings are located far from the channel.

4.2 Recommendations

Based on the findings, the study recommends the relocation of inhabitants living very close to the channel. This will not only reduce level of casualties during flood events but would enable the proper planning of the environment such as the canalization of the Epie Creek.

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PREDICTIVE ANALYTICAL DETERMINATION OF SAFETY EVENT PROGRESSION IN OIL & GAS INDUSTRY IN NIGERIA

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Abstract
Safety records are fundamental for identifying, assessing and mitigating workplace accidents. However, traditional methods often struggle to account for the dynamic nature of safety events and their progression in the long run. This paper explores the application of Markov chain as a predictive analytic dynamic tool to determine the stepwise movement of field personnel (staff) into an absorbing state. A 16-years safety record from the subsidiaries of a major oil and gas company was used for the study. The data collected was fit into the Markov chain model. The results showed that field personnel staff changes position seven times in the non-absorbing state before entrapped in any of the absorbing state. Significantly, worrisome is that oil spill call out which was 46% is indicative of high level of oil wastage which may be attributed to pipeline sabotage that have severe economic consequence and creates an ecosystem imbalance. Again, medical treatment case (severe) was 24% as showed in the long-run stabilized matrix- B which has implication in terms lost man-hours and productivity. To address the unpleasant safety scenario rrvealed in this study, it is recommended that the organization should prioritize intervention strategies and track the impact of its implementation of safety control measures and rejig its oil spill response action plan.

Keywords: Safety data, Markov chain model, absorbing state, Oil spill call out, stochastic regularity.

1.0 INTRODUCTION

1.1 Background of the study

Industrial safety data is an essential and powerful tool for understanding and management of industrial safety. It is a tool that industries use identify trends and patterns, high risk operations, equipment failures, evaluate safety performance, guide policy decisions and human factors contribution to workplace accident. The effective and rigorous analysis of this data for companies to take proactive action in addressing the root causes of accident before they manifest as serious injuries or catastrophe remain mostly in mere traditional methods. However, despite the efforts achieved in curbing industrial accidents over a century, Hofmann et.al (2017) noted that there is still much work to be done since there are many cases of workplace injuries, fatalities and diseases, suggesting continual improvement, which they posit better approaches beyond descriptive statistics. Again, they assert that we should not lose sight on the front for better ways of combating occupational accident.

Therefore, it is from the foregoing that newer and better approach to curtailing the rate of accident occurrence becomes imperative. Demanding for a newer and rigorous predictive engineering model to analyze industrial safety records in order to establish trend for active surveillance monitoring of accident of which Markov chain model comes useful. Besides, when Markov chain model is employed it shows the stock and flow as subject's transit (pass) through identified hazard in a system at any point in time and also over a period of time. It is this analysis of the movement of subjects through these hazards that depicts the flow or rather the prediction. In essence that is why accident data are needed to be analyzed with proper analytics for in-depth prediction.

Several factors have been identified and asserted as responsible for the causes of industrial accidents in the oil and gas industry such as workplace design (Alkhadi et.al,2017, Michael and Dylan, 2016), Human error (Bhavsar et.al,2015), risk inherent to production activity(Diaz de-Mera Sanchez et.al 2015, inadequate training strategies and poor maintenance priorities (Anderson,2005; Akash et.al

2018), and management insincerity and commitment (Ankit et.al 2018, Unnikrashan et.al 2015, Ayodeji,2022).

The rate of accident occurrence in most factories especially the oil and gas industries appears to be persistence. This can be ascribed to not using the appropriate or rigorous models to analyze accident records in order to establish a trend and patterns. Again, record keeping in most organizations are arbitrary and in some cases highly customized. This research employed Markov chain to analyze industrial accident data obtained so as to unearth underlying trends and patterns as personnel moves across different non-perilous and perilous hazardous states.

2.0 METHOD

In a way to shows the stock and flow as personnel or subject's transit (pass) through identified hazard in a system at any point in time and also over a period of time, which is the analysis of the movement of subjects through these hazards that depicts the flow or the prediction. A 16-years historic data as presented in Table2.1, from a subsidiary of a major oil company in Nigeria was fitted and examined for embedded Markov properties such as stochastic regularity, absorbing behavior and the long-run distribution among the various identified hazardous states. The basic theorems and assumptions behind the statistical computation are explicitly discussed. However, the computation was aided by used of MATLAB R,2016 software from which useful deductions and inferences were obtained as results for discussion and conclusion.

Table 2 .1 HSE Data for Pipeline and Product Marketing Company Ltd (2000-2015)

S/no	STATES (HSE INCIDENT)	TOTAL NO OF OCCURRENES	PROPORTION (%)	REGIME
1	Fatality	7	0.08%	ABSORBING STATE
2	Third party fatality (TPF)	15	0.16%	
3	Permanent Disability (PD)	0	0%	
4	Fire incidence (severe) FIs	112	1.23%	
5	Injury (severe) Is	231	2.53%	
6	Medical treatment case (severe) MTCS	464	5.09%	
7	Road traffic Accident (severe) (RTA_S)	10	0.11%	
8	Oil spill call outs Osco	590	6.47%	
9	Restricted work case (severe) RWCS	5	0.05%	
10	Human Error (HE)	10	0.11%	
11	Lost time Days (LTD)	27	0.30%	NON- ABSORBING STATE
12	Injury (Minor) I_M	248	2.72%	
13	Fire incidence (Minor) FI_M	151	1.66%	
14	Medical treatment case minor (MTC_m)	2371	25.99%	
15	*Restricted work case minor (RWCM)*	*35*	0.38%	
16	*Road traffic accident minor RTAM*	*36*	0.39%	
17	*First Aid case (FAC)*	*96*	1.05%	
18	*Unsafe condition (UC)*	*1435*	15.73%	
19	*Unsafe Acts (UA)*	*2838*	31.11%	
20	Near misses (NM)	441	4.83%	
	Total	9122	100%	

2.1 Theorem formulation

Markov chain is a simple concept which can explain most complicated real time processes. Markov chain is based on a principle of "memorylessness". In other words, the next state of the process only depends on the previous state and not the sequence of states (Srivistava, 2014). Given an initial distribution d_o of a transition probability matrix *T*, the n – step distribution

depends on the stabilized value of transition probability matrix (TPM) namely $\bar{T}$. Determination of $\bar{T}$ is computationally demanding because it involves determination of successive powers of T but there is a matrix algebraic technique for finding $\bar{T}$ that obviates the need to compute the power thereof (Igboanugo,2014).

In this consideration, absorbing states are listed first and the standard form is expressed as by Igboanugo (2010)

$$T = \begin{array}{c} \\ Abs \\ Non-abs \end{array} \begin{array}{c} \begin{array}{cc} Abs & Non-abs \end{array} \\ \begin{bmatrix} I & O \\ R & Q \end{bmatrix} \end{array} \qquad (1)$$

we seek to determine the long run distribution of *T*i.e. $T^n = \bar{T}$

where I matching identity matrix, O null matrix R and Q are arbitrary non-absorbing matrices having initial distribution, d_o.

Using successive block matrix multiplication for the partitioned matrix (eq.1) as derived by Igboanugo (2014)

$$T^2 = \begin{bmatrix} I & O \\ (I-Q)^{-1}R & Q^2 \end{bmatrix}$$

$$T^3 = \begin{bmatrix} I & O \\ (I+Q^2+Q^3)R & Q^3 \end{bmatrix}$$

$$T^n = \begin{bmatrix} I & O \\ (I+Q+Q^2+\ldots+Q^{n-1})R & Q^n \end{bmatrix} \qquad (2)$$

Since any two consecutive terms of $I + Q + Q^2+\ldots+Q^{n+1}$ have the same ratio the $\frac{Q^{n+1}}{Q^k} = Q$ series is geometric progression. It is also monotonic because given that

$P_{ij} \in T$ is a proportion, i.e. a probability with $0 < P_{ij} < 1$ then $Q_1 \geq Q_2 \geq Q_3 \geq \ldots, \geq 0$ and this implies that $Q < 1$

Set $S_n = 1 + Q + Q^2 + \ldots + Q^{n-1}$

Then $QS_n = Q + Q^2 + \ldots + Q^n$

$$S_n - QS_n = I - Q^n$$

$$\therefore S_n(I-Q) = I - Q^n$$

$$\Rightarrow S_n = \frac{I-Q^n}{I-Q} \qquad (3)$$

$$\lim_{n\to\infty}(S_n) = \lim\left\{\frac{I-Q^n}{I-Q}\right\}$$

$$= \left[\left(\frac{I}{I-Q}\right) - \frac{I}{I-Q}\lim_{n\to\infty} Q^n\right]$$

Since $Q^n < 1, Q^n \to O$

Hence S_n converges to $\frac{I}{I-Q} = (I-Q)^{-1}$

$$\therefore T^n = \bar{T} = \begin{bmatrix} I & O \\ (I-Q)^{-1}R & O \end{bmatrix} \qquad (4)$$

Furthermore, a situation can be modeled by Markov chain if it can be viewed as the repeated movement (trial) of one or more objects among various classification, or states. Let the states be presented by S_1, S_2, S_3, S_4……S_n.

For each pair (S_i, S_j), let a fixed proportion P_{ij} of object located at S_i move to S_j during each step or movement. Thus the scenarios can be represented in a transition probability matrix as;

$$T = \begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ .... \\ S_k \end{array} \begin{array}{c} \begin{array}{cccc} S_1 & S_2 & S_3 & .... \quad S_K \end{array} \\ \begin{bmatrix} P_{11} & P_{12} & \ldots & S_K \\ P_{21} & P_{22} & \ldots & P_{1K} \\ P_{31} & P_{32} & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots \\ P_{K1} & P_{K2} & \ldots & P_{KK} \end{bmatrix} \end{array}$$

$T_{ij} = P_{ij} =$ Probability that an object in state *i* move, to state *j*

$$P_{ij} = P\{\xi_n = j \mid \xi_{t\,n} = i\}$$

This follows one-step transition probability of transition from i at t_{n-1} to state j at t_n. It is believed that T is standard.

$$\sum P_{ij} = 1 \forall i$$

$$\sum P_{ij} \geq 0, \forall i \, and \, j$$

Partitioned matrix, i.e. the fundamental matrix was developed.
Interpretations were made using Markov theories.

Theorem 1

An object from an initial distribution d_o in a Markov chain, can move through many transitions to attain a long-run distribution, d_n and hence achieve a stable transition distribution probability matrix $\bar{T}_L$ with stabilized distribution as shown in (Eq.9)

$$d_n = d_o T^n \quad (5)$$

Where $\bar{T}_L$ stable transition distribution matrix.

Theorem 2

Thus, if as the number of transitions increases $(n \uparrow)$, the power T^n of the transition matrix T approaches a matrix $\bar{T}$; and then for each choice of an initial distribution d_o, the subsequent distributions can be expressed like so (Igboanugo and Edokpia, 2014):

$d_n = d_o T^n$ stabilize to the long run distribution given by

$$\bar{d} = d_o \bar{T} \quad (6)$$

here $\bar{T}$ is the stabilized transition Matrix. Moreover, each $\bar{d}$ arising in this fashion is stationary

Theorem 3

Let T be the transition matrix of a regular Markov chain. Then the power of T approach a matrix $\bar{T}$ with long-run distribution, $\bar{d}$ all of whose rows are identical and all entries positive.
There remains the practical problem of actually computing the unique long-run distribution $\bar{d}$ associated with $\bar{T}$ of regular Markov chain.
d = dT,
for stationary d and regular dT,
= dI = dT
= dI – dT = 0
and d (I - T) = 0
Take the transpose as shown in (3)

$$\Rightarrow \theta(I-T)^t d^t = 0^t \Leftarrow AX = 0 \quad (7)$$

Equation (7) is a homogeneous system.
This leads to theorem 4

Theorem 4

Every Markov chain with states has at least one long-run distribution. Moreover, each long-run distribution is the transpose of a solution to:
AX = 0
Whose entries sum to one here
A = (I – T) ^{t}, (8)
T = ƙ-by-ƙ transition matrix and both X and 0 are ƙ-by-I column vectors.
Theorem 5
Consider as absorbing Markov chain with transition matrix.

$$\bar{T} = \begin{matrix} \\ \text{Absorbing} \\ \text{Nonabsorbing} \end{matrix} \begin{bmatrix} I & - & O \\ - & - & - \\ (I-Q)^{-1}R & - & O \end{bmatrix} \quad (9)$$

The i^{th} row of the sub matrix B = $(I-Q)^{-1}R$ specifies the long-run distribution of objects among the various absorbing states provided all objects start in the i^{th} non-absorbing state. Note equation 4 is very essential for the analysis that follows such as the fundamental matrix
$N = (I – Q)^{-1}$ This is a basic property of an absorbing Markov chain and it represents the expected or average number of visits or number of times objects starts in the i^{th} non-absorbing state to a state(transient) j' before being absorbed.
Primarily, with the fundamental matrix (N) in hand, other properties or derivatives are obtained; such as variance on number of visits $N_2 = N (2N_{dg} – I) - N_{sq}$; Expected number of steps or cumulative movements of object = Nε; variance on number of steps
$_{2=}$ (2N – I) $-_{sq;}$ the long run distribution of object or staff among the various absorbing states B = NR and the transient probabilities $H = (N – I) N_{dg}^{-1}$.
(en.m.wikipedia,org/wiki/absorbing_markov_chain#Canonical_form)

2.2 Statistical computation

In mathematical theory of probability, a Markov chain is an absorbing chain provided:

Lemma1: There are one or more absorbing states. Furthermore, a state in a Markov chain is said to be absorbing if the probability of an object leaving the state once entered is zero, or once entered cannot be exited and the probability that it stays in that state is one.

Lemma 2: From each of the non-absorbing state it is possible to reach some absorbing state in the long run by a number of steps. In an absorbing Markov chain, a state that is not absorbing i.e Non-absorbing is also called transient.

2.3 Absorbing state computation

In this regime all the transition probabilities associated with the absorbing states are heuristically determined. Basically, heuristic algorithm method is adopted which involves reasoning in the determination of the Absorbing state probabilities. For example $P_{1,1}$ = $P_r(FT) = 1$.

Mathematically, this can be expressed as $P_{1,1} = P_r(FT) = 1$. Therefore, a field staff who is wasted by fatality (death) remains dead, which is a case of persistence. As stated above it follows similar heuristic determination for other transitions, that can be expressed mathematically as $P_{2,2} = P_{3,3} = P_{4,4}$ ….. = $P_{10,10} = 1$. Furthermore, $P_{1,2}$ which represents a subject transiting from fatality (FT) to third party fatality (TPF), is a case which is implausibility. In other words, this simply means that transiting from a state considered absorbing to another state which is an absorbing or non-absorbing state is implausible. Then, similar heuristic arguments are adopted, $P_{1,2} = P_{2,1} = P_{1,3} = P_{3,1} = P_{1,4} = P_{4,1} = \ldots = P_{1,10} = P_{10,1} = 0$, for reasons of implausibility. A diagraph is usually drawn to give an insight on the interaction on the way the system operates.

2.4 Non-Absorbing state Computation

In the determination of probabilities under the non-absorbing state regime Bayesian method is adopted. For this paper ten (10) non-absorbing states are considered namely; Lost Time Days (LTD), Injury (minor) I_m, Fire incidence (minor) FI_m, Medical treatment case (minor) MTC_m, Restricted work case (minor) RWC_m, Road traffic accident (minor) RTA_m, first aid case FAC, unsafe condition UC, unsafe act UA, and Near miss NM (state 11 to 20) as shown supra Table 2.1. Besides, in the use of Bayesian methodology to compute transition probabilities under non-absorbing regime certain assumptions were considered to allow for mathematical tractability and are briefly outlined as follows:

Assumption 1: A staff that is considered by management to have a lost time day cannot at the same time be available to commit Near miss (NM= 0), $P_{11,20}$.

Assumption 2: A staff who have just suffered a minor injury (I_m) as an entry, cannot be said to have minor fire incidence at the same time (FI_m =0), $P_{12,13}$=0

Assumption 3: A well trained staff that had a minor fire incidence (FI_m) in the industry as recorded cannot be involved in a minor road traffic accident at the same time (a case of impossibility) RTA_m=0, $P_{13,16}$=0.

Assumption 4: A staff whose state is considered as a minor medical treatment case MTC_M cannot be said to be in a state of permanent disability PD =0, $P_{14,3}$=0.

Assumption 5: A staff who at a given time is in a state considered as a minor restricted work case (RWC_m) will be unavailable to be exposed to unsafe condition (UC = 0), $P_{15,18}$=0.

Assumption 6: A healthy contract staff who had a minor road traffic accident (RTA_M) cannot transit instantly to third party fatality (death) TPF=0, $P_{16,2}$= 0.

Assumption 7: A staff whose injury is considered to be a first aid case (FAC) cannot be said to have committed a major work related human error (HE = 0), $P_{17,10}$

Assumption 8: It is impossible for a staff to be at a state considered an unsafe condition (UC) at the same time be said to be in severe restricted work case (RWCs = 0), $P_{18,9}$= 0

Assumption 9: A well-trained staff who is involved in an unsafe act (UA) cannot instantly transit to a state of severe medical treatment case MTCs = 0, $P_{19,6}$ = 0

Assumption 10: A well-trained staff who commits Near miss cannot instantly transit to fatality FT= 0, $P_{20,1}$ = 0.

The above assumptions made and their modes of transition are captured in the transition probability matrix tableau and in extension the transition probability matrix T.

Basically, with the ten (10) non-absorbing state considered previously ten different combinations of

the 20-state structure were arranged in Table2.2 with the columns indicating different combinations. Conditional probability is applied in developing this Table, except for those states that have zero occurrences or whose original HSE occurrence is equated to zero as in Table 2.1 for example permanent disability, in all the columns of Table 2.2 are all zeroes. Again, in each column of Table 2. 2 certain state are equated to be zero as conditional event for transition to occur e.g near miss (NM) in column 1 and Fire incidence (minor) in column 2(Vset2) ,column3(Vset3) RTA_m just to mention a few. This is can be understood better for instance, Column 1(VSET1), the probability of a subject who commits Unsafe Act (UA) transiting to First Aid Case (FAC), given that the condition that subject have not had near miss earlier is denoted mathematically, as $\mathbf{P}\{(UA \rightarrow (FAC)|NM = 0\}$. Similarly, the same column the probability of a subject who is exposed to unsafe condition transiting to the commission of human error on the account that the subject have not had near misses earlier, is stated thus $P\{(FAC \rightarrow HE|NM= 0)\}$. Furthermore, similar representations apply for all cases under column 1(V-set 1). Also, in column 5(Vset5): The probability of a subject who had a minor Fire Incidence (FI_m) in row 13 transiting to commission human error HE in column 10 (i-j) entry on the condition that he has not been exposed to an unsafe condition, expressed mathematically, $P\{(FI_M \rightarrow HE)|UC = 0\}$. A similar representative determination for each of the columns is done following similar pattern using conditional probability approach.

Table2.2: Ten(10) Different Combination of the 20-State Structure (PPMC) are Arrange as Follows

S/NO	V_SET 1	V_SET 2	V_SET 3	V_SET 4	V_SET 5	V_SET 6	V_SET 7	V_SET 8	V_SET 9	V_SET 10
1	FT=7	FT=7	FT=7	FT=7	FT=7	FT=7	FT=7	FT=7	FT=7	FT=0
2	TPF=15	TPF=15	TPF=15	TPF=15	TPF=15	TPF=0	TPF=15	TPF=15	TPF=15	TPF=15
3	PD=0	PD=0	PD=0	PD=0	PD=0	PD=0	PD=0	PD=0	PD=0	PD=0
4	FIs=112	FIs=112	FIs=112	FIs=112	FIs=112	FIs=112	FIs=112	FIs=112	FIs=112	FIs=112
5	Is=231	Is=231	Is=231	Is=231	Is=231	Is=231	Is=231	Is=231	Is=231	Is=231
6	MTCs=464	MTCs=464	MTCs=464	MTCs=464	MTCs=464	MTCs=464	MTCs=464	MTCs=464	MTCs=0	MTCs=464
7	RTAs=10	RTAs=10	RTAs=10	RTAs=10	RTAs=10	RTAs=10	RTAs=10	RTAs=10	RTAs=10	RTAs=10
8	OS_CO=590	OS_CO=590	OS_CO=590	OS_CO=590	OS_CO=590	OS_CO=590	OS_CO=590	OS_CO=590	OS_CO=590	OS_CO=590
9	RWCs=5	RWCs=5	RWCs=5	RWCs=5	RWCs=5	RWCs=5	RWCs=5	RWCs=0	RWCs=5	RWCs=5
10	HE=10	HE=10	HE=10	HE=10	HE=10	HE=10	HE=0	HE=10	HE=10	HE=10
11	LTD=27	LTD=27	LTD=27	LTD=27	LTD=27	LTD=27	LTD=27	LTD=27	LTD=27	LTD=27
12	Im=248	Im=248	Im=248	Im=248	Im=248	Im=248	Im=248	Im=248	Im=248	Im=248
13	FIm=151	FIm=0	FIm=151	FIm=151	FIm=151	FIm=151	FIm=151	FIm=151	FIm=151	FIm=151
14	MTCm=2371	MTCm=2371	MTCm=2371	MTCm=2371	MTCm=2371	MTCm=2371	MTCm=2371	MTCm=2371	MTCm=2371	MTCm=2371
15	RWCm=35	RWCm=35	RWCm=35	RWCm=35	RWCm=35	RWCm=35	RWCm=35	RWCm=35	RWCm=35	RWCm=35
16	RTAm=36	RTAm=36	RTAm=0	RTAm=36	RTAm=36	RTAm=36	RTAm=36	RTAm=36	RTAm=36	RTAm=36
17	FAC=96	FAC=96	FAC=96	FAC=96	FAC=96	FAC=96	FAC=96	FAC=96	FAC=96	FAC=96
18	UC=1435	UC=1435	UC=1435	UC=1435	UC=0	UC=1435	UC=1435	UC=1435	UC=1435	UC=1435
19	UA=283	UA=283	UA=283	UA=283	UA=283	UA=283	UA=283	UA=283	UA=283	UA=283

	8	8	8	8	8	8	8	8	8	8
20	NM=0	NM=441	NM=441	NM=441	NM=441	NM=441	NM=441	NM=441	NM=441	NM=441
TOTAL	**8681**	**8971**	**9086**	**9122**	**7687**	**9107**	**9112**	**9117**	**8658**	**9115**

The PPMC sets of Non-absorbing transition probabilities are collated and computed as depicted in Table 2.3.by applying Bayesian methodology. In computing the transition probabilities in the non-absorbing states, the method used the ratio of subjects in any state to the total population being considered which is obtained from each total of ten different combination of the 20-state structure. The basic requirement of Markov chain is that the sum of each row in the Transition probability Tableau must equate to one or if we sum the calculated probabilities in each probability sets it will be equal to one. For example, probability Set1 (lost time days) which corresponds to row eleven in the TPM Tableau Table 2.4.. P(FT)= $P_{11,1}$ = (7/8681) = 0.0008 and P(TPF) = $P_{11,\ 2}$ = (15/8681) = 0.0017, P(PD) = $P_{11,\ 3}$ = (0/8681) = 0.0000…P(UA) = $P_{11,19}$ = (2838/8681) = 0.3269 and P(NM)= $P_{11,20}$ =(0/8681)= 0.0000.Summing up the computed values of probability set(1) must equate to one i.e$P_{11,1}$+$P_{11,\ 2}$ + $P_{11,3}$ +……+$P_{11,20}$ =1. Similarly, Probability set 2 corresponding to row twelve in TPM Tableau will equate to one also $P_{12,1}$+$P_{12,\ 2}$ + $P_{12,3}$ +……+$P_{12,20}$ =1. Same for Probability Set 3, 4, 5, 6, 7, 8, 9, and 10. These non- absorbing transition probability computations and that of the Absorbing state computations form the transition matrix probability Tableau in Table 2.4.

Table2. 3: PPMC Sets of Non-Absorbing Transition Probabilities

Probabilities Set1	**Probabilities Set2**	**Probabilities Set3**	**Probabilities Set4**
P(FT)=(7/8681)=0.0008	P(FT)=(7/8971)=0.0008	P(FT)=(7/9086)=0.0008	P(FT)=(7/9122)=0.0008
P(TPF)=(15/8681)=0.0017	P(TPF)=(15/8971)=0.0017	P(TPF)=(15/9086)=0.0017	P(TPF)=(15/9122)=0.0016
P(PD)=(0/8681)=0.0000	P(PD)=(0/8971)=0.0000	P(PD)=(0/9086)=0.0000	P(PD)=(0/9122)=0.0000
P(FI_S)=(112/8681)=0.0129	P(FI_S)=(112/8971)=0.0125	P(FI_S)=(112/9086)=0.0123	P(FI_S)=(112/9122)=0.0123
P(I_S)=(231/8681)=0.0266	P(I_S)=(231/8971)=0.0257	P(I_S)=(231/9086)=0.0254	P(I_S)=(231/9122)=0.0253
P(MTC_S)=(464/8681)=0.0535	P(MTC_S)=(464/8971)=0.0517	P(MTC_S)=(464/9086)=0.0511	P(MTC_S)=(464/9122)=0.0509
P(RTA_S)=(10/8681)=0.0012	P(RTA_S)=(10/8971)=0.0011	P(RTA_S)=(10/9086)=0.0011	P(RTA_S)=(10/9122)=0.0011
P(OS_CO)=(590/8681)=0.0680	P(OS_CO)=(590/8971)=0.0658	P(OS_CO)=(590/9086)=0.0649	P(OS_CO)=(590/9122)=0.0647
P(RWC_S)=(5/8681)=0.0006	P(RWC_S)=(5/8971)=0.0006	P(RWC_S)=(5/9086)=0.0006	P(RWC_S)=(5/9122)=0.0005
P(HE)=(10/8681)=0.0012	P(HE)=(10/8971)=0.0011	P(HE)=(10/9086)=0.0011	P(HE)=(10/9122)=0.0011
P(LTD)=(27/8681)=0.0031	P(LTD)=(27/8971)=0.0030	P(LTD)=(27/9086)=0.0030	P(LTD)=(27/9122)=0.0030

P(I_M)=(248/8681)=0.0286	P(I_M)=(248/8971)=0.0276	P(I_M)=(248/9086)=0.0273	P(I_M)=(248/9122)=0.0272
P(FI_M)=(151/8681)=0.0174	P(FI_M)=(0/8971)=0.0000	P(FI_M)=(151/9086)=0.0166	P(FI_M)=(151/9122)=0.0166
P(MTC_M)=(2371/8681)=0.2731	P(MTC_M)=(2371/8971)=0.2643	P(MTC_M)=(2371/9086)=0.2610	P(MTC_M)=(2371/9122)=0.2599
P(RWC_M)=(35/8681)=0.0040	P(RWC_M)=(35/8971)=0.0039	P(RWC_M)=(35/9086)=0.0039	P(RWC_M)=(35/9122)=0.0038
P(RTA_M)=(36/8681)=0.0041	P(RTA_M)=(36/8971)=0.0040	P(RTA_M)=(0/9086)=0.0000	P(RTA_M)=(36/9122)=0.0039
P(FAC)=(96/8681)=0.0111	P(FAC)=(96/8971)=0.0107	P(FAC)=(96/9086)=0.0106	P(FAC)=(96/9122)=0.0105
P(UC)=(1435/8681)=0.1653	P(UC)=(1435/8971)=0.1600	P(UC)=(1435/9086)=0.1579	P(UC)=(1435/9122)=0.1573
P(UA)=(2838/8681)=0.3269	P(UA)=(2838/8971)=0.3164	P(UA)=(2838/9086)=0.3123	P(UA)=(2838/9122)=0.3111
P(NM)=(0/8681)=0.0000	P(NM)=(441/8971)=0.0492	P(NM)=(441/9086)=0.0485	P(NM)=(441/9122)=0.0483

Probabilities Set5	**Probabilities Set6**	**Probabilities Set7**	**Probabilities Set8**
P(FT)=(7/7687)=0.0009	P(FT)=(7/9107)=0.0008	P(FT)=(7/9112)=0.0008	P(FT)=(7/9117)=0.0008
P(TPF)=(15/7687)=0.0020	P(TPF)=(0/9107)=0.0000	P(TPF)=(15/9112)=0.0016	P(TPF)=(15/9117)=0.0016
P(PD)=(0/7687)=0.0000	P(PD)=(0/9107)=0.0000	P(PD)=(0/9112)=0.0000	P(PD)=(0/9117)=0.0000
P(FI_S)=(112/7687)=0.0146	P(FI_S)=(112/9107)=0.0123	P(FI_S)=(112/9112)=0.0123	P(FI_S)=(112/9117)=0.0123
P(I_S)=(231/7687)=0.0301	P(I_S)=(231/9107)=0.0254	P(I_S)=(231/9112)=0.0254	P(I_S)=(231/9117)=0.0253
P(MTC_S)=(464/7687)=0.0604	P(MTC_S)=(464/9107)=0.0509	P(MTC_S)=(464/9112)=0.0509	P(MTC_S)=(464/9117)=0.0509
P(RTA_S)=(10/7687)=0.0013	P(RTA_S)=(10/9107)=0.0011	P(RTA_S)=(10/9112)=0.0011	P(RTA_S)=(10/9117)=0.0011
P(OS_CO)=(590/7687)=0.0768	P(OS_CO)=(590/9107)=0.0648	P(OS_CO)=(590/9112)=0.0647	P(OS_CO)=(590/9117)=0.0647
P(RWC_S)=(5/7687)=0.0007	P(RWC_S)=(5/9107)=0.0005	P(RWC_S)=(5/9112)=0.0005	P(RWC_S)=(0/9117)=0.0000

P(HE)=(10/7687)=0.0013	P(HE)=(10/9107)=0.0011	P(HE)=(0/9112)=0.0000	P(HE)=(10/9117)=0.0011
P(LTD)=(27/7687)=0.0035	P(LTD)=(27/9107)=0.0030	P(LTD)=(27/9112)=0.0030	P(LTD)=(27/9117)=0.0030
P(I_M)=(248/7687)=0.0323	P(I_M)=(248/9107)=0.0272	P(I_M)=(248/9112)=0.0272	P(I_M)=(248/9117)=0.0272
P(FI_M)=(151/7687)=0.0196	P(FI_M)=(151/9107)=0.0166	P(FI_M)=(151/9112)=0.0166	P(FI_M)=(151/9117)=0.0166
P(MTC_M)=(2371/7687)=0.3084	P(MTC_M)=(2371/9107)=0.2603	P(MTC_M)=(2371/9112)=0.2602	P(MTC_M)=(2371/9117)=0.2601
P(RWC_M)=(35/7687)=0.0046	P(RWC_M)=(35/9107)=0.0038	P(RWC_M)=(35/9112)=0.0038	P(RWC_M)=(35/9117)=0.0038
P(RTA_M)=(36/7687)=0.0047	P(RTA_M)=(36/9107)=0.0040	P(RTA_M)=(36/9112)=0.0040	P(RTA_M)=(36/9117)=0.0039
P(FAC)=(96/7687)=0.0125	P(FAC)=(96/9107)=0.0105	P(FAC)=(96/9112)=0.0105	P(FAC)=(96/9117)=0.0105
P(UC)=(0/7687)=0.0000	P(UC)=(1435/9107)=0.1576	P(UC)=(1435/9112)=0.1575	P(UC)=(1435/9117)=0.1574
P(UA)=(2838/7687)=0.3692	P(UA)=(2838/9107)=0.3116	P(UA)=(2838/9112)=0.3115	P(UA)=(2838/9117)=0.3113
P(NM)=(441/7687)=0.0574	P(NM)=(441/9107)=0.0484	P(NM)=(441/9112)=0.0484	P(NM)=(441/9117)=0.0484

Probabilities Set9	**Probabilities Set10**
P(FT)=(7/8658)=0.0008	P(FT)=(0/9115)=0.0000
P(TPF)=(15/8658)=0.0017	P(TPF)=(15/9115)=0.0016
P(PD)=(0/8658)=0.0000	P(PD)=(0/9115)=0.0000
P(FI_S)=(112/8658)=0.0129	P(FI_S)=(112/9115)=0.0123
P(I_S)=(231/8658)=0.0267	P(I_S)=(231/9115)=0.0253
P(MTC_S)=(0/8658)=0.0000	P(MTC_S)=(464/9115)=0.0509
P(RTA_S)=(10/8658)=0.0012	P(RTA_S)=(10/9115)=0.0011
P(OS_CO)=(590/8658)=0.0681	P(OS_CO)=(590/9115)=0.0647
P(RWC_S)=(5/8658)=0.0006	P(RWC_S)=(5/9115)=0.0005
P(HE)=(10/8658)=0.0012	P(HE)=(10/9115)=0.0011
P(LTD)=(27/8658)=0.0031	P(LTD)=(27/9115)=0.0030
P(I_M)=(248/8658)=0.0286	P(I_M)=(248/9115)=0.0272
P(FI_M)=(151/8658)=0.0174	P(FI_M)=(151/9115)=0.0166
P(MTC_M)=(2371/8658)=0.2739	P(MTC_M)=(2371/9115)=0.2601
P(RWC_M)=(35/8658)=0.0040	P(RWC_M)=(35/9115)=0.0038
P(RTA_M)=(36/8658)=0.0042	P(RTA_M)=(36/9115)=0.0039

P(FAC)=(96/8658)=0.0111	P(FAC)=(96/9115)=0.0105
P(UC)=(1435/8658)=0.1657	P(UC)=(1435/9115)=0.1574
P(UA)=(2838/8658)=0.3278	P(UA)=(2838/9115)=0.3114
P(NM)=(441/8658)=0.0509	P(NM)=(441/9115)=0.0484

The above tabular computation as shown in Table2.3 Probabilities set1, set2, set3, set4, set 5,set 6…..set 10 with each probability set computations summing up to one(1) and occupies row11,12, 13……to row20 of the non-absorbing regime of the TPM Table 2.4, which essentially depicts the transition Probability Matrix Tableau of Pipeline and Product Marketing Company. It summarizes the computation of the absorbing state regime calculation obtained through heuristic approach and the Non-absorbing state regime computations obtained by Bayesian methodology. The Transition probability matrix Tableau is structured into two major parts; the Absorbing state transition probability occupying the first ten (10 by 20) matrix of the (20 x20)matrix, which is spanning from Fatality(FT)to Human Error (HE) on the rows and fatality (FT) to Near misses (NM) on the column, while the Non-absorbing state transition probability are arranged in the next (11 by 20) beginning from row 11, Lost time day (LTD) to row 20, Near miss (NM) and Fatality to Near miss (NM), column 1 to column 20. Essentially, the row sum of the Transition Probability Tableau must equate to one. Besides, the Transition probability matrix can be viewed as having four sub-matrices.

The Upper left-hand side which has a main diagonal of unity with upper and lower triangular matrix of zeroes represents the Identity matrix (I) and the upper right hand with all Zeroes is called the Null matrix or matrix of zeroes (O).]The lower left-hand side and Right hand side of TPM represents arbitrary Matrix R and Q respectively, which forms the Non-absorbing state transition probabilities matrix. However, the Transition probability matrix is consonance to the standard transition matrix

Table 2.4. PPMC Transition Probability Matrix Tableau

	FT	TPF	PD	Fis	Is	MTCs	RTAs	Osco	RWCs	HE	LTD	Im	Fim	MTCm	RWCm	RTAm	FAC	UC	UA	NM
FT	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TPF	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PD	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fis	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Is	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MTCs	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RTAs	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Osco	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
RWCs	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
HE	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
LTD	**0.0008**	**0.002**	**0**	**0.0129**	**0.0266**	**0.0535**	**0.0012**	**0.068**	**0.0006**	**0.0012**	**0.0031**	**0.0286**	**0.0174**	**0.2731**	**0.004**	**0.0041**	**0.0111**	**0.1653**	**0.3269**	**0**
Im	**0.0008**	**0.002**	**0**	**0.0125**	**0.0257**	**0.0517**	**0.0011**	**0.0658**	**0.0006**	**0.0011**	**0.003**	**0.0276**	**0**	**0.2643**	**0.0039**	**0.004**	**0.0107**	**0.16**	**0.3164**	**0.0492**
Fim	**0.0008**	**0.002**	**0**	**0.0123**	**0.0254**	**0.0511**	**0.0011**	**0.0649**	**0.0006**	**0.0011**	**0.003**	**0.0273**	**0.0166**	**0.261**	**0.0039**	**0**	**0.0106**	**0.1579**	**0.3123**	**0.0485**
MTCm	**0.0008**	**0.002**	**0**	**0.0123**	**0.0253**	**0.0509**	**0.0011**	**0.0647**	**0.0005**	**0.0011**	**0.003**	**0.0272**	**0.0166**	**0.2599**	**0.0038**	**0.0039**	**0.0105**	**0.1573**	**0.3111**	**0.0483**
RWCm	**0.0009**	**0.002**	**0**	**0.0146**	**0.0301**	**0.0604**	**0.0013**	**0.0768**	**0.0007**	**0.0013**	**0.0035**	**0.0323**	**0.0196**	**0.3084**	**0.0046**	**0.0047**	**0.0125**	**0**	**0.3692**	**0.0574**
RTAm	**0.0008**	**0**	**0**	**0.0123**	**0.0254**	**0.0509**	**0.0011**	**0.0648**	**0.0005**	**0.0011**	**0.003**	**0.0272**	**0.0166**	**0.2603**	**0.0038**	**0.004**	**0.0105**	**0.1576**	**0.3116**	**0.0484**
FAC	**0.0008**	**0.002**	**0**	**0.0123**	**0.0254**	**0.0509**	**0.0011**	**0.0647**	**0.0005**	**0**	**0.003**	**0.0272**	**0.0166**	**0.2602**	**0.0038**	**0.004**	**0.0105**	**0.1575**	**0.3115**	**0.0484**
UC	**0.0008**	**0.002**	**0**	**0.0123**	**0.0253**	**0.0509**	**0.0011**	**0.0647**	**0**	**0.0011**	**0.003**	**0.0272**	**0.0166**	**0.2601**	**0.0038**	**0.0039**	**0.0105**	**0.1574**	**0.3113**	**0.0484**
UA	**0.0008**	**0.002**	**0**	**0.0129**	**0.0267**	**0**	**0.0012**	**0.0681**	**0.0006**	**0.0012**	**0.0031**	**0.0286**	**0.0174**	**0.2739**	**0.004**	**0.0042**	**0.0111**	**0.1657**	**0.3278**	**0.0509**
NM	**0**	**0.002**	**0**	**0.0123**	**0.0253**	**0.0509**	**0.0011**	**0.0647**	**0.0005**	**0.0011**	**0.003**	**0.0272**	**0.0166**	**0.2601**	**0.0038**	**0.0039**	**0.0105**	**0.1574**	**0.3114**	**0.0484**

3. 0 RESULTS AND DICUSSIOND

3.1 Results and Discussions

The Transition probabilities

The Transition probability matrix T eq (10) is a standard form of a absorbing Markov chain in which the rows and columns are designated in such a way that all the absorbing state probabilities precedes all the non – absorbing state probabilities. In its standard form it is always partitioned into four sub-matrices. It is the transition probability Tableau in matrix form. Transition matrix in its stabilized form gives the long-run distribution of the safety practice of the given organization. i.e when the power of T^n of T approaches

$$T^n = \bar{T} = \begin{pmatrix} I & 0 \\ \hline (I-Q)^{-1}R & 0 \end{pmatrix}$$

Stability where $(I-Q)^{-1}R = B$ gives the absorbing state probability matrix and $(I-Q)^{-1}$ is the fundamental matrix (N). In other words, the stability transition probability $\bar{T}$ can be obtained simply from $B = NR$

$T =$

I	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
R	0.0008	0.002	0	0.0129	0.0266	0.0535	0.0012	0.068	0.0006	0.0012	0.0031	0.0286	0.0174	0.2731	0.004	0.0041	0.0111	0.1653	0.3269	0	Q
	0.0008	0.002	0	0.0125	0.0257	0.0517	0.0011	0.0658	0.0006	0.0011	0.003	0.0276	0	0.2643	0.0039	0.004	0.0107	0.16	0.3164	0.0492	
	0.0008	0.002	0	0.0123	0.0254	0.0511	0.0011	0.0649	0.0006	0.0011	0.003	0.0273	0.0166	0.261	0.0039	0	0.0106	0.1579	0.3123	0.0485	
	0.0008	0.002	0	0.0123	0.0253	0.0509	0.0011	0.0647	0.0005	0.0011	0.003	0.0272	0.0166	0.2599	0.0038	0.0039	0.0105	0.1573	0.3111	0.0483	
	0.0009	0.002	0	0.0146	0.0301	0.0604	0.0013	0.0768	0.0007	0.0013	0.0035	0.0323	0.0196	0.3084	0.0046	0.0047	0.0125	0	0.3692	0.0574	
	0.0008	0	0	0.0123	0.0254	0.0509	0.0011	0.0648	0.0005	0.0011	0.003	0.0272	0.0166	0.2603	0.0038	0.004	0.0105	0.1576	0.3116	0.0484	
	0.0008	0.002	0	0.0123	0.0254	0.0509	0.0011	0.0647	0.0005	0	0.003	0.0272	0.0166	0.2602	0.0038	0.004	0.0105	0.1575	0.3115	0.0484	
	0.0008	0.002	0	0.0123	0.0253	0.0509	0.0011	0.0647	0	0.0011	0.003	0.0272	0.0166	0.2601	0.0038	0.0039	0.0105	0.1574	0.3113	0.0484	
	0.0008	0.002	0	0.0129	0.0267	0	0.0012	0.0681	0.0006	0.0012	0.0031	0.0286	0.0174	0.2739	0.004	0.0042	0.0111	0.1657	0.3278	0.0509	
	0	0.002	0	0.0123	0.0253	0.0509	0.0011	0.0647	0.0005	0.0011	0.003	0.0272	0.0166	0.2601	0.0038	0.0039	0.0105	0.1574	0.3114	0.0484	

(10) 69)

The Identity matrix I, null matrix (O), the arbitrary matrix R and Q are the shown by the sides of standard transition Matrix T.

Standard form of transition matrix

$$T = \begin{pmatrix} I & O \\ \hline R & Q \end{pmatrix}$$

In computing the fundamental Matrix N, the above matrix I-Q inverse is taken which give N in eq.11. see (Bokolo et.al,2019) for clarity on steps to the computation of the fundamental matrix N, it associated variance $N_{2,,}$

$N =$

(i) \ (j)	11	12	13	14	15	16	17	18	19	20
11	1.0209	0.1921	0.1138	1.837	0.0271	0.0274	0.0744	1.1068	2.1989	0.2898
12	0.0209	1.1922	0.0969	1.8371	0.0271	0.0275	0.0744	1.1068	2.1989	0.3406
13	0.0209	0.1922	1.1138	1.8371	0.0271	0.0235	0.0744	1.1068	2.1989	0.3406
14	0.0209	0.1922	0.1138	2.8371	0.0271	0.0274	0.0744	1.1068	2.1989	0.3406
15	0.0209	0.1921	0.1138	1.8369	1.0271	0.0274	0.0744	0.92	2.1987	0.3406
16	0.021	0.1925	0.114	1.8401	0.0272	1.0275	0.0745	1.1086	2.2026	0.3412
17	0.0209	0.1924	0.1139	1.8391	0.0271	0.0275	1.0745	1.108	2.2014	0.341
18	0.0209	0.1923	0.1138	1.8381	0.0271	0.0275	0.0744	2.1074	2.2001	0.3408
19	0.022	0.2025	0.1199	1.9356	0.0286	0.0289	0.0784	1.1661	3.3168	0.3589
20	0.0209	0.1923	0.1139	1.8385	0.0271	0.0275	0.0744	1.1077	2.2006	1.3409

(4.70)

(11)

The matrix N specifies the number of habituations subjects undergo in the transient states before being finally absorbed or this is a basic property of an absorbing Markov chain and it represents the expected

or average number of visits or number of times objects starts in the ith non-absorbing state to a state (transient) j' before being absorbed. The fundamental matrix N is interpreted along N_2 matrix the associated variance. For example **20 → 11**(Near misses→ lost time days) (I ,j) = 0.0209. The significance of this entry is that for every one hundred (100) movements (visits) from near misses to lost time days, 2 times out 100 of such movements of near misses will result into matrix T.

an injury that will end up in lost time day. In other words, It can be stated that 2% of all near misses ends up in a lost time day. This happens with an associated variance of 0.0214, 0.0214 N_2

However, the long run distribution of the system in eq.12, B = N R. is the multiplication of the fundamental matrix (N) obtained above and the arbitrary R in the standard transition probability

$$B = NR = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5\ (i) \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \end{array} \begin{array}{c} \begin{array}{cccccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 \end{array} \\ (j) \\ \begin{bmatrix} 0.0052 & 0.0116 & 0 & 0.0868 & 0.179 & 0.2417 & 0.0077 & 0.4571 & 0.0033 & 0.0077 \\ 0.0052 & 0.0116 & 0 & 0.0868 & 0.179 & 0.2417 & 0.0077 & 0.4571 & 0.0033 & 0.0077 \\ 0.0052 & 0.0116 & 0 & 0.0868 & 0.179 & 0.2417 & 0.0077 & 0.4571 & 0.0033 & 0.0077 \\ 0.0052 & 0.0116 & 0 & 0.0868 & 0.179 & 0.2417 & 0.0077 & 0.4571 & 0.0033 & 0.0077 \\ 0.0052 & 0.0116 & 0 & 0.0868 & 0.179 & 0.2416 & 0.0077 & 0.4571 & 0.0034 & 0.0077 \\ 0.0052 & 0.0099 & 0 & 0.0869 & 0.1793 & 0.2421 & 0.0078 & 0.4579 & 0.0033 & 0.0077 \\ 0.0052 & 0.0116 & 0 & 0.0869 & 0.1792 & 0.2419 & 0.0078 & 0.4576 & 0.0033 & 0.0066 \\ 0.0052 & 0.0116 & 0 & 0.0868 & 0.1791 & 0.2418 & 0.0078 & 0.4574 & 0.0027 & 0.0077 \\ 0.0054 & 0.0122 & 0 & 0.0914 & 0.1886 & 0.201 & 0.0082 & 0.4816 & 0.0034 & 0.0081 \\ 0.0044 & 0.0116 & 0 & 0.0868 & 0.1791 & 0.2419 & 0.0078 & 0.4575 & 0.0033 & 0.0077 \end{bmatrix} \end{array} \quad (4.71)$$

(12)

The numbering by the sides and tops of matrices N, B is in consonance with the states as depicted in Table2. 1, which facilitates cross references (i, j). The B matrix gives the long-run transition of subjects (staff) within the system which shows the general trend. It is evident that the row entries in each column are the same showing that it actually represents a stabilized matrix (trend) and thus, can be interpreted column wise. Column 1, 2 represents state 1 which in fatality, while column 2 state 2 third party fatalities, and so on. For example, column wise, column 8 which represents Oil spill call out. The accompanying graphical representation maps states to long-run probabilities of occurrence as discernable from the B- matrix depicted supra.

Graphical representation of B- matrix is mapped out in eq.13 as visual aid.

$$B = \begin{pmatrix} Fatality \rightarrow 0.0052 & Third\ Party\ Fatality \rightarrow 0.0116 \\ Permanent\ Disability \rightarrow 0 & Fire\ Incidence\,(Severe) \rightarrow 0.0868 \\ Injury\,(Severe) \rightarrow 0.179 & Medical\ Treatment\ Case\,(Severe) \rightarrow 0.2417 \\ Road\ Trafic\ Accident\,(Severe0 \rightarrow 0.0077 & Oil\ Spill\,(Call\ Outs) \rightarrow 0.4571 \\ \text{Re}\,stricted\ Work\ Cases\,(Severe) \rightarrow 0.0033 & Human\ Error \rightarrow 0.0077 \end{pmatrix} \quad (4.72)$$

(13)

Using Long-Run Distribution to test the above procedure

Expected number of steps and Variance of number of steps

Expected number of steps gives or provides the total number of steps staff or subjects take within the non-absorbing states before being absorbed or the cumulative movements of staff or subject within the non-absorbing state before absorption as in eq 14.

$\tau = N\zeta =$

This is the multiplication of the fundamental matrix N, and unit column matix epsilon

$$\begin{bmatrix} 1.0209 & 0.1921 & 0.1138 & 1.837 & 0.0271 & 0.0274 & 0.0744 & 1.1068 & 2.1989 & 0.2898 \\ 0.0209 & 1.1922 & 0.0969 & 1.8371 & 0.0271 & 0.0275 & 0.0744 & 1.1068 & 2.1989 & 0.3406 \\ 0.0209 & 0.1922 & 1.1138 & 1.8371 & 0.0271 & 0.0235 & 0.0744 & 1.1068 & 2.1989 & 0.3406 \\ 0.0209 & 0.1922 & 0.1138 & 2.8371 & 0.0271 & 0.0274 & 0.0744 & 1.1068 & 2.1989 & 0.3406 \\ 0.0209 & 0.1921 & 0.1138 & 1.8369 & 1.0271 & 0.0274 & 0.0744 & 0.92 & 2.1987 & 0.3406 \\ 0.021 & 0.1925 & 0.114 & 1.8401 & 0.0272 & 1.0275 & 0.0745 & 1.1086 & 2.2026 & 0.3412 \\ 0.0209 & 0.1924 & 0.1139 & 1.8391 & 0.0271 & 0.0275 & 1.0745 & 1.108 & 2.2014 & 0.341 \\ 0.0209 & 0.1923 & 0.1138 & 1.8381 & 0.0271 & 0.0275 & 0.0744 & 2.1074 & 2.2001 & 0.3408 \\ 0.022 & 0.2025 & 0.1199 & 1.9356 & 0.0286 & 0.0289 & 0.0784 & 1.1661 & 3.3168 & 0.3589 \\ 0.0209 & 0.1923 & 0.1139 & 1.8385 & 0.0271 & 0.0275 & 0.0744 & 1.1077 & 2.2006 & 1.3409 \end{bmatrix} \times \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 6.8882 \\ 6.9225 \\ 6.9353 \\ 6.9393 \\ 6.752 \\ 6.949 \\ 6.9458 \\ 6.9425 \\ 7.2576 \\ 6.9438 \end{bmatrix} \quad (4.75) \quad (14)$$

The cumulative movements of subject within non-absorbing state before absorption is represented by matrix in eq.15

$$\tau = \begin{bmatrix} 6.8882 \\ 6.9225 \\ 6.9353 \\ 6.9393 \\ 6.752 \\ 6.949 \\ 6.9458 \\ 6.9425 \\ 7.2576 \\ 6.9438 \end{bmatrix} \quad (4.76) \quad (15)$$

It is evident from the entries of that subjects on the average change positions about 7 times at each of the transient states before being trapped in any of the ten (10) absorbing states. The estimate is associated with a variance of 42 and standard deviation of about 6 which is $_{2=}$ (2N – I) -$_{sq}$

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Safety data analysis lies in its ability to unveil several important details beyond mere descriptive statistics for accident prevention, identification of patterns, root causes and vulnerability of workers as they are exposed to their work environment. This study shows evidently the step wise movement of personnel in the organization as workers changes position only Seven(7) times in the non -absorbing states before the worker is being absorbed(severely affected) in any of the ten(10) classified absorbing regime. Furthermore, 46% oil spill call out was trumped out in the long-run distribution matrix B as mapped in the study. This development is worrisome as oil spill possess a significant and immediate danger to human life, agricultural lands, wildlife and fisheries.

However, it should be noted that oil spill can cause respiratory problems and fire explosion leading to loss of lives, assets, man-hour, lower productivity, ecosystem instability and economic decline.

4.2 Recommendation

Markov chain model in its predictive capability has revealed some worrisome trends in the safety data and as such the organization should be proactive to containment and undertake proper remediation and clean up measures to preserve the stability and viability of the ecosystem.

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