A MAP-BASED RISK ASSESSMENT OF COVID-19 PANDEMIC IN ABIA STATE USING GEOGRAHIC INFORMATION SYSTEMS.

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ABSTRACT

In recent times the associated problems of Covid-19 pandemic faced by many countries in the world, cannot be over emphasized giving its magnitude as a Public Health Emergency of International Concern.This paper focused on the capabilities ofa Map-Based Risk Assessment of Covid-19 Pandemic in Abia State, using Geographic InformationSystems(GIS) and Remote Sensing Techniques. The specific objectives included the Creation of GIS database; operationalization and modeling of identified spatial distribution of Covid-19 pandemic drivers and the generation of composite map of Covid-19 Risk Index of the Study Area. Combined risk assessment was done using the single output map algebra of the spatial analyst tools extension, Multi-Criteria Evaluation Techniques Using ArcMap 10.4 a GIS environment, to display areas prone to Covid-19 pandemic. Findings showed that Covid-19 is an infectious disease. The study ranks the Study Areas on a 1 to 3 scale (zonation order) based on the spatial alertness. Therefore, the results revealed that map-based analysis to depict 1089.69 km^2 representing 23.89% ranked 3 occupying High-risk incidences while 4837.74km^2 representing 10.61% (ranked 2) occupying Moderately vulnerable areas and Low areas (ranked 1) occupying 29859.5km^2 representing 65% of the study areas respectively. GIS Map-based analysis will be helpful to the authorities and stakeholders, in the location, identification of the sources, the distribution of information and timely preventive actions for the protection of potential vulnerable population and steer development towards sustainability. key words: GIS, Risk, Assessment, Covid-19, Abia State.

INTRODUCTION

The outbreak of COVID-19 pandemic since December, 31, 2019 has been a major disaster affecting many countries of the world today, causing great human and economic loss respectively (World Health Organization (WHO) 2020, a, b, c; West Africa Health (WAHO 2020). The impact of the pandemic shows that it has the potentials of reaching a larger proportion of the global population.That is, 40-70 percent of world's population could become infected (Baldwin and DiMauro, 2020). Considering the enormity of this problem, the Nigeria Centre for Disease and control (NCDC)(2020); National Institute for Communicable Disease (NICD)(2020) pointed out that confirmed cases and deaths as at November, 2021is increasingly high in a country where it was thought that the virus will not spread even though Even though the recovery rate is high, there is still that notion that cases are under reported and those reported are based in the urban areas (Okonofua Ntoimo, Yaya, Igboin, Ekwo and Imongan, 2020). Still following the Nigerian pattern, cases in the study area are reported at macro levels but there are little or no studies to justify the spatial patterns of the spread of the disease (Ihekweazu and Agogo,2020; Abubakar, Dalglish, Ihekweazu, Omotayo and Aliyu, 2021;Emenyeonu, 2023).

Previous authors such as Alasia and Maduka (2021), OkonoficaNtoimo, etal, (2020), Elimian, Och and Ebhedghe (2020a, b.) in their studies have looked at the COVID-19 pandemic from different dimensions. These studies were therefore, written from the health and medical angle based on the co-production of evidence and policy in Nigeria's COVID-19 response (Abubakar, etal, 2021). Thus, Map-based risk assessment of geographic perspectives need to be studied to gain a better understanding of the situation in Nigeria and in particular Abia State using GIS technologies as gap that this study intends to fill. Therefore, GIS technology is a major technique that can be used to unravel the relationships that are often hidden by the complexities of the data. That is, the use of GIS for Covid-19 mapping will provide the most comprehensive and effective up to data analysis. For instance, if the disease can travel so quickly, information dissemination has to move faster to ensure accurate monitoring and surveillance of public health practices and guidelines. Thus, covid-19 pandemic is generally a much talked about phenomenon in the study area, particularly given the unprecedented scales experienced globally. This has coherently recorded the issue of sustainable development of human settlement in the wake of covid-19 pandemic as that which needs every informed attention to guard against the occurrence of such a disaster as covid-19 pandemic.

STATEMENT OF THE PROBLEM

On December 31, 2019, a cluster of pneumonia-like infection was detected in Wuhan of Hubei Province, China. The infection is claimed to have originated from a sea food market in the city. It was first named SARS–CoV-2 and later relabeled as COVID-19 or better known as the Corona virus Disease (Osayomi, Adeleke, Taiwo, Gbadegesin, Fatayo, Akpoterai, Ayanda, Moyin-Jesu and Isioye, 2020; Yahya,Yahya,Thannoun,2021;Lai,Shih,Ko,Tang and Hsueh,2020; Lauer, Grantz, Bi, Jones, Zheng, Meredith, Azman, Reich and Lessler, 2020; Li, Pei, Chen, Song, Zhang, Yang, 2020). The virus is transmitted by air droplets; spreading through person-to-person contact. Its symptoms include cough, fever, headache, shortness of breath, and respiratory difficulty. Given its magnitude, the World Health Organization (WHO) on the 30th January 2020, classified COVID-19 as a Public Health Emergency of International Concern and subsequently a pandemic on March 11, 2020 (WHO,

2020). As of June 11, there were over 7 million confirmed cases and over 400,000 deaths that were associated with COVID-19 (WHO, 2020).Going by the above, it is therefore necessary and expedient for a study such as this to be carried out if the state is to avoid the associated problems of Covid-19 pandemic faced by many countries in the world.

This research seeks to answer the following questions:

1. How is COVID-19 pandemic spatially distributed in Abia State?
2. What are the drivers of COVID-19 pandemic distribution in the study area?
3. What are the response activities initiated to reduce the effects of the pandemic?
4. What is the risk of COVID-19 pandemic in Abia State?

AIM AND OBJECTIVES

Based on the foregoing questions, the thrust of this research is to model the spatial distribution of COVID-19 in the study area. This aim will be achieved using the following objectives;

1. To create a GIS database for the evaluation of the spatial distribution of COVID-19 pandemic in Abia State
2. To identify the drivers of COVID-19 pandemic distribution in the study area
3. To determine the response activities initiated to reduce the effects of the pandemic
4. To generate risk assessment maps using COVID-19 data.

SCOPE AND SIGNIFICANCE OF THE STUDY

This research work is limited to the study of Map-Based Risk Assessment of

Covid-19 Pandemic in Abia State using GIS. The findings of this work will be useful to policy makers in Sustainable Covid-19 Pandemic Management and Mitigation.

THE STUDY AREA

Abia State is situated in South Eastern Nigeria and lies between latitude 4°45'N and 6°00'N of the Equator and Longitudes 7°0'E and 8°09'E of Greenwich meridian (figure 1). The area covers about 5420km^2 with a total population of 31.234,203 people and a population density of 57.64 person/km^2 based on a projected population of 2006 (NPC, 2007). Mean annual rainfall over the area decreases gradually form 2200mm-1900mm south to North. The hottest period is between January and March with temperature of above 27°C (dry season starts from November to March). The relative humidity (remain at an average of 70% to 80%) is usually high throughout the year. The area is noted for its low-lying flood plains and rain forest. It is drained by a number of rivers and streams with Qua Iboe River being the most significant. The area has very high agricultural potentials and is rich in crude oil and gas, oil palm trees and many other natural resources.

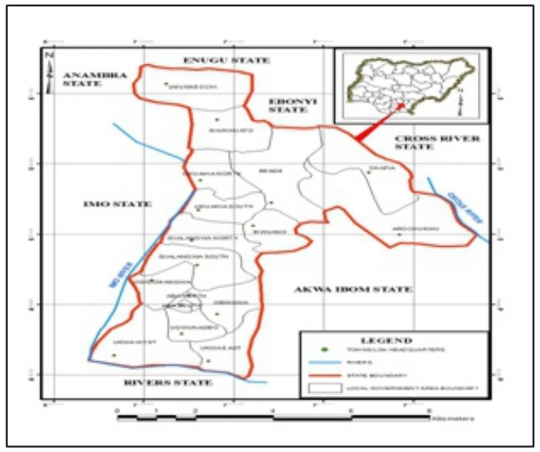


Figure 1: Map of the Study

REVIEW OF RELATED LITERATURE AND CONCEPTUAL FRAMEWORK

Vulnerability to Covid-19 Hazard Assessment

Evidence relating to the community use of mask, physical distancing, hand washing and avoidance of normal practices of handshakes or hugging to prevent

the disease of COVID-19 has not been effective, since it was discovered in China. Authorities and scientists do not yet have all the answers about the novel virus especially in the study area and the world at large. GIS technology can be used in the modelling of the spatial distribution of vulnerable population and response to COVID-19 pandemic by providing real-time data on symptoms and easy cost effective and efficient response from contracting the coronavirus disease on a daily basis (Arnab, Komal and Manti, 2020). Again, diagnostic testing is an essential response strategy to interrupt the transmission for the COVID-19 (NCDC, 2020) pandemic by informing patient management, identifying positive cases which can be isolated through the use of GIS technology.

Covid-19 Risk Assessment

Researches on the risk assessment of Covid-19 pandemic has been proven to differ with locations. The risk assessment of a situation also varies from place to place. Pujan and Shekatkar (2020), Murugesan et al (2020), Ahasan et al (2020) observed that using spatial networks for multi-city modelling of COVID-19 epidemics is a vital proposal computationally. That is using GIS approach will provide efficient hybrid method that makes use of SIR model for individual cities that will encourage transportation system. This model disseminates the overall population into compartments for vulnerable, Tainted and Recuperated people. This approach will be able to provide differential equations and describe the movement of population from one compartment to another and by extension, through the domestic transportation where the vital population can uncover from the onset of epidemic based on early warning. Kumar, Kalita, Patairiya, Sharma, Nanda, Rainb and Bhagarathula (2020) used GIS approach to predict some health trajectories of COVID-19 till April 30, 2020 using most advanced Auto-Regressive Integrated Moving Average model (ARIMA) for the most infections countries. These forecasting helps the public Health Authorities on hospital and clinic placement and quick infection control measures that are critically required to reduce the COVID-19 pandemic (Arnab, *et al.,* 2020).

According to Okonofua et al (2020), Nigeria has experienced COVID-19 pandemic as in nearly 200 countries around the world. The objective of Okonofua et al (2020) study was to investigate the knowledge, risk perceptions, and preventive practices among rural women in Edo State, Nigeria to identify the social circumstances under which women respond to COVID-19 in the community. The study design used was a cross-sectional and consisted of face-to-face interviews with 1,411 women in 20 rural communities in Edo state, south-south Nigeria using a structured questionnaire. Questions consisted of socio-demographic characteristics, the knowledge of COVID-19, its symptoms and prevention method, and the women's compliance with the prevention guidelines recommended by the Nigerian Centre for Disease Control. Some of the questions and formats were adapted from the survey tool and guidance for monitoring knowledge, risk perceptions and preventive behaviour by the WHO Regional Office for Europe. The data for the study were analyzed with univariate, bivariate and multivariable statistical techniques. The results showed relatively high knowledge of COVID-19 but low perceptions of risk, and inadequate self-reported compliance with the recommendations for prevention, use of face mask, and hand washing. The study also indicated that the most prominent determinants of lack of knowledge of COVID-19, the symptoms, and preventive measures; perception of COVID-19 as no health threat; and poor preventive behaviour include less exposure to the media, being in a polygynous and consensual marriage, illiteracy, age, and not having a mobile

phone. Okonofua et al (2020) concluded that although rural women in Nigeria have relatively high knowledge, low-risk perception and adoption of preventive measures for COVID-19 are grossly inadequate. These deficits are attributable to illiteracy, poor access to information, and the pervading poverty in rural communities. Appropriate policies and programs that address these challenges will prevent COVID-19 pandemic and its consequences in rural Nigeria.

CONCEPTUAL FRAMEWORK

Concept of Hazard Vulnerability

Conceptually, Hazard refers to the probability of occurrence of potentially damaging phenomenon. Hazard are the threats that have the potential to harm people (and the animals they value) and places (Franch Pardo, Desjardina, Bares-Navarro and Cerda, 2021). Franch Pardo, et al. (2021) argued that people most often travel to physical areas of hazard that commensurate with their economic stability. In other words, societal work opportunities may be present only in areas of high hazard and risk. The variety of land and space for work and habitation provide varying degrees of opportunities and risk to hazard. They argued that factors such as race, class, gender, and ethnicity all affect social susceptibility to hazard. Hazard vulnerability is determined by social influence and power and not the force of nature. Indeed, map based GIS recognize the interactions of various exposures, sensitivities and adaptive capacities function across scales (Anyanwu, 2015Franch Pardo, et al. 2021).That is,an attempt to geographically track and map the COVID- 19 disease, Boulos and Geraghty (2020); Rezaei, Nouri, Park and Kim (2020); Carballada and Balsa-Barreiro (2020), used GIS to track and map the corona virus disease and associated events around the world. They tracked the spread of the pandemic from Wuhan, China to other parts of China and then to other parts of the world. The tracking was done using geographic information systems and methods, online real time mapping of the disease cases, social media reactions to disease spread, predictive mapping using population travel data, mapping/tracing of super spreader trajectories and contacts across space and time. The results of the study indicated that the movement of population was the major cause of the spread of the disease and that the disease had already left Wuhan by air travel before quarantine efforts began. The results of the study also indicated that the virus moved from China to Thailand, Japan, Hong Kong, USA, Australia and the United Kingdom by virtue of air travel. The authors concluded that modern GIS technologies which centres around web-based tools, improved data sharing, and real time information is necessary to support critical health decision making.

Concept of Multi-Criteria Evaluation Techniques/Analysis (MCET)

The term Multi Criteria EvaluationTechniques/Analysis (MCET) refers to a group of formal approaches to the analysis of decision process and problems, which aim at determining preferences among overall different alternatives. Each alternative under estimation is evaluated on the basis of its performance with respect to a body of decision criteria (Belton & Stewart, 2002 ;Malczewki, 2004; Anyanwu, 2015). GIS-based Multi-Criteria Evaluation Decision Techniques/Analysis can be thought of as a process that combines and transforms spatial and aspatial data (input) into a resultant decision (output). Spatial analysis with the use of the GIS technologies has been increasingly utilized to study the effects of Covid-19 risk management for the study area. Thus, this study is a synthesis on GIS map base tool analysis, their themes and their field of application on Covid-19. That is GIS techniques have served to monitor,

evaluate situations, predict events and inform policy decisions about hazard vulnerability and risk involvement.

INTRODUCTION

The outbreak of COVID-19 pandemic since December, 31, 2019 has been a major disaster

MATERIAL AND METHODS

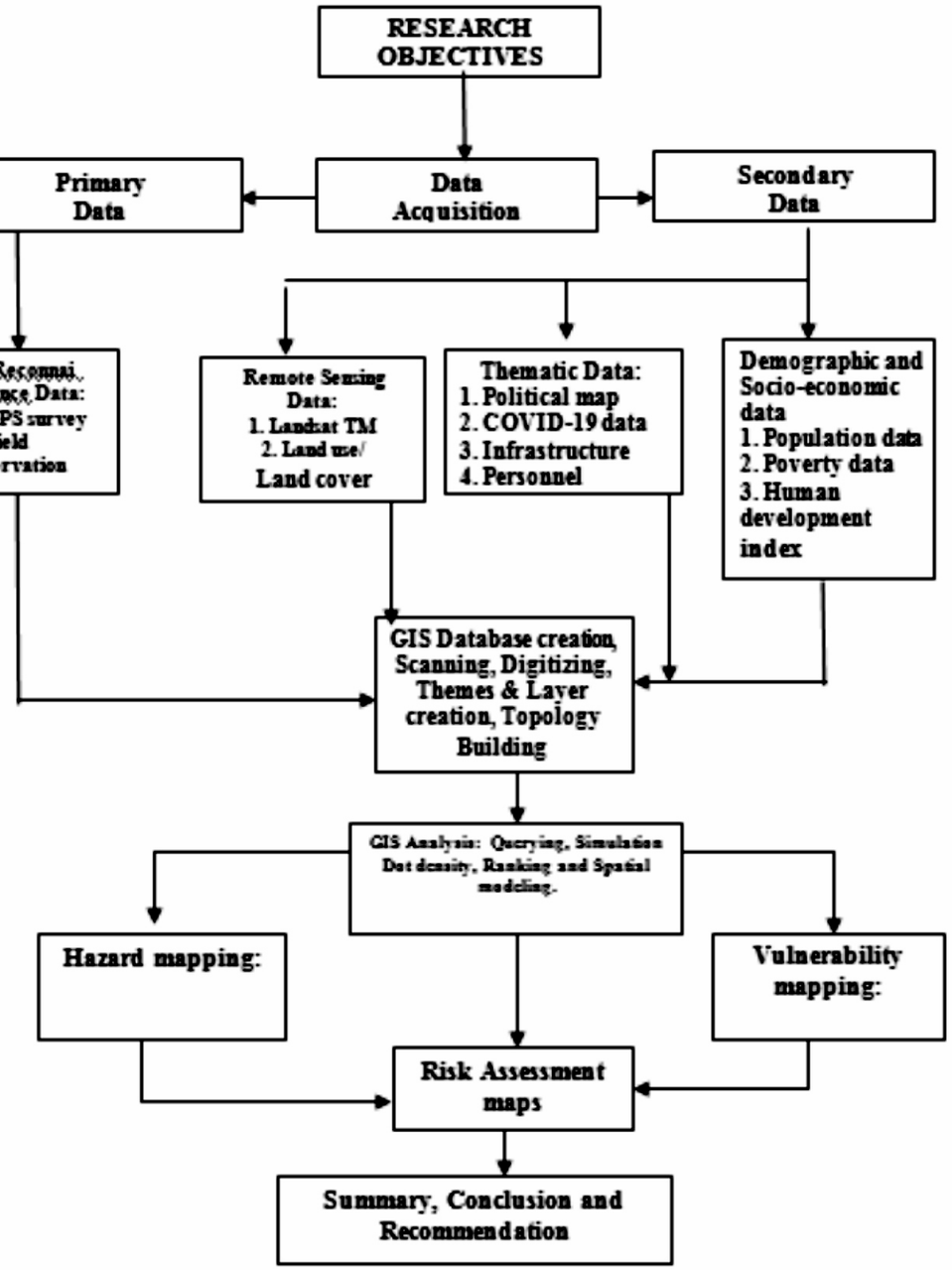


Figure:2. Schematic Diagram of the Research Methodology for GIS Modelling of Spatial Distribution and Response to COVID-19 Pandemic in Abia State.

The data sets in the study area were extracted from various sources as shown in figure 2

The political boundaries of 17 Local Government Areas (LGAs) were obtained from the administrative map of Abia State Ministry Lands and Town Planning. The Covid-19 data obtained from Nigerian Centre for Disease Control (NCDC, 2020); Landuse and Landcover data with a 30m x 30m resolution obtained from the United States Geological Survey (USGS, 1986); Demographic and socio-economic parameters were extracted from National Population (NPC, 2006); United Nations Development Programme Reports (UNDP, 2006); and Abia State Ministry of Health (2017; 2020) respectively and used in modeling the exposure distribution pattern and response to the risk of covid-19 pandemic. Field observation provided the inventory of spatial distribution of covid-19 pandemic in the study area.

The political map of Abia State was scanned into a GIS environment, geo-referenced and digitized. The attribute table of each LGA digitized as polygon was used to link the datasets to create and generate the base maps used for the GIS analysis. The base maps were converted from vector based shape-files to grids (rasterized) that made it possible to use all data sets further analysis and modeling in the GIS environment.

MAP-Based Risk Assessment of Covid-19:Covid-19 pandemic of the study area was conceptualized in a GIS environment as a function of Hazard and Vulnerability layers. The three surfaces generated and produced were combined using Arc map 10.4 (software) spatial analyst function. The hazard surface analysis was generated using identified exposure component sources: Covid-19 layer; landuse/landcover; projected population density (2006–2020) layers; Health personnel and Bed (population) facility layers respectively as presented in figure 3. While Vulnerability surface analysis were generated from Human Development Index Layer (HDI) and Human Poverty Index Layer (HPI) derived from UNDP Report (2006) and shown figure 4. Covid-19 Risk Surface analysis was obtained as a combination (summation) of hazard surface layer and vulnerability surface layers and shown in figure 5.

The three surfaces (presented in figure 3–5) were weighted and combined, using the single output map algebra of the spatial analyst tools extension, a Multi-Criteria Evaluation Technique (MCET) in Arcmap 10.4 environment to generate and produce Areal Control and Response Index in figure 9.

Thus, the Map-Based Analysis was zoned on a 1 to 3 scale based on the spatial alertness. Scaling (Ranking) methods was used 2.

To determine the fitness of a given type of spatial attributes with regards to morbidity of Covid-19 pandemic and risk assessment in the study area to reflect the extent and response to the risk involved.

The Designated Range Numbers (DRN):

1. Represent Minimal areas as LOW
2. Represent Areas with less critical risk as MODERATE
3. Represent critical areas for immediate response as HIGH Risk classes respectively as presented in Table 1 and created surfaces

Besides, this method can help the study area with appropriate landuse education for avoidable of sensitive areas by generating early warning system concerned with effective and efficient response towards Covid-19 pandemic. That is GIS-map based analysis can be used to predict incidence of unknown diversity, using the known distribution pattern of Covid-19 pandemic in the study as shown in Table 1.

RESULTS AND DISCUSSION

Table 1. Covid-19 Risk Distribution Index

Covid-19 Risk Index Zones		High (Ranked 3)		Moderate (Rank 2)		Low (Ranked 1)	
S/N	Data Layers	No of pixel	Area in km²	No of pixel	Area in km²	No of Pixel	Area in km²
1.	Hazard	11355	10159(18.75%)	11355	1559(28.76%)	11355	28451(52.49%)
2.	Vulnerability	11355	732.69(13.53%)	11355	3278.74(60.49%)	11355	1408.57(25.98%)
3.	Risk	11355	10891.69(23.89%)	11355	4837.74(10.61%)	11355	29859.57(65.5%)

In table 1, the study utilized the GIS environment to generate and combined hazard, vulnerability and risk datasets to create covid-19 maps of Abia state of Nigeria. Figure 3 – 9 shows the spatial distribution of covid-19 pandemic in the state – that is covid-19 Hazard analysis shows that in the exposure layer, the Highly exposed areas (18.75%) were found to occur in Aba North, Aba South, Bende, Arochukwu, Isiukwuato, Umuahia North and Umuahia South LGAs respectively. Moderate exposure areas to covid-19 hazard (28.76%) were predominant at some parts of Arochukwu Bende, Ikwuano, Isiala Ngwa North, Isiala Ngawa South, Osisioma Ngwa, Ukwa-East and Ukwa-West LGAs. While Low exposure areas (52.49%) were found predominantly in some parts of Arochukwu, Umunneochi, Ukwu-East, Ukwa-West and Ikwuano LGAs as shown in figure 3.

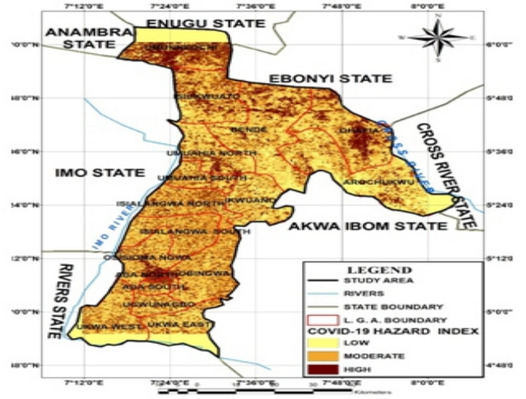


Figure.3. COVID-19 Hazard Distribution Index

Vulnerability layer displayed Covid-19: Vulnerability – Highly Vulnerable areas (13.53%) were revealed in Aba North, Aba South, Bende and Umuahia, North LGAs. Moderate Vulnerable areas (60.49%) were seen in Isiala Ngwa North, Ohafia, Arochukwu, Ukwa-West, Isiala Ngwa South, Isiukwuato, Osisioma Ngwa, Umunneochi and Umuahia South respectively. Low vulnerable areas (25.98%) were located in Ukwa-East, Obi Ngwa, and Ikwuano LGAs as shown in figure 4.

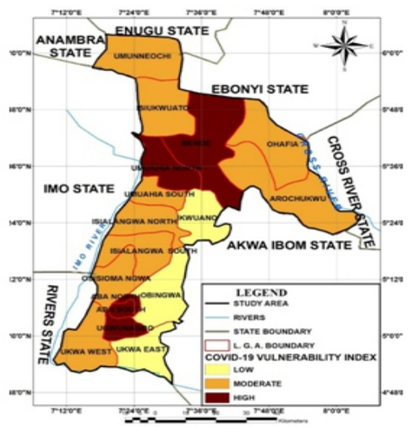


Figure.4. COVID-19 Vulnerability Distribution Index

Covid-19 Risk layer- Based on the table 1 and shown in figure 5, the adoption of GIS approach becomes crucial to Covid-19 response and should incorporate alertness to combat the pandemic in due course. That is, the study ranks the Study areas on a 1 to 3 scale

(zonation order) based on the spatial alertness. Therefore, the results revealed that map-based analysis depict 1089.69 km^2 representing 23.89% ranked 3 occupying High risk incidence in Umuahia North, Aba South, Bende, Ohafia, Osisioma Ngwa ,LGAs, while 4837.74km^2 representing 10.61% (ranked 2) occupying Moderately vulnerable areas in Umuahia South, IsialaNgwa North, Isiala Ngwa South, Ikwuano, Arochukwu, ObiNgwa, Ugwunagbo, Isiukwuato and Umunneochi respectively. Aba North, Ukwa East, Ukwa West some parts of Arochukwu and Umunneochi occupied low areas (ranked 1) of 29859.5km^2 representing 65% of the study area. GIS analysis was helpful in the location, identification of the sources, the distribution of information and timely preventive actions for the protection of potential vulnerable population. It therefore, stresses the need for authorities and all stakeholders to steer socio-economic development towards sustainability. This can be done by implementing a comprehensive plan that is systematically involved multi-scale control of the virus to minimize its impacts in the study area.

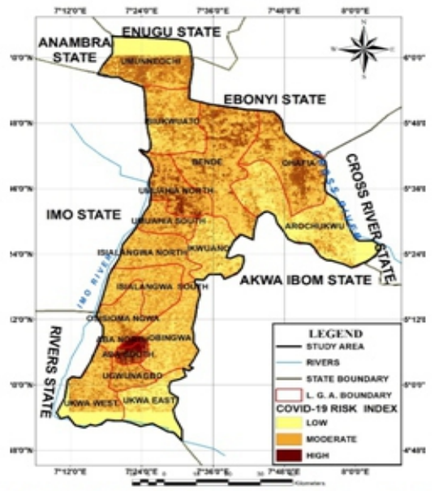


Figure.5. COVID-19 Risk Distribution Index

DISCUSSION OF FINDINGS

Spatial Distribution of Vulnerability to Covid-19

Hazard /Risk Assessment

Based on the foregoing map-based GIS analysis, this study has shown that Abia State environment is prone to high risk of Covid-19 pandemic which is gradually spreading fast across the State with the spatial extent of the pandemic and spatial interaction among the population especially in Umuahia North, Aba North, Bende, ObiNgwa and Osisioma LGAs as shown in figure 6. A better understanding of the spatial distribution of Covid-19 pandemic is very important in sustainably tackling the effect and response to the covid-19 morbidity at State level. Therefore, building a GIS database will enable the response to the pandemic to be effective and efficient leading to a halt in spatial distribution in the study area.

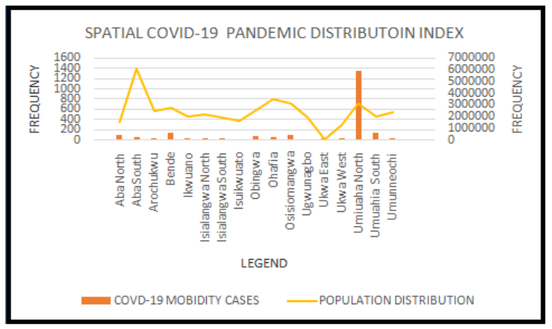


Figure.6. Spatial Distribution of COVID-19 pandemic

Response Initiative Assessment

Abia State response as directed by Nigeria Centre for Disease Control (NCDC) met less proactive implementation. That is poor implementation issues: lockdowns, social-distancing, vaccination facilities, face mask wearing, respiratory hygiene, cleaning and disinfecting frequently touched surfaces, and avoidance of handshakes or hugs and kissing were not soundly communicated as these structural morphological characteristics and appearance revealed that Covid-19 survives best on surfaces (Prakash, Priyatma, and Ranjan,2020; Raju, Laranya, Manikandan,Srilekha,2020). This is because, the platform for networking the spatial and drivers of Covid-19 pandemic distribution, administrative and

structure wise were not adequately established to provide a quantum leap towards initial responses that suggest better understanding for auditing and regular Covid-19 morbidity and Poverty alleviation inventories as shown in figure 7 and 8 respectively. Hence, the application of GIS in the modeling of spatial distribution and response to Covid-19 pandemic in the study area is a welcome development.

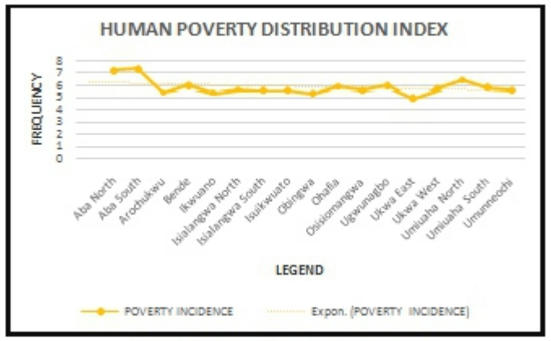


Figure.7. Human Poverty Distribution

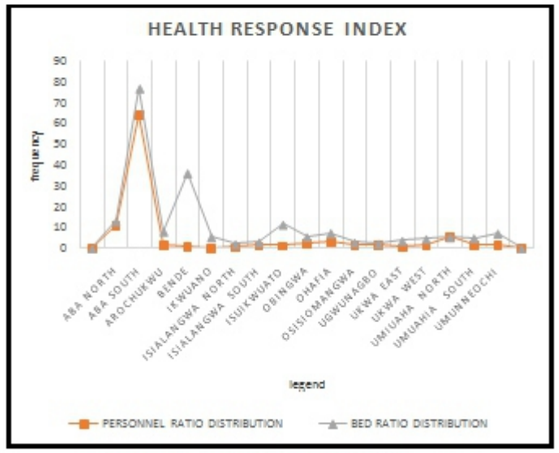


Figure.8. Health Response Distribution

GIS Technology Risk Assessment

The Covid-19 pandemic has generated great uncertainty from social, health and economic perspectives. This emergence has forced health authorities and policy makers to adopt unusual decision and have a better understanding of size of the challenged. Map-based tools made it possible to conduct complex analysis across multiple scales, by providing information on the spatial behavior of the virus. Thus, the present situation requires medical GIS data to generate quick responses and investigations for the timely prevention and control of the pandemic. It also requires a rapid source of information about the study of pandemic dynamics which directly or indirectly has been ignored by previous studies. GIS establishes a strong bond between medical epidemiology to develop, identify, implement and control mechanisms for efficient decision making for healthcare administrators and professionals.

That is the emergence of covid-19 pandemic has driven a need to understand more about the diversity and ecology of Hotspot areas. Hotspot maps generated by using multi-criteria evaluation techniques a GIS environment, used to provide cluster concentration of Covid-19 morbidity, represents the high Covid-19 density areas which can help the government and health authorities to respond effectively and efficiently in controlling the pandemics in Umuahia North LGA especially. That is GIS is centers around map-based tools, improved data sharing and real-time information to support critical decision-making. It is a communication that can predict where the unknown diversity is likely to occur and offers accessible information to people around eager to protect themselves and their communities. GIS helps improves data transparency and dissemination of information by modeling the known distribution pattern of Covid-19 pandemic in the study area. It is a powerful pandemic prevention and investigation tool for mapping out Hotspot Covid-19 morbidity that goes beyond the traditional maps, crucial for dealing with emergencies. Further directives and advice by the Nigeria Centre for Disease Control (NCDC) such as the following: - Wearing of face masks. Physical distancing. Hand

washing. respiratory hygiene. Cleaning and disinfecting touched surface. Avoidance of hand shaking/Hugs. Intensified risk communication. As a remedial preventive measure which can easily be integrated into GIS platforms or environment for a wide improved dissemination of information precisely with various targets in the study area, when Covid-19 strike (Udoh,2010;Anyanwu,2015; Emenyeonu, 2023). Such map-based analysis was seen in figure 9 to establish responsive sustainable control mechanisms for the study area.

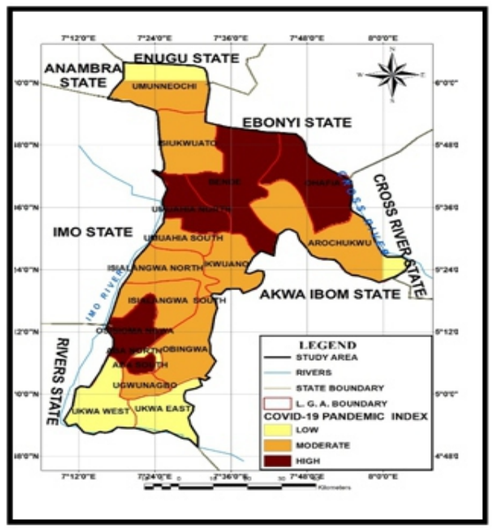


Figure.9. Areal COVID-19 Risk Distribution Control Index

CONCLUSION

This study revealed different patterns of the spatial distribution of Covid-19 pandemic management system in the study area. GIS tools were utilized to gain an understanding of the issues of Covid-19. That is the study proved GIS as a map tool which can be deployed in the assessment of Covid-19 risks. This is because GIS provided an excellent and efficient means of monitoring and presenting Covid-19 pandemic dynamics. It also demonstrated an immense contribution of the data sets as bases in capturing hotspot surfaces for informing quality decision-making processes for the study area. Hence, the integration of GIS technologies will help researchers, urban planners, health planners and other policy makers to deal with the problems of mitigations, preparedness, response and recovery in such adverse situations. It also created the required infrastructure to ensure that information on Covid-19 pandemic distribution mapping can be easily collected, disseminated and maintained.

RECOMMENDATIONS

In line with the research questions, aim and objectives, the following recommendations were made:

1. Effective and efficient Covid-19 morbidity control in the study area should target pandemic prone Hotspot areas such as Umuahia North, Aba North, Bende, Obingwa, Osisioma Ngwa and Umuahia South respectively. In this regard harnessing of GIS database technologies should be given attention to support a comprehensive plan and multi-hazard risk assessment/mapping of vulnerability hotspot areas.
2. Intensification of campaigns based on NCDC directives should be encouraged to establish a better understanding for auditing and providing a regular inventory to keep abreast of drivers of Covid-19 pandemic dynamics using GIS. Also, the establishment of more healthcare facilities and counseling centres will help people be counseled by the personnel/health authorities in order to reduce the distribution of the disease.
3. Response initiatives should encourage the establishment of adequate healthcare service delivery and capacity building programmes on personnel population, bed population ratios and other major health infrastructure in other to facilitate strategic respond on the spread of the pandemic.
4. The blossoming of socio-economic interaction on the process of adoption should embrace environmental management network strategy integrated into GIS technology with the mandate of tracking Covid-19 morbidity in the study area. Thus, the application of dashboard screen shot analysis and health maps will aid better understanding and decision-making of Covid-19 pandemic.
5. Employment opportunities should be created to discourage unnecessary migration within the study area. Job creations and poverty alleviation programmes will increase human development index thereby reducing risk travelling within the study area.
6. To ensure progression towards improved quality of life mitigation measures are required to focus on policies and practices that are aimed at minimizing Covid-19 morbidity risk by effective planning and proper capturing of early warning systems.

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A REVIEW: OZONE TECHNOLOGY AS A PROMISING SANITIZER IN THE MEAT PROCESSING INDUSTRY

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ABSTRACT

The application of ozone technology in the food industryis effective against many types of pests in food.Ozonation is a promising method for decontamination purposes in the food industry, due to its relatively high oxidation-reduction potential. It spontaneously decomposes into oxygen, leaving no residues on the product, making it safe for food application. Ozone has shown the potential to remove microbial biofilms on materials such as stainless steel and polypropylene used as processing surfaces in the food industry and also, to inactivate microorganisms in food. Meat can be contaminated with a large variety of pathogenic and spoilage microorganisms during slaughtering, processing, and storage periods.This paper discusses the origin of ozone, its production and how it is generated. It further, discussed the application of ozone in the food industry and how it is effective in sanitization of meat and its processing surface, which helps to reduce the challenges posed by microorganism and other hygienic practices in the meat processing industry.

Keywords: Ozone, Sanitizer, Meat

INTRODUCTION

Ozone finds wide application as a powerful disinfectant inwater treatment, food processing and preservation and variousother environmental applications(Kim et al., 1999). Ozonation is a promising method for decontamination purposes due to its relatively high oxidation-reduction potential (Pandiselvam et al., 2018). It spontaneously decomposes into oxygen, leaving no residues on the product, making it safe for food application (Pandiselvam and Thirupathi. 2015; Pandiselvam et al., 2017). Ozone as an oxidant is considered to havenumerous potential applications in the food industry because,it serves as an alternative to traditional food preservation techniques (Rezende et al., 2022).(Botzenhart et al., 1993; Aslam et al., 2022) reported that, ozone is a more effective sanitizer than chlorine dioxide. Chlorine, a potent oxidative agent, is widely used to decontaminate poultry carcasses as a solution in water-chilling or spray-chilling (Ayranci et al., 2020). However, there are reports in which the authors stated that chlorine could react with organic substances and form carcinogenic compound, such as chloroform, chloramines, and trihalomethanes (Robinson et al., 1981; King et al., 2006; Cardador and Gallego, 2018; Ayranci et al., 2020).

Ozone has shown potential to remove microbial biofilms on materials such as stainless steel and polypropylene (Korany et al., 2018; Marino et al., 2018; Harada and Nascimento, 2021) and to inactivate microorganisms in food (Cárdenas et al., 2011; Kanaan, 2018). Marino et al. (2018) investigated the efficacy of ozone in water on attached cells and microbial biofilms on three foodborne species *Pseudomonas fluorescens, Staphylococcus aureus,* and *Listeria monocytogenes.* Harada and Nascimento (2021) evaluated the effect of gaseous ozone on the control of *Bacillus cereus* in polypropylene and stainless steel. It is important to mention that biofilms are considered a severe public health hazard, implying a significant economic impact on the food industry (Sharan et al., 2022).

Meat can be contaminated with a large variety of pathogenic and spoilage microorganisms during slaughtering, processing and storage periods (Ayranci et al., 2020). Contamination of meat can occur mainly during the deboning of quarters and the subsequent manipulation of primal cuts before packaging, which takes place in deboning rooms and secondary meat processing rooms respectively (Nel et al., 2004; Shale et al., 2006; Williams and Keener, 2013; Botta et al., 2020). In these steps, bacteria (especially psychrotrophic) from human skin, cleaning water and cuts are collected on the surfaces of chopping boards, conveyor belts and equipment belts and equipment (Stellato et al. 2016). Accordingly, meat cross-contamination reaches the highest level when cleaning and sanitizing are improperly carried out and meat exudates are available for bacterial growth (De Fillippis et al., 2013; Hultman et al., 2015; Stellato et al., 2016)

OZONE GENERATION

On ozone generation, a diatomic oxygen molecule must first be split (Gonçalves, 2009). The resulting free radical oxygen is thereby free to react with diatomic oxygen to form the triatomic ozone molecule (Langlais et al., 1991; Greene et al., 2012). Electric discharge in oxygen (or air) and irradiation of oxygen (air) with short-wavelength ultraviolet (UV; 188 nm wavelength) rays produce ozone (Takeuchi, 2005). Ozone is generated commercially within the food industry by one of two generally accepted procedures: by passing an oxygen-containing gas through either a source of ultraviolet radiation (UV; photochemical method) (Dohan and Masschelein, 1987) or a high-energy electrical field (corona discharge - CD) (Langlais et al., 1991). On a commercial scale, the most widely used method is corona discharge. (Guzel-Seydim et al., 2004).

OZONE AND ITS APPLICATIONS

Ozone (O_3) is the triatomic oxygen formed by the addition of a free radical of oxygen to molecular oxygen (Hill, 1982). The strong reactivity of ozone is due to the molecule's structure (Greene et al., 2012). Ozone (O_3) is considered a strong antimicrobial agent with many potential applications in the food industry. It is important to highlight that high reactivity, penetrability, and spontaneous decomposition to a nontoxic product (oxygen) make ozone a viable disinfectant for ensuring the microbiological safety of food products (Kim et al., 1999; Akata et al., 2015). Ozone has been used for decades in many countries and is generally recognized as safe (GRAS) (Kim et al., 1999). Ozone (ozone gas or ozonated water) is effective against the majority of microorganisms tested by numerous research groups (Kim et al., 1999). It has stronger antimicrobial activity than chlorine and is considered a broad-spectrum antimicrobial agent that acts against a variety of foodborne pathogens (Priyanka et al., 2014). Relatively low concentrations and reduced contact time are effective to inactivate bacteria, fungi, yeasts, parasites, and food viruses and can be applied to food in gaseous form or dissolved in water (Kim et al., 2003; Zhang et al., 2011; Alwi and Ali, 2014; Ferreira et al., 2017). However, the rates of inactivation are dependent on oxidizable organic substances in the medium (Khadre et al., 2001). Susceptibility of

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microorganisms to ozone also varies with the physiological state of the culture, pH of the medium, temperature, humidity, and presence of additives, such as acids, surfactants, and sugars (Kim et al., 1999).

Ozone applications in the food industry are mostly related to decontamination of product surface and water treatment (Kim et al., 1999). Ozone has been used with success to inactivate contaminant microbiota on meat, poultry, eggs, fish, fruits, vegetables and dry foods (Kim et al., 1999; Alencar et al., 2012; Ferreira et al., 2017). In addition, ozone as an anti-fumigant, antioxidant and antibacterial agent is widely used to retain the freshness of meat and vegetables (Gertzou et al., 2017; Karakosta et al., 2019; Li et al., 2021).

MEAT PROCESSING

Meat is an indispensable component of a healthy diet.It is widely consumed all over the world as fresh meator processed meat products such as sausage, patty,hamburger, etc. However, it is quite susceptible tomicrobial attack and has a relatively short shelf lifedue to its natural characteristics such as rich nutrientsand highwater activity, pH, etc. In addition, it wasregarded as one of the most important sources of foodborneillnesses (Antunes et al. 2016; Fearnley et al.2011). The nutrients in meat, including proteins, essential fatty acids, vitamins, and minerals, make it one of the most important food sources (Elbehiry et al., 2022). As well as being highly active in water, it is highly susceptible to spoilage by microorganism (Wickramasinghe et al., 2019; Elbehiry et al., 2022). During and after the slaughtering process, microbial contamination of meat can occur (Bantawa et al., 2018). For instance, contamination of chicken carcasses with *Salmonella* spp., *L. monocytogenes, Campylobacter* spp. and *Pseudomonas* spp.can occur at various stages of processing in poultry processing plants (Goncuoglu et al., 2016; Zhu et al., 2017; Oliveira et al., 2018; Agirdemir et al., 2020).

It is important to highlight that the different processes and manipulation of meat products can influence contamination by pathogens and other microorganisms capable of deteriorating the meat (Wang et al., 2017; Courrol and Vallim, 2021). In the case of poultry meat, it is the second most important meat consumed worldwide (Samapundo et al., 2019; Courrol and Vallim, 2021). To determine the quality grade, appearance, texture, tenderness, juiciness, and flavor are considered (Zettel et al., 2016b). Contamination of meat by microorganisms is a significant public health issue as it can cause diseases to consumers due to neglect of handling, storage, cooking, and after cooking (Zettel et al., 2016a, b; Courrol and Vallim, 2021). Increased chicken product consumption results in many diseases due to the poor conditions in the breeding sites.

CHALLENGES IN MEAT PROCESSING

Meat can be contaminated with a large variety ofpathogenic and spoilage microorganisms duringslaughtering, processing and storage periods. Washingand spray rinsing of carcasses with water or chemicalsolutions are widely used practices for meat decontamination.During and after the slaughtering process, microbial contamination of meat can occur (Bantawa et al., 2018). Contamination of chicken carcasses, beef, pork with *Salmonella* spp., *L. monocytogenes, Campylobacter* spp. and *Pseudomonas* spp.can occur at various stages of processing in the processing plants (Goncuoglu et al., 2016; Zhu et al., 2017; Oliveira et al., 2018; Agirdemir et al., 2020). These foodborne pathogens can cause life-threatening infections in humans (van Nierop et al., 2005; Cetin et al., 2019).

Foodborne pathogens are a major concern and represent a public health problem worldwide (Manoj et al., 2015; Sánchez-Gamboa et al., 2018; Chavez-Martinez et al., 2019; Cruz et al., 2019; Yang et al., 2020). Among the microorganisms that form biofilms and are important in the meat processing industry, *Salmonella* spp., *S. aureus*, *L. monocytogenes*, *Escherichia coli*, *Pseudomonas* spp., *Campylobacter jejuni*, and *Enterococcus* spp. can be highlighted (Sharan et al., 2022). In Nigeria, most of the methods of meat processing are done manually under extreme unhygienic conditions thereby posing a threat to public health of those who consume such meat products in the market place.

OZONE AS A POTENTIAL SANITIZER

Sanitizers such as hypochlorite solutions and quaternaryammonium compounds have been used in food-processingfacilities to control contaminant microorganisms,particularly those causing foodborne diseases. Use of somesanitizers has been limited or banned (e.g., formaldehyde)because of the potential health hazards. On the other hand,the need for potent antimicrobial agents has increased inrecent years due to increasing disease outbreaks and emergenceof new foodborne pathogens. Illnesses arising fromthe presence of *Escherichia coli* O157:H7 in frozen groundbeef patties and burgers (Center for Disease Control. 1997), *Listeria monocytogenes* inwieners (Centers for Disease Control. 1998), and hepatitis A in frozen strawberries (Centers for Disease Control. 1997)have renewed interest in effective control measures. Therefore,the food industry is in search of disinfectants that areeffective against common and emerging pathogens and safeto use in many specific applications of food processing.One such compound is ozone (O_3) that has been utilized asa sanitizer in many European water treatment plants sincethe beginning of this century (Gomella, 1972).Ozone (O_3) is known for its strong oxidative power withan oxidative potential of 2.07 V, nearly twice the oxidizingpotential of chlorine (1.36) and greater than the oxidizingpotential of PAA (1.81) (Russel et al., 1999). Because of itsstrong oxidation potential, O_3 is very toxic to bacteria, evenat concentrations as low as 0.01 ppm (Qingshi et al., 1989). There are many advantages of using ozone as a potentoxidizing agent in food and other industries. It is potentiallyuseful in decreasing the microbial load, the level of toxicorganic compounds, the chemical oxygen demand, and thebiological oxygen demand in the environment. Ozone converts many nonbiodegradable organic materials into biodegradableforms. The molecule decomposes spontaneouslyto oxygen; thus, using ozone minimizes the accumulationof inorganic waste in the environment (Horvath, Bilitzky, and Huttner, 1985; Aslam et al., 2022). The high oxidizingpower and spontaneous decomposition also makeozone a viable disinfectant for ensuring the microbiologicalsafety and quality of food products.

Ozone was tested for its antimicrobial efficacy against important spoilage and pathogenic microorganisms found on various meat products (Ayranci et al., 2020). Kanaan (2018) evaluated the effectiveness of ozonated water (0.5 ppm/45 min) in controlling *S. aureus* in fresh and frozen chicken meat and found reductions of 2-4 log cycles. Ayranci et al. (2020) investigated the effects of ozone treatment (concentration of ozone - 1×10^{-2} kg m^{-3}/ for up to 8 h) on the microbiological quality of turkey meat and found reductions of 2.9, 2.3 and 1.9 log cycles in the counts of aerobic mesophilic bacteria, *Enterobacteriaceae* and yeast-mold, respectively.Coll Cárdenas et al. (2011) inoculatedbeef samples with *Escherichia coli* and treated withozone gas (154 × 10−6 kg m−3) for 3 and 24 h. Theyobserved decreases ranged from 0.6 to 1.0 log in theozone-treated samples when compared with theuntreated samples.

CONCLUSION

Ozone is a potent disinfecting agent and a strong

oxidant, whose application on meat and their processing surfaces does not leave residue because it auto-decomposes rapidly to produce oxygen. It has stronger antimicrobial activity than chlorine and is considered a broad-spectrum antimicrobial agent that acts against a variety of foodborne pathogens including Gram positive and Gram-negative bacteria, as well as their spores and vegetative cells, fungi, and even it has shown a capacityto be a virucidal agent.

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ANALYSIS OF THE IMPACT OF NITROGEN DIOXIDE (NO_2) ON AIR QUALITY, IN ABA URBAN, NIGERIA, USING THE GEOGRAPHIC INFORMATION SYSTEM (GIS).

By

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ABSTRACT

Nitrogen Dioxide (NO_2) is one of the major components of atmospheric air pollution which has very severe adverse health and environmental implication on man. In this research, Geographic Information System (GIS) was coupled to pollution studies toanalyse the impact of Nitrogen Dioxide (NO_2) on air quality in Aba Urban, Nigeria. The spatial data base, captured as digitized location map and elevations, and attribute data base, captured as pollutant concentrations were integrated with GIS software (ArcView 9.2) in mapping the concentration densities of Nitrogen Dioxide (NO_2)in the study area. A Nitrogen Dioxide (NO_2) meter was used for the measurement of Nitrogen Dioxide (NO_2) in the sampled area and measurements were taken in two seasons (rainy and dry seasons). The contour plots for the dry season and for the rainy season are presented. These contour maps depict the concentrations of NO_2 in the sampling stations in the study area. Furthermore 3-Dimensional surface plots corresponding to the contour were generated accordingly. Corresponding coordinates in both the contour and surface plots show that the pollution density distribution of NO_2 is well distributed in Aba but are mostly concentrated at Park, Aba town hall, Immaculate, Asa triangle, Ngwa road and Alaoji areas. These are regions of high vehicular, industrial and commercial activities within Aba Urban, Nigeria.The study recommends that Government and other regulatory agencies should come up with policies and laws that will discourage the use of fossil fuel and promote the use of renewable energy, which are cleaner.

***Keywords**: Nitrogen Dioxide (NO_2), Geographic Information System (GIS), air quality, air pollution, fossil fuel.*

INTRODUCTION

Atmospheric pollution is the persistent presence of hazardous substances referred to as pollutants in the atmosphere at levels that would be detrimental to man and his environment (Yerramilli et al., 2011). Such pollutants include particulates, biological molecules and harmful chemicals. Various types of natural and anthropogenic pollution negatively affect the air quality of many urban cities of the world, such effects result to smog, haze and deterioration of the air quality. This has important consequences on health, industry, and recreation.

The atmosphere is a complex natural gaseous system whose average composition comprises oxygen, nitrogen, water vapour, carbon (IV) oxide as the major constituents, and the balance which are usually referred to as rare gases are important to the maintenance of the earth's biosphere. The proportions are given in Table 1.1. An imbalance of these constituents for a considerable long time may lead to serious implication of air quality, weather, climate and the environment (Yerramilli et al., 2011).Atmospheric pollution arises from two major sources; natural and anthropogenic. Natural sources of pollution include effects of such phenomena as electrostatic oxidation of nitrogen to nitrogen oxides during thunder storms; ozonisation of oxygen by UV-radiation; Volcanic eruption which introduces sulphur oxides, nitrogen oxides, carbon oxides, dust, soot and particulate matter into the atmosphere. Erosion weathering and weathering of rock formation by dust bowls cyclones.Anthropogenic sources of pollution are as a result of man's activities. They include effluents from internal and external combustion of fuels in engines such as factory boilers, diesel engines in ships, jet engines, gas turbines for electricity generation and others. Agricultural land abuse such as damming of rivers and other construction works which lead to erosion and weathering of mineral rocks; domestic heating processes using kerosene, firewood and gas; and emission from modern industrial and domestic appliances that are necessary for industrial development (WHO, 2006).

In urban cities, anthropogenic activities are the major cause of atmospheric pollution. These anthropogenic sources may be classified as point or non-point sources.A point source of air pollution is a fixed identifiable source of pollution. This source of pollution can be effectively controlled and managed. Point source pollution include sources such as power stations, steel works, foundries, incinerators, wood and pulp processors, paper mills, refineries and chemical production plants (Kibble and Harrison, 2005). The Non point source (NPS) pollution are pollution that cannot be directly attributed to a single source and usually occur over a wide area (Corwin, 1996). They are characteristically low in concentration and are difficult to control by regulation because they come from multiple sources (Jianzhong et al., 2012). Non-point sources of pollutants includes emissions arising from vehicular traffic, industrial activity of small and medium – sized enterprises (SMEs), agricultural activities (UNITAR, 1998), and from many other sources such as homes, dry cleaners, and petrol stations. Point source and NPS pollutants differ solely in the scale of the areal extent of their source. The point source pollutants are identifiable and more easily controlled than NPS pollutants (Corwin et al., 1999). Because NPS pollutants are difficult to assess over a wide area, a suitable pollution model coupled with GIS/GPS that incorporates spatial variation can be effectively used for its assessment.

The atmospheric pollutants can be classified into two types according to the nature of formation- primary and secondary pollutants. The primary pollutants are those emitted directly from a source while the secondary pollutants are produced when the primary pollutants react or interact with one another in the

atmosphere.

The major pollutants as classified by The World Health Organization (WHO) and Environmental Protection Agencies ((EPA) of countries and associations are carbon (ll) oxide, nitrogen oxides (NO_x), sulphur oxides (SO_x), ozone, lead and particulate matter (WHO, 2006). These atmospheric pollutants are subsequently referred to as pollution attributes during analytical application of Geographic Information Systems and Geographic Positioning System (GPS) (ESRI, 2014). The common atmospheric pollutants are shown in table 1.2. All pollutants have adverse effects on the environment especially when they persist in the air and exceed certain levels. Hence, they are constantly regulated by WHO and EPA's through the setting up of permissible concentration levels for each of the pollutants. Countries and transnational organizations collaborate with environmental scientists/ engineers to establish acceptable protocols for permissible levels.

Nitrogen oxides comprise Nitrogen (IV) oxide (NO_2) and Nitrogen (II) Oxide (NO) and Nitrogen (I) Oxide (N_2O).The major sources of anthropogenic nitrogen oxides (NO_x) are high temperature processes such as those that occur in power plants and automobiles. Nitrogen (IV) Oxide is a reddish brown gas formed in the ambient air through the oxidation of Nitrogen (II) Oxide (NO). Home heaters and gas stoves are also big sources of NO_2. The presence of NO_2 can lead to acute respiratory illnesses such as airway inflammation in healthy people and increased respiratory symptoms in people with asthma and bronchitis, and environmental effects.NO_x contribute to a wide range of environmental effects directly and when combined with other precursor's results in the incidence of acid rain, smog, haze, particulate matter and in the formation of lower tropospheric ozone. Increased nitrogen inputs to terrestrial and wetland systems can lead to changes in plant species composition and diversity. Similarly, direct nitrogen inputs to aquatic ecosystems such as those found in estuarine and coastal waters can lead to eutrophication (a condition that promotes excessive algae growth). This in turn leads to a severe depletion of dissolved oxygen and decrease of aquatic fauna. Nitrogen, alone or in acid rain, also can acidify soils and surface waters. Acidification of soils causes the loss of essential plant nutrients and increased levels of soluble aluminum that are toxic to plants.The regulated threshold value for NO_2 by WHO (2006) is 40ug/m^3 annually.

The atmosphere pollutant levels at any location can be explained by three factors:

a) Rate of emission from all sources
b) Rate of chemical or physical deposition, and
c) The dispersion and transport of a chemical within, to, or from an area (Daly and Zannetti, 2007).

These are influenced by climate and meteorological factors such as temperature (Lin et al. 2008), wind speed and direction (windrose), precipitation, topography, relative humidity and light intensity. The variability of these processes, which affects the variability in pollution, is primarily governed by the movement of large-scale high and low-pressure systems; the diurnal heating and cooling cycle; and local regional topography (Yerramilliet al.,2011). These factors may exacerbate or minimize the polluting efficiency of air pollutants.

Geo-informatics is the science, technology and art of dealing with acquisition, storage, processing, production, presentation and dissemination of geo-spatial data. Geo-informatics combines geospatial analysis comprising modeling, development of geospatial databases, information systems design, wired and wireless networking technologies and human-computer interaction. The multiple branches of geo-informatics include remote sensing, spatial analysis, cartography, geodesy, geographic

information system (GIS), web mapping and global navigation satellite systems (GNSS). Remote sensing is the acquisition of information about an object without being in physical contact with it (Dubey, 2014). It is the use of aerial sensor technologies to detect and classify objects on earth (both on surface, atmosphere, and ocean) by means of propagated signals. It is an invaluable tool for data acquisition for integration into a Geographic Information System (GIS). Geographic Information Systems (GIS) have been identified as an important tool for integrating and analyzing spatial information from different disciplines and sources (Maruo et al, 2002).

GIS is characterized by its capacity to integrate layers of spatially-oriented information and by so doing classify such data into appropriate categories. In order to model NPS pollution within the context of a GIS, each pollution attribute of the model is represented by three-dimensional layers of spatial information. The three-dimensional spatial distribution of each attribute must be measured and this creates a tremendous volume of spatial information due to the numerous factors involved in atmospheric pollution (Corwin et al., 1999). GIS thus serves as the tool for organizing, manipulating and visually displaying this information efficiently.The development of geographic information system (GIS) and global positioning system (GPS) has allowed analytical data to be treated as objects in data space (Berry, 2007).This allows for the visualization, evaluation and interpretation of data by a multitude of iterative computer operations. GIS and GPS have thus enabled the preprocessing of pollutant data; making maps of input data; and the modeling of results. This is due to the ability of GIS to discover and display spatial relationship of model data (Walsh, 1988).In the application of GIS to atmospheric pollution researches, a digitized map of the region which comprises of set of data elements consisting of reduced coordinates and other unique identifiers such as elevation, meteorological indices and other variables may be utilized in the setting up of polynomial expressions which describe the summary of pollutant attributes as expressed in a given location. Explicit solutions to these polynomial expressions provide constants which modify the resulting simultaneous equations comprising these polynomial relationships are conveniently solved by applying matrix algebra.

In Nigeria as in most other African countries, atmospheric pollution studies have been largely concerned with collection of pollutant data, followed by determination of baseline concentration of pollutants. Such simple data are compared through bar graphs. The data are integrated into standard data regulatory limits (Ayodele et al., 2007). In this way advanced information technologies such as GIS coupled with Data Based Management Systems (DBMS) have positively impacted on the analysis and interpretation of pollution data. It is clear that simple data ordering is no longer adequate for meaningful pollution studies. Even for baseline study purposes, pollutant concentrations must be seen to vary with time; and as a function of other indices visa vie (a) rate of emission, (b) rate of chemical/ physical deposition, and(c) rate of dispersion and transport of a pollutant. These three factors are in turn modified by meteorology and topography. This continuous variability demands some way of installing a predictive component in the establishment of both baseline data and Best Management Practices (BMP) for pollution control. This constitutes quantitative assistance to the government in formulating and taking good management policies that would help sustain wholesome air quality maintenance.

Nitrogen (IV) Oxide (NO_2) is determined by the Modified Jacobs &Hochheiser Method. In this

method NO_2 is collected by bubbling air through an impinge containing a solution of sodium hydroxide and sodium arsenite. This forms nitrite ions, and the concentration of nitrite ion (NO_2^-) produced during sampling is determined colorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)-ethylenediamine di-hydrochloride (NEDA). A highly colouredazo-dye is formed and the absorbance measured at 540nm.

Advantages of this techniques are that it is specific for nitrogen dioxide, it uses a simple and in expensive apparatus. Disadvantages are that samples must be analysed soon after collection and there are possible interferences from oxides of nitrogen and some metals. Other disadvantages include a relatively low response time, the need for frequent periodic maintenance and the required use of wet chemical reagents (Corwin et al., 1999).

MATERIALS AND METHOD

DESCRIPTION OF STUDY AREA

DIGITIZATION OF MAP

In order to achieve the objective of this research work, the map of Aba district is digitized using Environmental systems Research Institute (ESRI)Arc Map 9.2.The coordinates of each study location in the map is obtained using the geo-referencing instrument GARMIN GPS MAP 765 chart plotting receiver. Arc Map 9.2 was used to obtain the digitized map because it is primarily used to view, edit, create, and analyse geospatial data, and it also allows the user to explore data within a data set. Arc Map 9.2 has been used by local authorities and research institutes for air pollution management due to its relative user friendliness.

The base map from which the map of Aba urban was geo-referenced was obtained from Google world map using ArcView 9.2 Software. The digitized map of Aba district on which is superimposed an equivalent analogue map is shown in figure 1.

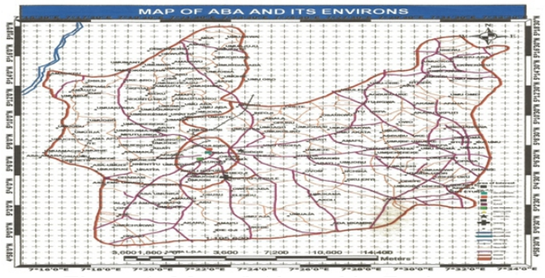


Figure.1: Map of Aba and its Environs.

The study area, in Aba metropolis is a commercial and rapidly growing small and medium enterprise industrial conglomerate. The city has a population of about three million people according to the last population census in 2010. Aba is located on latitude 05^0 18' N and longitude 07^0 35'E. It has a tropical climate and an average annual temperature of over 28^0C. Two major climatic seasons are evident: a rainy season between April and October, and a dry season between November and March. However, within the recent past years the seasons are no longer easily distinguishable. It is the most commercialized town in Abia state in South East Nigeria and a growing urban city with small and medium sized enterprises (SMEs) located within residential areas all over the city. These SMEs and residential houses release different types of pollutants in varying concentration that may be too low to quantify individually, but when emissions from all the sources are added up may contribute significantly to atmospheric pollution in the area.

The study area Aba is chosen for this study because it exemplifies a typical urban area with classic non-point sources of air pollutants.

Eight (8) different locations within Aba metropolis were chosen for this study. Each of the designated location was divided into five points for five sample collections. The points are identified by common names and coordinates as shown in table 1. The spatial data base was generated by referencing the locations as coordinates using Geographic

Positioning System (GPS) and the map reference area was digitized and gridded as shown in figure.2.

Thus, there are 8x5 sampling points. The mean of the determination from the five sampling points represent the data of that location for the particular atmospheric attribute studied. For the study, eight parameters were measured in each of the eight locations resulting to 8 X 8 (64) experimental units of measurements. Each sampling location has five points for sampling that are five hundred meters (500m) apart, hence there are a total of three hundred and twenty determinations. Three replicate measurements of each attribute were performed within a period of fifteen minutes to give a mean value for each attribute at a given point. Measurements were taken in two seasons (rainy and dry seasons). Measurements were taken biweekly for a period of three months in each of the seasons such that for a given year of two seasons, three thousand eight hundred and forty (3,840) experimental units were obtained. To enhance sufficiency in data collection, a three year study was carried out so that there is a total of eleven thousand five hundred and twenty (11,520) experimental determinations for the study area.

In this work, automatic gas analysers and sensors have been used for measurement of pollutant concentrations. This is able to measure concentrations to $10^{-6}g/m^3$. All the attributes data were captured in-situ using Crowncon models gas sensors as employed by Moduszewski et al., (2011). Readings were taken through a three month period using a biweekly regime for each rain or dry season. Wind speed, temperature, and relative humidity were measured using a Rumsey Environmental LLC model AE 09685. This instrument uses a multi-sensor package to measure the meteorological parameters. Crowncon gas analysers was used for the measurements of Nitrogen (IV) Oxide (NO_2),.

RESULTS AND DISCUSSION

The results of the study are hereby presented in the tables below:

The concentration of measured NO_2 for all the sampling points in the study locations for the dry season are shown in table 1.

Table 1: Measured NO_2 concentrations ($\mu g/m^3$) for the study locations in the Dry Season

Sampling locations	P1	P2	P3	P4	P5
Alaoji area	225.6	131.6	244.4	169.2	150.4
Asa Triangle area	206.8	141.0	141.0	131.60	150.40
Ngwa Road area	122.2	159.8	169.2	169.2	178.6
Ogbor Hill area	122.2	141.0	141.0	94.0	122.2
Aba Town Hall area	206.8	94.20	178.60	159.8	225.6
Park area	178.6	225.6	141.0	150.4	122.2
Immaculate area	178.6	103.40	159.8	141.0	150.4
Abayi area	150.40	103.4	159.8	150.4	178.6

Table 2: Measured NO_2 Concentrations ($\mu g/m^3$) For the Study Locations in the Rainy Season

SamplingLocations	P1	P2	P3	P4	P5
Alaoji area	131.6	150.4	150.4	112.8	141.0
Asa Triangle area	150.4	112.8	131.6	150.4	103.4
Ngwa Road area	141.0	122.2	131.6	65.8	112.8
Ogbor Hill area	103.4	122.2	103.4	131.6	103.4
Aba Town Hall area	159.8	169.2	141.0	141.0	94.0
Park area	159.8	103.4	150.4	131.6	112.8
Immaculate area	122.2	103.4	112.8	141.0	103.4
Abayi area	112.8	94.0	150.4	103.4	122.2

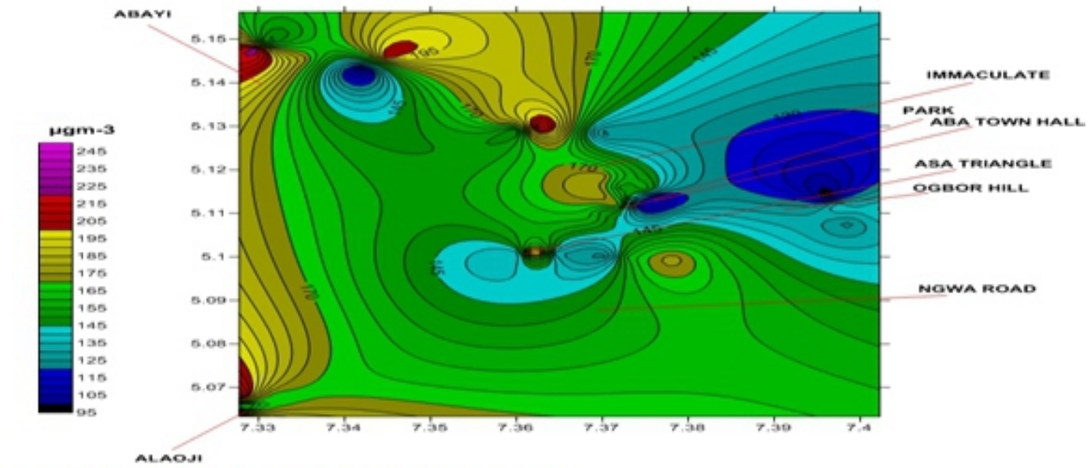


Fig. 4.9.2a: GIS Contour plot of NO_2 for Aba (Dry)

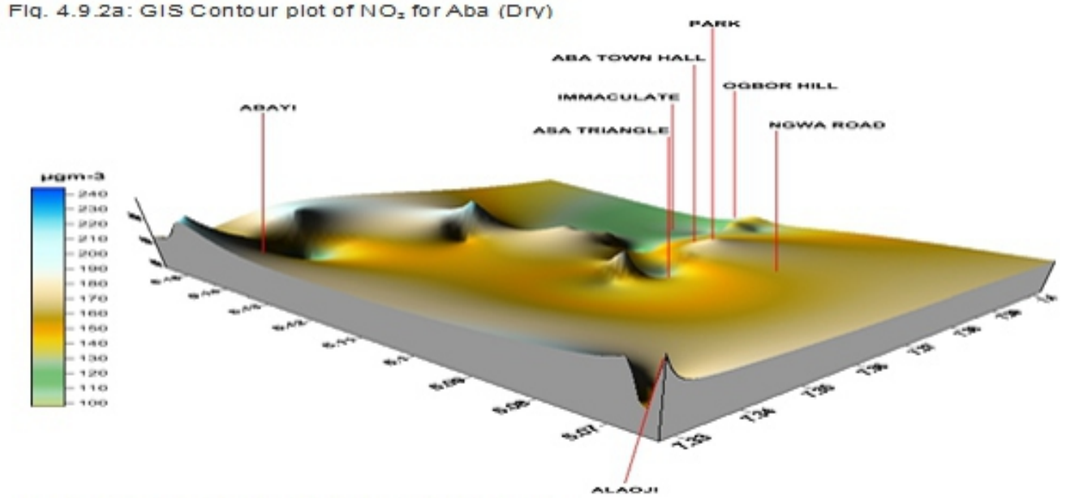


Fig. 4.9.2b: GIS Surface plot of NO_2 for Aba (Dry)

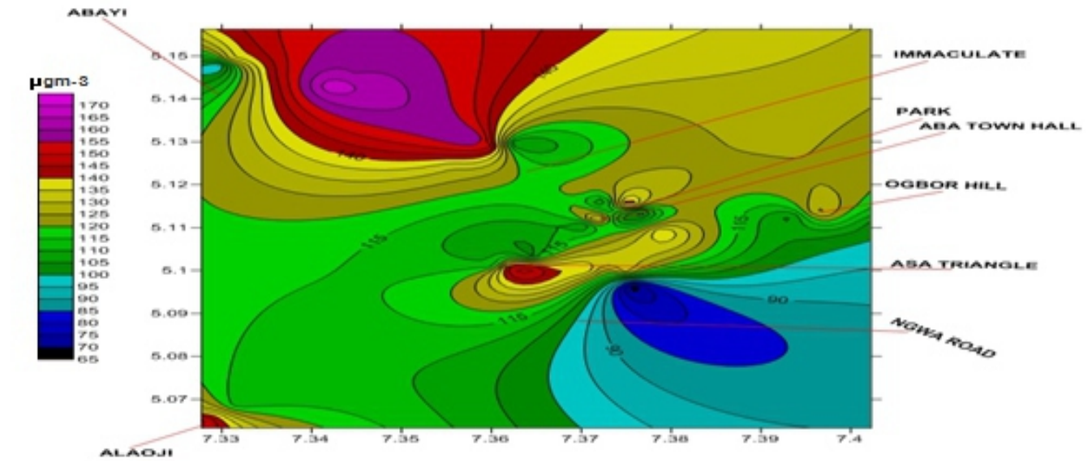


Fig. 4.9.7a: GIS Contour plot of NO_2 for Aba (Rain)

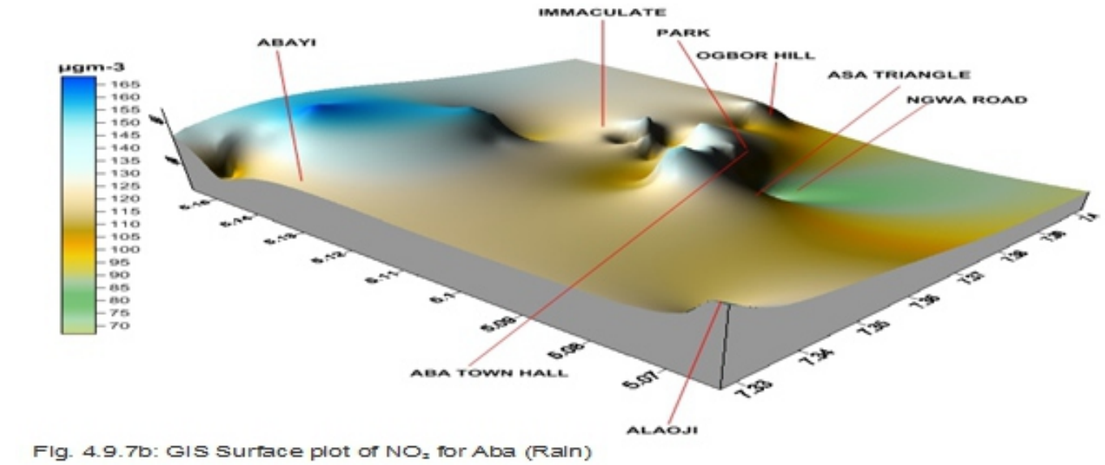


Fig. 4.9.7b: GIS Surface plot of NO_2 for Aba (Rain)

AIR QUALITY INDEX (AQI) OR POLLUTION STANDARD INDEX

Air quality index (AQI) is a number that is used to describe the extent of pollution in any location relative to set standards. It shows how clean or polluted the air around a location is, and what associated health effects might be a concern for persons in the area. AQI as a yardstick runs from 0 to 500. Higher AQI values correspond to greater level of air pollution and hence a greater the health concern (Cogliani, 2001). The AQI is divided into six categories as shown in Table 3.

The air qualities of the study locations were determined. This was achieved by calculating the air quality index (AQI) for the area and incorporating breakpoint values indicated in table 3 as established

Table 3: Breakpoints for the AQI and Categories of Air Quality Index (AQI)

PM_{10} $(\mu g/m^3)$	$PM_{2.5}$ $(\mu g/m^3)$	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	AQI Value	Level of Health Concern
0 – 54	0.0 - 15.4	0.0 - 4.4	0.000- 0.034	-	0 – 50	Good
55 – 154	15.5 - 40.4	4.5 - 9.4	0.035- 0.144	-	51 – 100	Moderate
155 – 254	40.5 - 65.4	9.5- 12.4	0.145- 0.224	-	101 - 150	Unhealthy for sensitive group
255 – 354	65.5 - 150.4	12.5-15.4	0.225- 0.304	-	151 - 200	Unhealthy
355- 424	150.5- 250.4	15.5 - 30.4	0.305- 0.604	0.65- 1.24	201 - 300	Very Unhealthy
425 – 504	250.5- 350.4	30.5 - 40.4	0.605- 0.804	1.25- 1.64	301 - 400	Hazardous
505 – 604	350.5- 500.4	40.5 - 50.4	0.805- 1.004	1.65- 2.04	401 - 500	Hazardous

NOTE: $N0_2$ has no short-term NAAQS and can generate an AQI only above a value of 200 (USEPA, 2006).

DISCUSSION

In order to further respond to the complex expressions of pollution indices Geographic Information System (GIS) has been coupled to pollution studies to give a better understanding of the pollution characteristic of a given location. In this study, the spatial data base captured as digitized location map and elevations, and attribute data base captured as pollutant concentrations were integrated with GIS software (ArcView 9.2) in mapping the concentration densities of the pollutants in the study area.

The contour plots are depicted for the dry season and for the rainy season. These contour maps depict the concentrations of NO_2 for the sampling stations in the study area. These figures are 2-dimensional graphical presentation constructed from which are the tables representing fitted model equations in two dimensions of concentration against coordinates. Furthermore 3-Dimensional surface plots corresponding to the contour maps have been generated according. Corresponding coordinates in both the contour and surface plots show that the pollution density distribution of NO_2 is centered at Alaoji, Abayi and Asa triangle in the rainy season. A similar pattern was exhibited in the dry season with high concentration density also observed for Ngwa road area.

In summary, all the pollutants are well distributed in the study area but are mostly concentrated at regions of high vehicular, industrial and commercial activities such as Park, Aba town hall, Immaculate, Asa triangle, Ngwa road and Alaoji areas in the study area.

CONCLUSION

This study has shown that pollution data can be treated in various ways to aid in best management practice of atmospheric pollution.The application of GIS/GPS in mapping of the concentration densities of the pollutants reveals that the pollution distribution of NO_2, is centered at Alaoji, Ngwa Road, Asa Triangle and Immaculate areas of the study in both the dry and rainy seasons. These occur in areas with high commercial and vehicular densities.

The air quality index for the locations fell within the moderate and hazardous condition for areas of high commercial and vehicular densities. This suggests great danger to health conditions in the areas.

RECOMMENDATION

The study recommends that Government and other regulatory agencies should come up with policies and laws that will discourage the use of fossil fuel such as Coal, Petroleum, Natural gas, Oil Shales, Bitumen, Tar sands and heavy oils and encourage the use of renewable energy, which are cleaner. Renewable energy sources include: Wind Power, Solar Power, Biomass, Hydropower, Hydroelectricity, Geothermal Energy, Biomass and Tidal Energy.

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ANTI – DIABETIC POTENTIALS OF ETHANOL LEAF EXTRACT OF L*asiantheraafricana*ON ALLOXAN – INDUCED DIABETES IN WISTAR RATS.

BY

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ABSRACT

The present study evaluated the anti – diabetic potentials of ethanol leaf extract of L*asiantheraafricana*on alloxan – induced diabetes wistar rats. In the study, a total of fifty one adult wistar rats (both sexes) were used and activities of the leaf extract on body weight, liver function indices, lipid profile and other biochemical parameters of the animals were investigated. While twenty one rats were used for acute toxicity study of the extract, thirty rats divided into five groups of six animals each were used for the anti - diabetic study. In the acute toxicity test, the results of the two phases indicate that LD_{50} of the extract could be higher than 5000mg/kg b.wt as no death or observed toxicity on rats was recorded.In the diabetic study extract treatment was administered to two different groups of the alloxan – induced rats namely *LA* 1 and *LA*2 at doses of 250mg/kgb.wt and 500 mg/kgb.wt respectively and treatment effects on the different parameters involvedwere compared with three controls (normal, diabetic and diabetic treated with a standard anti-diabetic drug at 150mg/kgb.wtglucoghage (metformin)). At the end the result showed that leaf extract of *L.africana* is safe and possesses anti-diabetic potentials, a justification for its use by ethno-botanist in the management/treatment of diabetes and its complications.

Key words: Dibetes, L*asianthera Africana,* Alloxan– induced rats, Liver, acute toxicity.

1.0 INTRODUCTION

Medicinal plants have served as food and medicine to man for a long time. Stems and leaves of some trees domesticated or wild are widely used by human beings for preparation of foods and/or drinks for consumption. Some of these edible plants are equally medicinal and are used in the therapy of some diseases, majority of which have been reported to contain vital chemical compounds of medicinal importance.

Lasiantheraafricana(L.africana) is a perennial glorious shrub of the family Icacinaceae whose height may reach from 61 to 136 cm and is widely distributed in the tropical rain forest (Hutchinson and Dalziel, 1973). There are four ethno - varieties distinguished by the taste, leaf colour and ecological distribution of the plant. The leaves are consumed as vegetable in southern Nigeria particularly the Ibibios of Niger Delta region. It is called “editan” in Efik and Ibibio local dialects.Ethnobotanically, *L. Africana*is is used as antacid, analgesic, antispasmodic, laxative, and anti pyretic, antiulcerogenic and anti malarial. *Lasianthera Africana* has been reported to be bacteriostatic Itah, (1997), fungicidal Itah (1996) antidiabetic Ekanem (2006) and antiplasmodial (Okokon et al., 2007). The leaf contains alkaloids, terpenes, saponins, tannins, flavonoids, anthraquinones and cardiac glycosides (Okokonet al., 2007).

Diabetes is a heterogeneous group of disorders

characterized by high blood glucose level. It is a non communicable disease in which there is a metabolic disorder of various aetiologies described by sustained hyperglycemia with disorders of carbohydrate, fat, and protein metabolism following defects in insulin secretion, insulin action or both. It is caused by the destruction of pancreatic β-cells or dysfunctional β -cells and insulin resistance which results in hyperglycemia, Cerf (2013). Over time, diabetic patients with poor glycemic control undergo micro and macro vascular diseases including nephropathy, retinopathy, neuropathy and cardiovascular diseases, (Deshpande *et al*., 2008). However the present study was to evaluate the antidiabetic potential of the ethanol extract of *Lasiantheraafricana*on experimental animals.

1.1 AIM OF THE STUDY

This study aimed at Biochemical evaluation of anti – diabetic potentials of ethanol extract of *Lasiantheraafricana* leafon alloxan – induced diabetes in wistar rats.

1.2 SPECIFIC OBJECTIVES

The specific objectives of the study include:

I. Determination of Acute toxicity of the plant.
ii. Determination of anti-diabetic potentials of the ethanol extracts of *L. africana*via

a. Effect of the extract on blood glucose of alloxan-induced diabetic rats
b. Effect of the extract on rat body weight of alloxan -induced diabetic rats
c. Effect of the plant extract on oxidative stress indicators in the rats. The oxidative stress indices determined include:
i. Lipid peroxidation (LPO)
ii. Glutathione (GSH) concentration
d. The effect of the plant extract on liver function tests of the diabetic rats (ALT, AST, ALP and Total Bilirubin).

2.0 MATERIALS AND METHODS

2.1 EQUIPMENT AND APPARATUS

Digital Spectrophotometer model 390 (Turner, USA),Weighing balance- Mettler PT 320 (Mettler-Wagen,Switzerland), Water bath (Grant, England), Bench centrifuge (Clay Adams, USA), Incubator, Automatic pippetes (Teco diagnostics, USA), Digital P^H meter (Labtech India), Deep freezer (Fresh point FDF-196), Test-tubes, test-tube racks, Cuvettes,

2.2 CHEMICALS/REAGENTS

Thiobarbituric acid (Sigma-Aldrich Mo USA), Sodium dodecyl Sulphate (Fluka-Chemie, Switzerland), acetic acid, Trichloroacetic acid, Sodium dihydrogen orthophosphate, Disodium hydrogen orthophosphate, Glutathione ((FlukaChemie, Switzerland), ALT test kit (Randox, UK), AST test Kit (Randox, UK), Alkaline phosphatase test kit (Randox, UK), Bilirubin test kit (Biosystems, Spain), Cholesterol test kit (Biosystem), HDL- Cholesterol test kit (Biosystem), Triglyceride test kit (Biosystem), LDL- Cholesterol test kit (Biosystem), All other chemicals and reagents used were of analytical grade.

2.3. COLLECTION AND IDENTIFICATION OF PLANT SAMPLE

Fresh leaves of *Lasiantheraafricana*were obtained from a village in Umuagwo community of Ohaji/Egbema LGA, Imo State. The plant was identified by Prof. F.N. Mbagwu, a plant taxonomist in the department of plant science and biotechnology, Imo state university, Owerri, Imo state.

2.4. PREPARATION/ EXTRACTION OF PLANT SAMPLE

The leaves of the plant were washed with clean water, sun-dried to a constant weight and then grinded into

powder. Ethanol extract of the leave was made using hot soxhlet extraction method Ehrman (1994). The extract was concentrated with water bath at desired temperature (37oC – 40oC) and stored in a refrigerator at temperature (4oC).

2.5. EXPERIMENTAL ANIMALS

A total of fifty one adult wistar rats (both sexes) were bought from the animal house of Biochemistry department of University of Nigeria Nsuka. The animals were allowed to acclimatize to laboratory conditions for two weeks with standard feeding under standard condition of humidity, temperature and light. The animals were weighed and their base line blood sugar levels recorded.

2.6. ACUTE TOXICITY STUDY

A total of 21 Wistar albino rat weighing 80-120g were used for the study. Animals were randomly grouped for the study according to body weight. They were fasted overnight, but with access to water *ad libitum* and then treated orally with *Plant* extract. Acute toxicity study was determined according to the method of Lorke (1983). The study was carried out in two Phases.

PHASE (1): This phase requires nine rats subdivided into three (3) groups of three animals each. The groups in this phase of study were administered doses of 10, 100 and 1000mg/kg.b.wt. of the extract and then observed for 24 hours for paw licking, salivation, stretching of the entire body, weakness, respiratory distress, coma and possible death in the first 4 h and subsequently observed daily for 7 days.

PHASE (2): The procedure above was repeated using another fresh set of twelve rats randomly divided into four groups of three rat each, and were given 1200, 1600, 2900 and 5000 mg extract/kg body weight, respectively. The doses were chosen based on deduction from the first phase. These were observed for signs of toxicity and mortality for the first critical 4 h and thereafter daily for 7 days.

2.7 INDUCTION OF DIABETES IN EXPERIMENTAL ANIMAL

Diabetes was induced intraperitoneally in 12hrs fasted rats with alloxan (150mg/kg) dissolved in normal saline, and with injection volume of 0.1ml per rat. After 72hrs of alloxan injection, blood was withdrawn from the animals through the tail veins and blood glucose was estimated using a commercial glucose kit (Accucheck Active, Roche diagnostics, Mannheim, Germany).

Rat with fasting blood glucose valine above 250mg/dl or 13.89mmol/L was considered as diabetic (Cam *et al.,* 2003) and included in the study.

2.8 EXPERIMENTAL DESIGN OF ANTIDIABETIC STUDY

The animals were acclimatized for 7 days to Laboratory conditions, light, temperature (21±2°C) and relative humidity (55±5%). The animals were fed standard rat pellets (Vital finisher, Nigeria) and distilled water *ad libitum*and thereafter used for the study.

In the antidiabetic study, the animals were divided in five (5) groups of six (6) rats per group.

1. Group 1– Negative Control (NC); This group was fed with normal feed and clean water *ad libitum*, It includes normal rats, with no alloxan and plant extracts treatment .
2. Group 2– Diabetic control (DC); This group also called positive control group was fed with normal feed and clean water *ad libitum*, It includes diabetic rats, with alloxan with no plant extracts treatment .
3. Group 3 –L. Africana(LA1) 250mg/Kgb.wt : This is first test group and was fed with normal feed and clean water *ad libitum*, It includes diabetic rats

with alloxan and extract treatment at 250mg/Kgb.wta dose determined based on the acute toxicity results.

4. Group 4 - L. africana(LA2) 500mg/Kgb.wt: This is second test group and was fed with normal feed and clean water *ad libitum*, It includes diabetic rats, with alloxan and extracts treatment at 500mg/kgb.wt a dose determined based on the acute toxicity results
5. Group 5– Standard group: This is reference standard group and was fed with normal feed and clean water *ad libitum*, It includes diabetic rats, with alloxan and treatment with Metformin (glucophage) (150mg/Kgb.wt).

All treatments were administered for 7days after diabetes induction have been achieved.

2.9. COLLECTION OF BLOOD

At the end of 7 days of treatment with respective drugs for ameloriation, animals were fasted overnight and after being lightly anaesthetized were sacrificed by cervical dislocation and blood collected by cardiac puncture.

2.10. ESTIMATION OF BLOOD GLUCOSE:

Blood gloucose was estimated using a commercial glucose kit (Accucheck Active, Roche diagnostics, Mannheim, Germany), during which blood was collected at tail end each day and blood Glucose level recorded.

Body Weight: This was determined daily using electronic Weighing balance and weight recorded.

3.0 RESULTS

Table 3.1: Acute toxicity studies of ethanol extract of *L. africana* leaves

Group of rats	Dose of *L. Africana* (mg/kg b.wt.)	No. of death recorded
Phase 1		
GP 1	10	0/3
GP 2	100	0/3
GP 3	1000	0/3
Phase 2		
GP 1	1200	0/3
GP 2	1600	0/3
GP 3	2900	0/3
GP 4	5000	0/3

Table 3 .2 Effect of ethanol extract of *L. africana* leaves administration on Fasting blood glucose concentration in alloxan-induced diabetic rats

Groups	Glucose Concentration (mg/dl)						
	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 7
Gp 1	109.25 ± 6.13	112.75 ± 9.03	108.25 ± 2.75	102.00 ± 3.56	100.25 ± 5.97	99.50 ± 9.54	96.25 ± 5.91
Gp 2	402.25 ± 27.28	427.75 ± 25.59	452.00 ± 26.17	384.75 ± 11.03	349.50 ± 23.30	340.75 ± 25.17	321.25 ± 22.40
Gp 3	306.50 ± 16.60	349.25 ± 15.69	312.75 ± 25.90	308.25 ± 24.23	292.50 ± 27.09	274.75 ± 21.70	196.50 ± 9.33
Gp 4	344.25 ± 32.54	394.50 ± 24.47	301.00 ± 27.02	291.00 ± 22.54	271.00 ± 21.94	244.25 ± 11.59	164.75 ± 10.40
Gp 5	308.75 ± 13.25	353.67 ± 33.62	316.33 ± 15.50	257.00 ± 20.21	200.50 ± 6.11	193.25 ± 4.93	125.75 ± 31.79

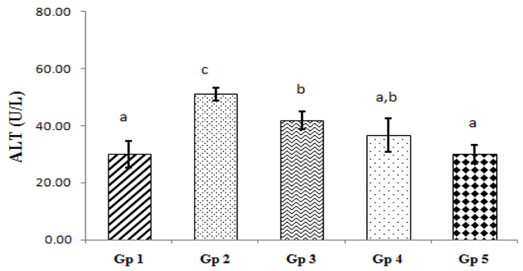
Values are Mean ± standard deviation of 4 determinations.

Table 3 .3 Effect of ethanol extract of *L.africana*leaves administration on body weight in alloxan-induced diabetic rats

	Days			
Groups	1	3	5	7
Gp 1	124.96 ± 10.09	134.53 ± 12.00	143.11 ± 10.63	163.90 ± 9.44
Gp 2	95.04 ± 11.07	98.45 ± 6.93	110.99 ± 14.91	109.78 ± 12.59
Gp 3	101.64 ± 11.58	107.47 ± 11.66	107.69 ± 10.74	123.42 ± 13.64
Gp 4	104.81 ± 7.86	107.28 ± 8.95	121.91 ± 11.42	133.66 ± 9.62
Gp 5	118.89 ± 9.50	107.17 ± 13.86	125.79 ± 12.19	135.63 ± 11.18

Values are Mean ± standard deviation of 4 determinations.

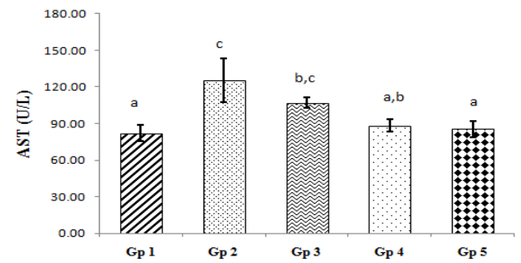
Fig 3.1.



Groups

Effect of ethanol extract of *L.africana*leaves administration on serum ALT activity in alloxan-induced diabetic rats.

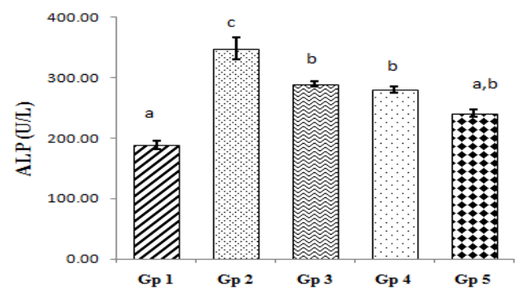
Fig 3.2



Groups

Effect of *L. Africana* leave ethanol extract administration on serum AST activity in alloxan-induced diabetic rats.

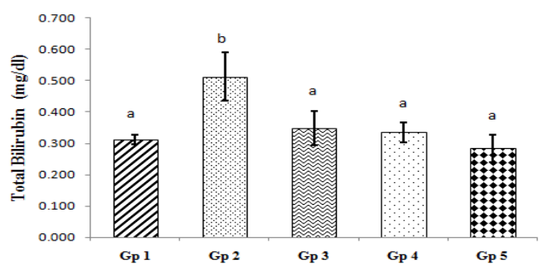
Fig 3.3



Groups

Effect of ethanol extract of *L.africana*leaves administration on serum ALP activity in alloxan-induced diabetic rats.

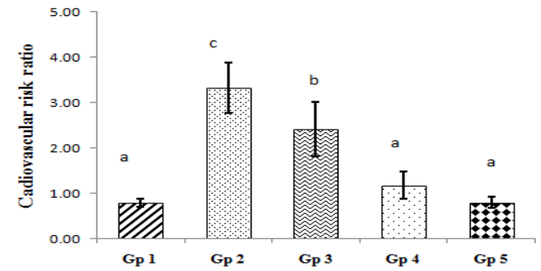
Fig 3.4



Groups

Effect of ethanol extract of *L. africana*leaves administration on serum total bilirubin concentration of alloxan-induced diabetic rats.

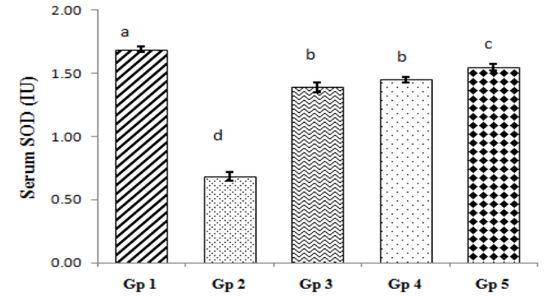
Fig 3.5



Groups

Effect of ethanol extract of *L. africana*leaves administration on cardiovascular risk ratio of alloxan-induced diabetic rats.

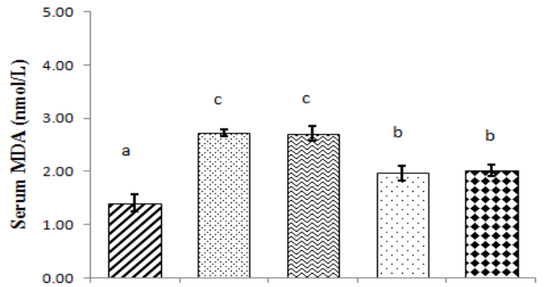
Fig 3.6



Groups

Effect of ethanol extract of *L. africana*leaves administration on serum superoxide dismutase activity of alloxan-induced diabetic rats.

Fig 3.7



Groups

Effect of ethanol extract of *L. africana*leaves administration on serum Malondialdehyde (MDA) concentration of alloxan-induced diabetic rats.

DISCUSSION

In the present study, the biochemical changes and anti-diabetic potentials of *Lasiantheraafricana* leaves ethanol extract on alloxan – induced diabetic wistar albino rats were assessed.

The result of acute toxicity studies on *Lasiantheraafricana* leaves ethanol extracts showed that in the two phases of the acute toxicity studies at the test dose of 10-5000 mg/kg b.wt.,administration of the extracts resulted in no death or observed toxicity on rats. There were no observable weight lost and signs of toxicity. These findings indicate that the ethanol extract of these plants are considered generally safe for animal consumption up to 5,000 mg/kg b.wt. (Lorke 1983, Kennedy *et al.,* 1986). This corroborates the work of Inyang*et al.,* 2015, Ekanem*et al.,* 2016, and Essie*et al.,* 2020; their studies reported that the LD_{50} of ethanol extract of the plants is above 5000 mg/Kgb.wt.

Assessment of the effect of *L. africana*leaves ethanol extract on blood glucose concentration, demonstrated a significant ($p<0.05$) reduction of blood glucose in diabetic rats. The extract at 250 mg/Kgb.wt and 500mg/Kgb.wt caused a 35.89% and 52.14% reduction in blood glucose respectively; which was comparable to 59.27% reduction in blood glucose obtained for the standard drug Glucophage. The extract administration resulted in a dose dependent reduction in blood glucose concentration; the dosage of 500mg/Kgb.wt was more effective and compared favourably to the standard drug glucophage after 7 days of administration. The reduction of blood glucose concentration in alloxan-induced diabetic rats by administration of the extract is indicative of potent antidiabetic properties. The results of the study agree with the works of Inyang, *et al.,* 2015 and Essie*et al.,* 2020 which reported that *L. africana*leaves exhibits promosing anti-hyperglyceamic properties. The blood glucose lowering effect observed in this study may be attributable to a number of phyto-active secondary components of the plant. The anti-diabetic properties of the plant maybe attributable to a number of active mechanisms such as enhancement of glucose uptake, stimulation of insulin secretion from pancreatic β- cells and inhibition of pancreatic amylase (Kameswara*et.al.,* 1999). *L. africana*leaves have been reported to inhibit α-amylase, α-glucosidase and ACE activities enzymes linked to type-2 diabetes and hypertension (angiotensin-1-converting enzymes (ACE) (Shodehinde*et al.,* 2017). The plant has been demonstrated to be rich in a number of phenolic acids such as caffeic acid, chlorogenic acid and ellagic acid as well as flavonoids such as quercetin (Shodehinde*et al.,* 2017). These are phytochemicals with known medicinal and anti-oxidative properties; and maybe working in synergy to produce the blood glucose absorption and lowering effect observed in this study. Quercetin, kaempferol, myricetin and rutin are important antioxidants with beneficial effects, such as anti-inflammatory, antiallergic, antiviral as well as an anticancer activity. They have also been suggested to play a protective role in liver diseases, cardiovascular diseases (Santos *et al.,* 1998, Hillwell, 1994, Zhang *et al.,* 2015).

The findings of this study also showed that the body weight of the normal control and diabetic rats body weight were gradually increased during the study period. The diabetic control group showed slight increase in body weight which reduced at the end of the study period. The administration of *L. africana*leaves extract was able to cub drastic reduction in the body weight of alloxan-induced diabetic rats. Hyperglycaemia and decrease in body weight of experimental animals have been reported to be correlated (Igile*et al.,* 1995; Zafar *et al.,* 2009).

Also, the study demonstrated an ameliorative effect of the extract on hepatotoxicity associated with diabetes. The result showed that diabetes induction was accompanied by significant ($p<0.05$) elevation of ALT, AST and ALP activity as seen in alloxan exposed rats; which are characteristics of liver impairment. However, the administration of *L. africana*leaves ethanol extractat 250mg/Kg.bwt and 500mg/Kgb.wt resulted in a significant ($p<0.05$) reduction in ALT, AST and ALP activity compared to diabetic control group. The reduction in ALT, AST and ALP activity were concentration dependent, with rats receiving 500mg/Kgb.wt of the extract showing ALT, AST and ALP activity which were comparable to standard and normal control rats. Also the extracts administration resulted in a significant ($P<0.05$) reduction in total bilirubin concentration in rats exposed to alloxan. Alloxan exposure resulted in hyperbilirubinaemia which were restored to normal concentrations in animals treated with the extracts.

Liver tissue damage is usually associated with elevation of serum marker enzymes which correspond to a decrease in the tissue enzyme, the result for liver AST suggests that the damage done to the liver was largely ameliorated by the extracts. Xenobiotic hepatotoxic action is usually expressed by cell respiration disorders that interfere with oxidation and reduction mechanisms, by impairment in protein, carbohydrate and lipid metabolism and by disturbances in intra- and extracellular transport. In consequence, whole cell or its cytoplasmic organelles can be damaged. Most frequently the damage is expressed as parenchymal vacuolar degeneration, necrosis of hepatocytes or disorders in the activity of metabolic enzymes (Anderson, 1985, De Valck, 1988, and Philips, 1987). Elevation of ALP activity usually occurs as an indication of bilary obstruction or intra-hepatic cholestasis (Whitehead *et al.,* 1999, Elizabeth and Harris, 2005). The findings of this study are consistent with the works of Nwidu and Teme, 2018, and Inyang, *et al.,* 2015; Inyang and Ani, 2015, Ekpo*et al.,* 2021; in their studies reported depressed AST, ALT, and ALP activity in rifampicin-isoniazid-induced hepatotoxicity and alloxan-induced diabetic hepatotoxicity respectively. The observed reduction of elevated transaminase activities in the serum of treated diabetic rats suggests that the plant leaves possess hepatoprotective effect. This may be associated with an improved liver function with normalization of gluconeogensis and other hepatic function (Inyang, *et al.,* 2015; Inyangand Ani, 2015, Ekpo*et al.,* 2021).

This studies reported significant ($p < 0.05$) reduction in total cholesterol, cardiac risk ratio (CRR), atherogenic index of plasma (AIP) and the atherogenic coefficient respectively.

Furthermore, assessment of some markers of oxidative stress showed that SOD activity was significantly ($p<0.05$) decreased by alloxan induction when compared to normal control group.

Similarly, there was significant ($p<0.05$) elevation of serum MDA concentration in alloxan administered groups when compared to normal control group.

However, administration of the ethanol extracts of *L. africana*leaves at 250mg/Kg.b. wt (Gp.3) and 500mg/Kgb.wt (Gp. 4) resulted in a significant ($p<0.05$) reversal of SOD activity depletion and

reduction of serum MDA concentration in groups treated with ethanol extracts of *L. africana*leaves at 500mg/Kgb.wt (Gp. 4) comparable to the reference drug (Gp 5).

Increased oxidative stress and altered antioxidant pool have been implicated in both clinical and experimental type 1 diabetes (Kakkar*et al.,* 1998, Vincent *et al.,* 2002, Indradevi*et al.,* 2012, Khan *et al.,* 2013, Wang *et al.,* 2013). This is evidenced in depletion of superoxide scavenger SOD and increase in lipid peroxidation product MDA. Alloxan induces diabetes through cytotoxic impact on the beta-islets cells of the pancreas resulting in hypoinsulinemia and eventually hyperglycemia (Szkudelski, 2001, Etuk, 2010). This cytotoxicity is mediated through intracellular production of free radicals exhibited both in vivo and in vitro (Yadav *et al.,* 2002). Lipid peroxides are secondary markers of oxidative stress and are released in response to cytotoxicity of reactive oxygen species produced during lipid peroxidation in diabetes (Evans *et al.,* 2002). Superoxide dismutase and other antioxidant enzymes (Catalase, gluthathione peroxidase and Glutathione-s-transferase form a primary defence involved in the direct elimination of radical species (Aebi, 1983). Superoxide dismutase catalyses the dismutation of superoxide radicals (Kakkar*et al.,* 1984).The gross changes in SOD activity and MDA concentration are empirical evidence of an increased lipid peroxidation and over production of free radicals resulting in mucosal damage. Administration of the extracts significantly protected against this oxidative changes. The mechanism of action of the extracts cannot be directly elucidated in this study, but may be attributable to the phytochemical blue print of the extracts; some of its phyto-constituents have been identified to possess free radical scavenging ability.

CONCLUSION

The present investigation has provided empirical evidence on the anti-diabetic properties of *L. africana*leaves ethanol extract. The result of the study indicated that *L. africana*leaves ethanol extract possess potent antidiabetic properties through its blood sugar reducing effect and in addition could ameliorates hepato-toxicty associated with diabetes mellitus. The study also verified the toxicity of the plant, acute toxicity results showed that the plant is generally safe and consumption of the extracts may not result in acute damage within the safe dose of 5000mg/Kgb.wt. Evidence indicates that treatments that can modulate oxidative stress and enhance antioxidant would indirectly delay the onset of diabetic cardiomyoparthy. The extracts of *L. africana*leaves may be useful in direct management of diabetes or as adjuvants with other treatment course.

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ART FOR SUSTAINABLE ECONOMIC DEVELOPMENT

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ABSTRACT

Art influences lifestyles, individual behaviour, consumption patterns and environmental health. For humanity to enjoy good health and sustainable economic development, artists must be sensitive to issues confronting his or her society. Most of these issues are as a result of environmental pollution generated by man's activities which constitutes health and environmental hazard. These raise concerns for artists to seek viable ways of producing arts by transforming waste to wealth for sustainable economic development. This paper is aimed at exploring the relevance of art for sustainable economic development by analyzing visually artworks of various Nigerian artists made from recycled, scavenged and reused materials. The visual analysis covered five aspects of visual elements which are: Composition, focal point, colours, form and symbolic value. The findings showed that there are multiple sustainability messages within the artworks through the analysis of the actual meaning overtime. The paper recommended that artists should be provided with necessary resources to encourage the process of producing arts for sustainable economic development.

Keywords: *Art, Sustainable, Sculpture, Development.*

INTRODUCTION

Art is the product of man's creative ingenuity. It is a field of study that creates aesthetic and utilitarian objects through the power of human initiative employs numerous media in this modern era for the achievement of that goal. Many modern artists have explored and experimented with recycled, scavenged and reused materials as viable creative media that reflect the current happenings in the society for economic sustainable development. Most modern artists who are engaged in using recycled, scavenged and reused materials for art production do not practice it just for the fun of converting the seemingly recycled, scavenged and reused materials into praiseworthy works of art. The practice has become the means of livelihood for many of them and good number of them has attained economic buoyancy through the practice.

Although some artworks produced from recycled, scavenged and reused materials are conceptual and their structures are not conventionally formalistic, Livinus and Chikelu (2019) observed that they have to be skillfully crafted in order to induce people's admiration and appreciation. Odiboh (2015:27) posits that “in modern art, the concern of art could shift from the physical embodiment to the 'art idea'… Works of art are now seen essentially as the map of a thought process.” Even though Odiboh's proposition is true concerning modern works of art focusing attention more on the concept that prompted the creation of an art piece rather than the formalistic appearance, in most cases, the conceptual meaning alone is not enough to attract reasonable appreciation as well as patronage in Nigeria as of today.

This paper examines the relevance of art for sustainable economic development by analyzing visually artworks of various Nigerian artists made from recycled, scavenged and reused materials. The visual analysis covered five aspects of visual elements which are: Composition, focal point, colours, form and symbolic value.

SUSTAINABLE DEVELOPMENT

Ndem (2019) posit that Sustainability is the process of striving to meet the needs of people, culture, and business as today in a way that restores the planet and does not compromise our ability to meet the needs of future generations. Anih (2002) defined “development as a positive improvement in the human and material resources of a society. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"(Blowers, A. et al, 2012).This definition has been used as benchmark in efforts to make it more comprehensive and accommodative from the socio-economic, political and environmental perspectives. Nnamdi and Alvan-Ikoku (2014) submits that, sustainable development aims at the sustainable use of natural resources of the earth and the protection of the environment on which nature and human life as well as social and economic development depend. With this in view, Art is considered in a discuss as this because its production process also have serious impacts on the environment with consequences for the depletion of the resources that provide for and threatening very essence of human survival and continuity (Mohammed, 2011).

ART

Uzoagba (2004:4) stated that 'art is a means of self-expression that must create pleasing forms.' In support, Getlein (2002: 19) writes that, “Art is one of the ways we express ourselves and attempt to communicate”. For the purpose of this discourse, this paper adopts the definition of art from the stand point of sustainable economic development, which brings to fore the similarity between the two (the Arts and Economics) in the academy and professional practice. Nyah and Omaru (2014) describe art from the sociological dimension as Systematic application of knowledge and skill affecting a desired result and an application of skill so acquired and taste developed in production according to aesthetics principles. The economic principle applied in their description is devoid of ambiguities. Nyah and Omaru (2014) opine that skills, taste or aesthetics should be applied in the production of commodities and other useful products acquired by man. Their philosophy is that products of any kind must possess some pleasing forms, an aesthetic quality applied by skilled person(s) based on the facts that those who acquire the product require certain aesthetic standards which consist of visual elements.

Analysis of Some Artworks for sustainable development “Ant and Fish” by Gbenga Adeku



Figure 1.
Artist: **Gbenga Adeku Title: Ant and Fish**
Medium: Metal and Plastic Scraps Year: 2022

Gbenga Adeku is an upcycle artist from south-western Nigeria, is helping protect his local environment through art and uses his works to promote climate action and awareness (Ekpali, 2022). Adeku collected bottles and beverage cans and converts them into art pieces for educational and awareness-building purposes. The idea for his art pieces came after he observed that most bottles and beverage cans that are not properly disposed are blocking water ways in his community, which resulted in a flood.

Figure 1 above, shows one of Gbenga Adeku's work titled “Ant and Fish”. The Ant colonies in the work are made from waste. According to Ekpali (2022), the ant colonies expresses the role ants play in cleaning the environment. Most often, they clean the environment, clear off dead cockroaches and other things they find. The researcher observed that Ants have a rich economy built on waste - not on generating waste, as humans do. The researcher also observed that, Gbenga in his work used them to represent life on land. Our human lives on land could do better if we learn from ants. The ants also symbolize team work. It shows that, no one achievessomething without the help of another; meaning fighting environmental pollution for sustainable development is the business of everyone. Everyone should be involved.

METAL SCULPTURES BY DOTUN POPOOLA

Fajuyigbe (2017) posited cogent agents that has an effect on artist style which he mentioned studio practice, societal background, exposure and archival knowledge. These are what affect Dotun Popoola metal exploration as a genre of contemporary Nigerian arts in the upcycling and recycling of repurpose materials of metal objects which birth waste aesthetics, environmental aesthetics and activism.

Dotun Popoola art is an attempt to draw the attention of people into the awareness of their maltreatment of nature. Most of his sculpted objects showcased the degradation of our environment which causes ill health to the inhabitants. This expresses the need to have a free and safe environment devoid of hazardous atmospheric condition.



Figure 2. The Cock Crow



Figure 3. Irin Pemi

In making of the metal sculpture in Figure 2, Dotun used waste metal objects such as spoons, spanners, musical instruments parts, and scrap metal in actualizing the work. He used spoons to portray the cock's red flat jaw. Its significance is that, it reminds one of the embrace of Western food over our own indigenous food. The work serves as a clarion call to all the lovers of Western culture over their own culture. The use of pieces of musical instruments, and spanners also have significant meaning to the work. Some parts of one of the musical instruments known assaxophone were used. The saxophone parts represent the "Kakaki" trumpet of Nigeria and the spanners designate the need to rectify all this disbelief in our culture by correcting it with the propagation of our own true heritage.

Irin Pemi in Figure 3 is another work by Dotun using waste material and metal scrap. The dog is configured anatomically using tailoring materials and generator part to create it. All these parts is significant to dog nature of being smart and barking which is one of it true nature of dog family.

THE WASTE EXPLORATION AND METALMORPHOSIS OF AKEEM MURAINA

Muraina's use of discarded materials like, metal junks from motor spare parts, glass, wood, plastic etc. inspired by the gross decadence and degradation of our environment, is powered by aesthetic and artistic vision and not out of share necessity. Most of Muraina's work are free standing, relief and assemblage (Adeleye, 2019).



Figure 4

Artist: **Akeem Muraina.**

Title of Work: Agbero (Mass Transit) Medium: Pipes, Vehicle parts, washer, clamps elbows.

Year: 2012

The work titled "Agbero", depicts two horses pulling a chariot, it runs commentaries on social, and physical issues thus, creating dialogue about environmental realities. The sculpture draws our attention to the menace of the typical Lagos "agbero" – the miscreant. It also addresses the issues of noise pollution and environmental trauma. Metal is the medium of production welded together to create the stylized form. The head of the horses were rendered with discarded vehicle parts and clamp elbows, the heads were more detailed in achieving Akeem's principle of "Frontal",metal sheet was cut to shapes creating big circles as voids, the box as the carrier represents the body was made of metal plate without detailing, pipes were used as exhaust and legs. It is observed that the front legs are four while the rear legs are two, this could be to balance the sculpture.

Creative arrangement of the various elements gives the sculpture a balanced form. The piece is given an elongated form by the size, 28"x21"x52". This sculpture is not painted, rather the original color of the parts were left naturally and vanished with lacquer. "Agbero" as title given to the sculpture depicts the attitude and character of "agberos", viewing the sculpture from the side, the mouth of the two horses give an impression of how the "agberos" open their mouth to call passengers.

CLIMATE CHANGE BY UCHE ONYISHI

Uche Onyishi also addresses the problems of waste management in urban areas. His current works explores non-biodegradable materials in ways that concretizes the ecological implications of poor waste management, gas flaring and oil spillage. In *Climate Change I*, the artist gathered plastic bags of assorted colours, burned them into amorphous shapes and then cast them on a tree that shed its leaves (figure 5). With this exercise, he transformed the natural tree into an artificial one, thus creating an unsettling uncertainty on the rest of the trees around it. In spite of its colourful outlook, the work evokes the rhythm of conflagration and seems to suggest that man must rethink his subversive approach to exploitation and use of natural resources in which his consumption habit and attitude to conservation of nature is open to



Figure 5

Artist: Uche Onyishi, Title: *Climate Change I*

Medium: Plastic bags on a tree. Year: 2013**"Young Woman's Cloth" by El Anatsui**



Figure 6

Artist: El Anatsui

Title: Young Woman's Cloth

Medium: Aluminium Bottle Tops and Copper Wire

Size: 290 x 841cm

Anatsui's work titled *Young Woman's Cloth*, an outstanding mixed media work, is rendered in bottle caps strung together with copper wires. Although this technique adopted by the artist looks tedious, it is clearly impressionistic and involves deliberate Methodism (Ubogu, 2019).

First, the artist collected bottle caps of different alcoholic drinks in various colours, some with inscriptions from his environment. He then flattened the caps, one after the other, with some parts chopped off during the process. Some of the flattened caps are irregular in shape and slightly squeezed. The bottle caps were then arranged in vertical and horizontal movements with some flat caps in the same colour bearing graphical inscriptions of the manufacturers

of the brand. At the topmost part of the picture plane are flat bottle caps with symbols, double zigzags with the company names running through the middle. More so, the colour scheme of the caps are different, some in red hues, some plain without inscriptions, while some are in gold-coated colours with graphical blind embossed lines and embossed inscriptions on them.

Some parts of the topmost part of the picture plane are rendered in brown and gold, and others in blue and red, with inscriptions of brand names and symbols. On the bottom part of the composition, the colour scheme comprises blue, orange and gold hues. The artwork is properly mounted on the background. Evidently, the artist did not apply any pigment to the bottle caps.However, the natural colours of the caps give the artwork a brilliance which enhances its beauty especially when viewed from different angles or perspectives.

CONCLUSION

This paper sought to highlight relevance of art for sustainable economic development by analyzing visually artworks of various Nigerian artists made from recycled, scavenged and reused materials using some visual elements. The findings shows that various works, transformations of everyday waste materials found in the environment are of great visual, aesthetic and economic value.

It reflects use of waste materials to produce sculptures inspired by the artists' environmental challenges and supported by the researcher's findings. A number of sculptures were produced in different techniques using waste metal as a material. The works analyzed have also supported the growth of jobs through the inspiration of both established and aspiring artists in the production of artistic creations. This is of great economic advantage, not only to these artists who benefit financially, but also to the economy of the nation because their artistic endeavours stimulate and sustain the economy. The works analyzed possess quality, meaning and aesthetic value and attract individuals and organizations who invest in art. Such resources benefit not only the artist but also impact the nation's economy and, at the same time, promote social interest in the rich cultures that are highlighted in them. This leads to the creation of multiple socio-economic benefits in society.

RECOMMENDATIONS

Based on the aim of this paper, the researcher made the following recommendations;

1. It is recommended that institutions, schools, artists facing lack of materials in the production of sculpture should improvise with recycled, scavenged and reused materials. This turn provides a resourceful material that is easy to get and cheap thus making sculpture more accessible by the public.
2. It recommends that materials that are ecofriendly should be adopted by both art students and professionals undertaking sculpture for the betterment of the environment.
3. Artists should be provided with necessary resources to encourage the process of producing arts for sustainable economic development.

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ASSESSMENT OF ENVIRONMENTAL IMPACT OF SOLID WASTE DUMPSITES AROUND OKO AND AMAOKPARA ENVIROS, SOUTH EASTHRN, NIGERIA.

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ABSTRACT

The wet and dry deposition of acidic substances from the atmosphere to landscapes (acid rain) is a serious environmental problem, negatively impacting seriously on the environment.These substances can rise very high in to the atmosphere, where they mix and react with water, oxygen, and other chemicals to form more acidic pollutants, known acid rain. Tao main sites were chosen for this analysis, these are; Amaokpala and Federal Polytechnic Oko in Anambra State. The parameters investigated includes; Nitrogen Dioxide ($N0_2$), Sulphur Dioxide ($S0_2$), Carbon Monoxide (C0), Ammonia (NH_3) all in part per millions (ppm). The mean concentration of the two dumpsites location are; nitrogen dioxide (NO_2) 0.74ppm, and 0.47ppm sulphur dioxide (SO_2) 0.37ppm and 0.35ppm, Carbon monoxide 47.35ppm and 37.65ppm, Ammonia (NH_3) 11.38ppm and 13.83ppm for Amaokpala and Federal Polytechnic Oko respectively. It was observed that the mean values of the parameters varied form one point to the other at different dumpsite. The mean concentration were compared with the United State Environmental Protection Agency (U.S.E.P.A.), 2008 ambient air quality standard. The gases reacts with H_20 (water) in the atmosphere to form acid rain E.g $S0_2 + H_20 \rightarrow H_2S0_4$, $CO_2 + H_2O \rightarrow H_2CO_3$. The impact of acid rain to the environment includes decays of buildings, lungs disease on human, destruction of Aquatic life's, material damages including vegetation damage, reduction in visibility and darkling of the sky.

Keywords: Dumpsite, Pollutants, Atmosphere, Environment.

INTRODUCTION

Acid rain is caused by a chemical reaction that begins when compounds like sulphur dioxide and nitogen oxides are released into the air. These substances can rise very high in to the atmosphere, where they mix and react with water, oxygen, and other chemicals to form more acidic pollutants, known acid rain. Some of these gases dissolve very easily in water and can be carried very far by the wind. As a result, the two compounds can travel long distance where they became part of the rain, snow, sleet and fog that we experience on certain days.

Human activities remain the main cause of acid rain. Over the past few decades, humans have released so many different chemicals into the air that they have changed the mix of gases in the atmosphere. Power plants release the majority of sulphur dioxide and much of the nitrogen oxides when they burn fossil fuels, such as coal, to produce electricity. In addition, the exhaust from cars, trucks, and buses releases nitrogen oxide and sulphurdioxide into the air. These pollutants cause acid rain.

Acid rain increases the acidity of lake water. This causes changes in the assemblages of plant and animals that occur naturally in the lake. An acid-stressed lake is typically very clear, with filamentous algae along the bottom and reduced fish population. Acid rain can leach copper, aluminum, and other heavy metals out of the soil and into runoff and drinking water. This process in turn puts more harmful materials in the water and soil, thus reducing the populations of organisms in the waterbody or soil. Some lakes in New Hampshire have reached the point where fish are unable to survive due to the acidity of the water

Acid rain, or acid deposition, is a broad term that includes any form of precipitation that contains acidic components, such as sulfuric acid or nitric acid. The precipitation is not necessarily wet or liquid; the definition includes dust, gases, rain, snow, fog and hail. The type of acid rain that contains water is called wet deposition. Acid rain formed with dust or gases is called dry deposition.

Although acid rain is no longer prominently featured in the North American and European media, scientists continue to observe and study deposition levels as well as the status of ecosystem recovery in many regions. Indeed, many scientific advances have been made in recent years such as: improving our understanding of the role of soils in mediating ecosystem recovery, unraveling the myriad factors that affect how biota respond to lower levels of deposition, and documenting the rate at which ecosystems are recovering (Douglas etal., 2016)

Our modern understanding of acid rain as an environmental problem caused largely by regional emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) stems from observations in the 1960s and early 1970s in Sweden by (Svante Odén,1976) and in North America by Gene Likens and colleagues (Liken and Bormann, 1974). These scientists and many who followed showed the link to emissions from coal-fired power plants and other industrial sources, and documented the environmental effects of acid rain such as the acidification of surface waters and toxic effects on vegetation, fish, and other biota.

The chemical reaction that results in the formation of acid rain involves the interaction of SO_2, NOx and O_3. When the pollutants are vented into the atmosphere by tall smoke stakes, molecules of SO_2 and NOx are caught up in the prevailing winds, where they interact in the presence of sunlight with vapours to form sulphuric acid and nitric acid mists. These acids remain in vapour state under the prevalent high temperature conditions. When the temperature falls, condensation takes the form of aerosol droplets, which owing to the presence of unburnt carbon particles will be black, acidic and carbonaceous in nature (subodh, 2017)

The wet and dry deposition of acidic substances from the atmosphere to landscapes (acid rain) is a serious environmental problem, negatively impacting aquatic and terrestrial ecosystems (likens 2021)

Acid rain is an indirect product of climate change. Only a small portion of the emissions that are required for the formation of acid rains are generated naturally and the majority of them are the result of human activities that involve burning fossil fuels. For instance, two-third of the primary components of acid rain, that is, SO_2 and NO_2, are generated by human activities (USEPA, 2020).

Wind can carry acid rain dust around the globe far from the source of the pollution. The U.S. tracks

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the chemicals in acid rain. The Northeastern region is the most acidic because it has many power and industrial plants, people, and cities. Many plants in the Midwest release harmful chemicals that also blow to the Northeast, increasing the acidity. Also, the soil in the Northeast is less likely to be able to neutralize the acid rain.

Serious acid rain remains a problem in parts of China and elsewhere in Asia that are rapidly industrializing.

Both stem from pollution created by humans. Even though acid rain is a regional problem, it can eventually alter the chemical makeup of soil and water around the world.

Some compounds that cause acid rain, including nitrous oxide, are greenhouse gasses like carbon dioxide and methane that trap heat in the atmosphere. That contributes to global warming. In turn, the higher average temperatures are melting glaciers and setting off more and more extreme weather changes that are a sign of climate change.Global warming can make acid rain worse because it speeds up the chemical reactions that produce acid rain.

AIM

To provide information that would be relevant in proper pollution mitigation strategy of the study area.

OBJECTIVES

1. To know the effects of solid waste influence in the environment of Amaokpala and Federal Polytechnic Oko.
2. To determine the hazard nature of the acid rain in the environment
3. To ascertain the rate of ambient air quality in the environment.
4. To ascertain the environmental effects of dispose of solid waste.
5. To educate and recommend solutions to the possible environmental crisis.

MATERIAL AND METHODS

The field work carried out during the wet season(May-July). Gaseous emission such as CO, NO_2, SO_2 and NH_3 are measured and analyzed with the aid of Crown gas Analyzer which has a digital readout at some strategic positions around the study area. A total of 8 different sample locations for the air quality was analyzed. The gas analyzer or air monitor is calibrated in parts per million (ppm) with an accuracy of +0.01 ppm and a total of thirty two (32)measurement were taken at the study area within the period of two days. The average concentration of the gases at the study area are computed and recorded. The data acquisition was taken in the area of maximum concentration. In the case of air quality, it is necessary to note the prevailing wind direction enables one to obtain sufficient data (in terms of the concentration of the gaseous emission nearer to the instrument for easy detection.

RESEARCH TOOL

These include: topographic map, global position system (GPS), crown gas analyzer, digital camera., calculator, field note, laptop, batteries, gloves. Boots etc.

RESULTS AND DISCUSSION

The tables below shows the ambient air quality data determine at two different dumpsites, which are located at, Amaokpala and Federal Polytechnic Oko,Anambra State. These data were compared to United States Environmental Protection Agency (USEPA) and World Health Organization (WHO), 2008 guidelines and standards for environmental

pollution in the form of acid rain and its effect.

Table: below show the data determined from the dumpsite located at Amaokpala, Anambra State.

Table: Gaseous emissions at Amaokpala dumpsite for wet season.

Gases	Locations				Average	USEPA/WHO
Parameters in ppm	S.L1	SL_2	SL_3	SL_4	Mean	Limits
NO_2	0.70	0.70	0.75	0.8	0.74	0.155
SO_2	0.38	0.38	0.40	0.30	0.37	0.145
CO	45.2	48.1	47.1	49.0	47.35	35.50
NH3	8.72	12.32	13.10	11.36	11.38	25.0

From table above, the average concentration nitrogen dioxide (NO_2) is determined to be 0.75ppm, sulphur dioxoide (SO_2) is 0.37ppm, cabon monoxide (CO) is 47.35ppm and ammonia (NH_3) is 11.38ppm. the concentration of NO_2, SO_2, and CO were not in confirmity with the United State Evironmental protection Agency and World Health Oganization (2008) ambient air quality standard, of 0.155,0.145 and 35.50ppm respectively. While ammonia (NH_3) confirmed with USEPA and WHO(2008) standard. This has shown that the area may be prone to acid rain due to the high concentration of gases emitting from the dumpsite.

Table: Below show the data determined from the dumpsite located at Federal Polytechnic Oko, Anambra State.

Table: Gaseous emissions at Federal Polytechnic Oko dumpsite for wet season.

Gases	Locations				Average	USEPA/WHO
Parameters in ppm	S.L1	SL_2	SL_3	SL_4	Mean	Limits
NO_2	0.46	0.49	0.50	0.44	0.47	0.155
SO_2	0.30	0.30	0.38	0.41	0.35	0.145
CO	35.00	40.00	39.15	36.45	37.65	35.50
NH3	12.52	15.32	17.10	10.36	13,825	25.0

From table above, the average concentration nitrogen dioxide (NO_2) is determined to be 0.47ppm, sulphur dioxoide (SO_2) is 0.35ppm, cabon monoxide(CO) is 37.65ppm and ammonia (NH_3) is 13.825ppm. the concentration of NO_2, SO_2, and CO were not in confirmity with the United State Evironmental protection Agency and World Health Oganization(2008) ambient air quality standard. of 0.155,0.145 and 35.50ppm respectively. While ammonia (NH_3) confirmed with USEPA and WHO(2008) standard. This has shown that the area may be prone to acid rain due to the high concentration of gaseous emitting from the dumpsite.

➢ Nitrogen dioxide NO_2

In the two dumpsites Nitrogen dioxide (NO_2) exceeded the USEPA limit 2008 ambient air quality of 0.155 ppm and thus a major contributor to the acid rain problem in the study area.

The major sources of Nitrogen Dioxide in the study area includes; burning of fossil fuels, decomposition of plants and animals dumped in the sites, chemicals like pesticides, fertilizer etc. that are dumped in the sites as a refuse, which are either burned or decomposed and part of it escape to the atmosphere and combines with water to produce acid rain, in the study areas.

Chemical equation

$$No_2 + H_2O \longrightarrow HNO_3$$

$$2HNO_2(aq) + O_2(q) \longrightarrow 2HNO_3(aq).$$

In the above equation, it indicates that when nitrogen dioxide that is evolved in the dumpsites, combines with water molecules in the atmosphere to produce nitric acid in form of acid rain are experienced within the study areas. The effects of the acid rain in the study areas causes major environmental problems, such as causing corrosion of building materials and statues also devastation of aquatic lives in the study areas.

➢ Sulphur dioxide (SO_2)

In the two dumpsites sulphur dioxide has exceeded

USEPA limit 2008 ambient air quality and therefore, forms an acidified rain. Sulphur dioxide is one of the top priority pollutants because of its adverse effects. Sulfur dioxide(SO_2) is released into the air, it reacts with water and oxygen to form sulfuric acid H_2SO_4. Sulfuric acid is a stong acid. It ionises completely to hydrogen ions. This gives rain water the pH below 5.0.

The major sources of sulphur dioxide in the two locations Amaokpala and Federal Polytechnic Oko, is also as a result of human activities. The human activity there is the presence of groups of people melting aluminum, copper, zinc, lead and iron that contain sulhur. This melting of aluminum releases large amount of sulphur dioxide in the atmosphere and reacts easily in water, therefore, forms acidified rain. Other sources of sulphur dioxide is as result of burning fossil fuels, woods, plastics and some metals found in the site etc. Because of burning process of the refuse by human, these gases are released in the atmosphere within the area and when combines with water in the atmosphere, it produces acid rain.

Chemical equation

$SO_{29g)} + H_2O_{(l)}$ $H_2SO_{3(l)}$ sulphuric acid

$SO_{2(aq)} + O_2\,(g) + H_20_{(l)} \rightarrow 2H_2SO_{4(aq)}$

The chemical equation above signifies, when sulphur dioxide reacts with water in the atmosphere, it produces, suphuric acid, which causes the acid rain that is formed in the study area.

Sulphuric acid is one of the strongest acid in the study areas, therefore, have many of its effect in the environment. The effects are; it accelerates the decay of building materials, and paints including irreplaceable monuments, statues and sculptures that are part of cultural heritage. Acid rain damages building material and even affect humans in the study areas.

- **Carbon monoxide (CO)**

In the two dumpsites, the mean concentration of carbon monoxide exceeded USEPA and WHO (2008) ambient air quality standards. The mean concentration of carbon monoxide in the two dumpsite are 47.35 and 37.65ppm for Amaokpala and Federal Polytechnic Oko respectively. From the tables above, Carbon monoxide do not confirm with the USEAP and WHO (2008) for ambient air quality. It is a major pollutant in the formation of acid rain across the world. It's major source is as a result of human activities. Human activities in the site involve groups of people melting metals right in the site and smoke from this process fills everywhere, carbon monoxide has its highest value at Amaokpaladumpsite. Also from the other two sites (Federal Polytechnic Oko) the major sources of carbon monoxide (CO) is as a result of incomplete combustion of carbon containing substances in the sites. Since the dump sites is characterized by the activities of burning the refuse by human, therefore, releases large amount of carbon monoxide in the atmosphere. Substances that can produce carbon monoxides when burnt are papers, woods, fossil fuels, plants etc.

Also, carbon monoxide also contributes indirectly to the formation of acid rain.

Chemical equation:

$CO + O \longrightarrow CO_2$

$CO_2 + H_2O \longrightarrow H_2CO_3$

From the above equation CO is oxidized to form carbon dioxide (CO_2) which then reacts with water to form carbonic acid (H_2CO_3).

Carbonic acid in the form of acid rain can increase the toxicity levels both in human and aquatic lives.

CO can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues. Exposure to lower levels of CO is most serious for those who suffer from heart disease, and can cause chest pain, reduce the ability to exercise, or—with repeated exposures—may contribute to other cardiovascular effects.

Even healthy people can be affected by high levels of CO. People who breathe high levels of CO can develop vision problems, reduced ability to work or learn, reduced manual dexterity, and difficulty performing complex tasks. At very high levels, CO is poisonous and can cause death.

- **Ammonia (NH_3) and Hydrogen sulphide (H_2S)**

In the two dumpsites, ammonia has an average mean value 11.38 ppm and 13.83ppm for Amaokpala and Federal Polytechnic Okodumpsite respectively. The test indicates that ammonia fall below the standard of USEAP and WHO(2008) limit for ambient air quality of 25ppm. Odors in landfill gas are caused primarily by hydrogen sulfide and ammonia, which are produced during breakdown of waste material. Ammonia has a strong pungent odor. Humans can detect hydrogen sulfide and ammonia odors at very low levels in air, generally below levels that would cause health effects.The materials are; rotten smell of decayed plant and vegetables, dumped in the sites which emit hydrogen sulphide while some domestic waste, hospital wastes and garbage's emits ammonia in the study areas.

CONCLUSION AND RECOMMENDATION

The concentration of Nitrogen dioxide (NO_2), carbon monoxide (CO) and Sulphur dioxide (SO_2) which are the principal air pollutants are above the United State Environmental Protection Agency (U.S.E.P.A), (2008) Ambient air quality standards. This leads to the formation of acid rain which have serious impact on amaokpala and Federal Polytechnic Oko environs. These impact includes corrosions of metals, decays of building, monuments, roofs and other exposed facility on the environments.

Also, surface water around these dumpsites have been contaminated by the action of these acid rain which makes it unsafe for domestic use and causes destruction to aquatic lives.Even healthy people can be affected by high levels of these gases. People who breathe high levels of CO can develop vision problems, reduced ability to work or learn, reduced manual dexterity, and difficulty performing complex tasks.

Furthermore, human health are also affected by these acid rain which causes lung diseases, reduction in visibility, skin infection etc.

RECOMMENDATION

The following recommendation were made as a way to proffer solution to this ravaging threats posed on the environment by acid rain.

- The deposition of these varieties of waste should immediately be stopped and good sanitary land fill should be sited in an environment away from human dwelling
- The persons living in these areas should be properly educated and enlightened on the already existing dangers posed from these dumpsites and the need to embrace proper method of waste deposal.
- Proper treatments should be carried out on these dumpsites. Treatment like, the use of scrubbers which help to check the impact of air pollutant arising from the dumpsite.

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ASSESSMENT OF THE LEVEL OF ADOPTION OF EMERGING TECHNOLOGIES IN HOUSING DEVELOPMENT IN NIGERIA

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Assessment of the Level of Adoption of Emerging Technologies in Housing Development in Nigeria

ABSTRACT

The need to leverage on technology in the construction industry cannot be overemphasized. Technology has revotionalised most sectors of the economy and the construction industry cannot afford to be left behind. With an estimated 28 million housing deficit in the country, adoption of technology should be the driving force in bridging the gap. This study aims at evaluating the adoption of various emerging technologies in housing development by constructing firms. One hundred copies of structured questionnaires were distributed to professionals in the construction industry. Data collected were analyzed using descriptive statistics. Emerging technologies such as blockchain technology, construction automation, drones technology, concrete technology (ready- mixed and self compacting) etc. The study reveals that most firms have low levels of adoption and awareness of these technologies. The study also indicated that there was no significant difference in the perception of construction professionals on the influence of technology on housing development. The study also revealed barriers to adoption of these technologies to include poor power supply and inadequate digital infrastructure. It was concluded that enormous benefit accrue to adoption of technologies in housing development as it improves the effectiveness of construction operations and project performance . Therefore government, professionals bodies and stakeholders in the construction industry should adopt suitable and sustainable frame work for more awareness, policy and adoption.

***Keywords**: Emerging technologies, Housing development, Adoption, Nigeria.*

INTRODUCTION

The need for housing is basic for living. However, decent housing seems elusive for great percentage of Nigeria. The reason cannot be far fetched as (Uduu 2023) stated that Nigeria has an estimated 28 Million housing deficient indicating that the country needs at least 28 Million housing units to provide adequately for the population. This need for housing is more obvious in the urban cities where there is a lot rural-urban migration. Cities most cope with great number of people, plan to provide services, find resources to meet the need of maintaining and augmenting infrastructure, respond to urbanization and poverty, preserve their environment and retain their competitive edge. (Bharat and Chawl 2011). This paper tends to evaluate the various emerging technologies that can help in reducing housing deficit by fast-tracking the process of construction and eliminate bottle necks inherent in Housing development processes.

This has been the case for a very long time, despite various efforts made to bridge this gap. The country's first national rolling plan 1990 – 1992 then was to address housing challenges. According to FRN (1990) the housing deficient was around 4.8 Million and 5.9 Million and the plan was to build 700,000 housing unit each year in order to meet the housing gap. However, instead of the gap to be filled, it was expanding more. (Ogu and Ogbuzobe, 2001) posited that as housing supply lags behind demand and housing condition continue to worsen in the face of teeming urban population in the developing world, it became increasingly imperative that a new a paradigm has to be adopted if the housing challenges is to be met**.**

STATEMENT OF PROBLEM

There is a massive shortage in housing in Nigeria and similar infrastructure for the growing population. Many measures have been promulgated to address this.

One of the ways to close this gap is the adoption of emerging technology in construction processes. Technology makes processes simplified, saves time and improves quality. Technology has been adopted in most sectors of the economy and the result is obviously positive. Therefore, adopting technology in housing developing will enhance the development of the housing sector. Digitization of processes is key in enhancing prompt housing delivery. Rapid digitalization is influencing the way we interact work, receive, deliver services, including how value is created and exchanged (Lamber 2018, Zimneran (2018). There are many emerging technologies that can be adopted to influence the housing development. This paper tends to assess the level of adoption and its limitations.

LITERATURE REVIEW

One of such is blockchain technology. Blockchain technology is described as a type of distributed ledger data structure that transmits and stores data in units known as blocks that are linked together by a virtual chain. Agidan, Jumai (2020). Blockchain helps in sharing information and data to stakeholders and fasten processes. Another technology in monitoring is Drone Technology. Drones are unmanned aerial vehicles that are equipped with camera, geo-location sensors, infrared sensor to capture precise details about the environment and physical site prior to and during construction (Hugh, 2018). This will help in project monitoring as a lot of waste and corruption will be curbed by use of thesetechnology in monitoring. Construction automation is another emerging technology that will help in improving and use of scarce resources.

Automation at design stage use tools such as BIM, revit, Archicard – in construction stage, a typical automated masoning plant can produce 1000 blocks in an hour.

Nanotechnology is the use of very small particles of materials either by themselves or by their manipulations to create new large scale material. Nanomaterials can be used to produce materials for better cementious materials that are higher and have stronger structural composite (Khandve 2014). This will helps brings gap in high cost of certain construction materials or can be used as partial replacement. Prefabrication of components is the future of the construction industry, for some prefabrication of components is equipped with high powered grinders to produce high quality component for fast production Shahrubudin et al (2019).

AIM AND OBJECTIVES

This study aims at evaluating the adoption of various emerging technology with a view of bridging the gap in housing deficit in Nigeria.

The will be achieved through the following objectives:

i. To assess the level of adoption of technology in housing development in Nigeria.
ii. To determine the factors inhibiting adopting these emerging technologies.
iii. To develop strategies for promoting technologies in housing development in the study area.

RESEARCH QUESTIONS

i. What is the level of adoption of emerging technologies in housing development in Nigeria.
ii. What are the factor inhibiting the adoption of these technologies in the Nigeria.
iii. What are the strategies for promoting the adoption of these technology for housing development.

RESEARCH METHODOLOGY

This study assessed the level of adoption of emerging technologies in Nigeria. One Hundred structured questionnaires were distributed to obtain primary data for the analysis. The questionnaires were distributed to professionals in the construction industry such as Architects, Builders and civil engineers by the researchers and research assistant. The professionals were drawn from the existing data base of registered professionals.

A FIVE-POINT SCALE OF 1 – 5

1 – Not significant 2- Fairly significant
3 – Moderately 4 – Significant and
5 – Highly significant

Where w is the weight given to each variable by the respondents. This result is in consonance with Groves (2006) who posited that a response of at least 50%. Results and discussions is considered adequate.

Table 1 shows that 100 questionnaire were administered to the respondents out of which 80 were duly completed and returned representing 80%.

Questionnaires	Frequency	Percentage
Returned	80	80
Unreturned	20	20
Total	**100**	**100%**

Source: Field Survey 2023

Table 2
Respondents Profile

Grade	Qualification	Frequency	Percentage
Highest	a. OND	5	6.25
EDUCATION	b. HND	20	2.5
Level	c. B.SC	40	5.0
	d. M.Sc	10	12.5
	e. Ph.D	5	6.25
	Total		
Profession	Architect	30	
	builder	30	
	Civil Engineer	20	
	Total		**80**

Source: Field Survey (2023)

Table 2 shows the respondents profile, it can be observed that the majority of the respondents with highest frequency are B.Sc holders 50% and Ph.D has none, similarly architects and civil engineers have 40% each while the builders have 30%.

Table 3
Working experience of Respondents

Years of Experience	Frequency	Percentage
6 – 5	5	20
6 – 10	20	14
11 – 15	40	50
16 – 20	5	20
20 – years and above	10	14
Total	**80**	**100%**

Source: Field Survey 2023

Table 3 shows that 20% of respondents have working experience 6 – 40 years and 50% of respondents have working experience between 11 – 15 years. Therefore, the respondents can be said to have adequate knowledge and experience in technology in housing development.

Level of Adoption of Emerging Technologies in Housing Development

Emerging Technology	1	2	3	4	5	Mean	Rank
Block chain Technology	0	0	58	14	8	3.375	12
Nanotechnology	0	22	15	34	9	3.375	12
Prefabrication Technology	0	0	6	37	37	4.387	1
Use of CCTV for monitoring	0	0	44	29	7	3.537	7
Concrete Technology	0	0	8	58	14	4.075	3
Automation and Robotics	0	0	16	26	38	4.27	2
Radio Frequency Identification	8	20	38	0	14	2.90	15
Labour Input Tracking Model	0	8	42	24	6	3.350	8
BIM (Building Information Modelling)	0	0	38	20	22	3.80	5
Artificial Intelligence (AI)	5	7	78	44	6	3.487	10
Augmented Reality	0	0	62	12	6	3.300	14

Internet of Things (IOT)	0	8	42	24	6	3.350	8
3D Printing	0	16	28	3	33	3.662	6
Virtual Reality	0	0	48	26	6	3.475	11
Expanded Polystyrene (EPS) Technology	0	0	8	58	14	4.075	3

Source: Field Survey 2023

From the findings in table 4, it shows that Emerging technologies that can influence housing development positively as ranked showed that is of prefabrication technology ranked 1st with mean score of 4.38. this is in line with Shabrubrubudin (2019) that prefribrication produces buildings faster as the elements are pre-made and just need to couple its joints or use of grouts for Mansory based. The 2nd ranked is automation with a mean score of 4.275 as it also saves time and efficient.

Table 5
Factors Inhibiting the Adoption of these Emerging Technologies for Housing Development.

FACTORS	1	2	3	4	5	Mean	Rank
Lack of client awareness	0	0	58	14	18	3.375	12
Lack of education and training	0	0	62	12	6	3.300	14
Expensive plant and equipment to establish	0	0	44	219	7	3.537	10
Poor power supply	0	0	48	26	6	3.475	11
Lack of subsidy to promotetertiary limits	0	0	8	58	14	4.075	6
Knowledge of digital technology	0	0	28	10	42	4.175	4
Unfamiliarity and resistance to change	0	0	6	37	37	4.387	3
High initial cost	0	0	0	60	20	4.75	1
Disincentive for local material production	0	22	3	34	24	3.750	7
Unavailability of standard method for procurement	8	20	28	0	14	2.90	15
Lack of financial incentives	0	0	34	38	8	3.675	8
Poor working environment that fosters use of technology	0	0	0	28	52	4.65	2
Inadequate Infrastructure	0	0	16	26	38	4.275	4
Poor road network	0	8	42	24	6	3.35	13
High level of unemployment	8	20	38	0	14	2.900	15
Multi-dimensional poverty	0	0	34	38	8	3.675	8
High interest rate of mortgage	0	0	31	11	38	4.087	5
Lack of political will	8	20	38	0	12	2.800	17

Source: Field Survey 2023

Findings from table 5

From the table it shows high initial cost as the most inhibiting factor that enable use of technology in constitution with a mean score of 4.75. The 2nd is poor working environment that fosters use of technology with mean score of 4.65 this is corroborated by (Ojoko et al 2016) that states that ineffective housing laws hampen use of technology in attaining sustainable housing in Nigeria.

CONCLUSION AND RECOMMENDATION

This study has showed the level of adoption of emerging technologies in Nigeria which is low.

Adopting technology will help in bridging the housing deficit in Nigeria as benefits accruable to use of technology cannot be over emphasized. It saves time, provides avenue for data sharing among professionals, virtual monitoring of sites, security and ensures standards and efficiency.

The professional bodies in the built environment should create more awareness towards the adoption of technology for housing delivery.

Government organization such as office for Technical Acquisition and Promotion (NOTAP) Standard Organization of Nigeria, Research Institutes should spear head the use of technology

The curriculum of the education system should be updated to include those technologies in the scheme.

Incentives inform of tax rebates, subsidy etc to motivate manufacturers in the production of equipment that than facilitate the development of these technologies should be encouraged

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AUDIT ATTRIBUTES AND FINANCIAL REPORTING QUALITY OF SOME SELECTED QUOTED FOOD AND BEVERAGES FIRMS IN NIGERIA ECONOMY

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ABSTRACT

The study examined the impact of audit attributes on the financial reporting quality of quoted food and beverages firms in Nigeria. Secondary data from annual reports and accounts was employed. The survey research design was used in a sample of fifteen (15) firms for a period of six years (2015-2020). The questionnaire method was used to collect data from selected listed firms on Nigeria Stock Exchange. The maximum likelihood estimation (MLE) regression technique of ordered logistic regression was used in estimating the stated model. The study found that auditor size and audit delay have a significant positive impact on the quality of financial report of the sample firms. The study on the other hand found that auditor rotation has no significant impact on the financial reporting quality of the sample firms. The study recommends that the regulators (SEC) of the listed companies in Nigeria should emphasize and encourage the use of audit quality attributes; especially the auditor size and audit delay. The study also recommends that managers of the food and beverages firms in Nigeria should improve compliance with the acceptable ethical standards in discharging their duties and responsibilities, so as to enhance the credibility of their financial reports and safeguard their entities from going-concern threats.

INTRODUCTION

The quality of financial reporting has been a subject of debate among regulatory bodies and stakeholders especially after the collapse of major companies (Hassan & Bello, 2013). Series of corporate scandals around the world eroded the trust in the financial statement and placed a doubt in the mind of investors, which resulted to the loss of confidence by investors worldwide (Fodio, Ibikunle & Oba, 2013). The cases of Enron, WorldCom, and Xeronx in developed nations; Maxwell in United States of America and Transmilein Malaysia. These crises have forced a re-think on how to curb the menace on the part of regulators and governments, throughout the developed world and other developing countries. Iyoha (2012) documented that there are concerns about financial reporting quality among Nigerian firms. The concerns regarding the quality of financial reporting, have raised questions regarding the effectiveness of monitoring mechanisms of companies like the audit committee. This assertion is linked to recent cases of corporate financial frauds, accounting improprieties, scandals and failures in Nigerian companies such as Cadbury Nigerian Plc in 2016, Afribank Nigeria plc in 2009 and Intercontinental Bank Plc in 2009. Ajibolade (2008) stated that, the Lever Brothers Plc case in Nigeria aroused the attention of investors because of losses in their investments. Financial report should be reliable, comparable, understandable, flexible and also should consider time factor. All these can only be achieved when there is an efficient and effective audit committee because they are charged with the responsibility of producing reliable and adequate information about the financial statement.

Audit quality describes how well an audit detects and reports material misstatements (including intentional and unintentional errors) of financial statements, reduces information asymmetry between management and stockholders and helps protect the interests of stockholders (Chen, Elder, & Liu, 2005). High audit quality is therefore associated with high information quality of financial statements because financial statements audited by high quality auditors should be less likely to contain material misstatements and unethical accounting practices. In Nigeria, it is important to note that the Regulatory agencies have responded by compelling companies to comply with stringent corporate governance codes to ensure sound and efficient financial reporting in Nigeria (Ibrahim, Abdulazeez & Muktar, 2020). Despite the interventions of the regulatory authorities, the challenges of ensuring credibility in financial reporting and auditing are still prevalent. It therefore becomes pertinent to investigate some of these factors that can affect financial reporting quality in order to enhance the relevance of audit and assurance functions in Nigeria. Food and beverages firms are considered in this study due to the little or absent of empirical studies on audit quality and financial reporting quality, which calls for the investigation of the sector.

STATEMENT OF PROBLEM

The issue of efficient financial management has become topical in the last two decades. A series of financial scandals that happened both at national and international level have raised a lot of questions on the capacity of auditing firms globally. World financial scandals such as Enron, World Com, Barings, Parmalat, Cadbury Nigeria Plc, have raised concern on the role of external auditors in providing security against financial fraud and deliberate misrepresentation of financial reports. However, one of the major issues that are of concern in the public domain has been the incessant problems that have bedevilled the major firms in Nigeria. In recent times, financial crime has become more pervasive and the probability of corporate fraud occurring has become more severe. These aspects of business failure have

put greater responsibility on financial experts particularly auditors to improve their capability in order to identify at the right time the symptoms and fraud so as to nip in the bud any case of corporate failure.

There is also a theoretical debate as regard the effect of the audit firm size on financial reporting quality. Madugba, Howell, Nwanji, Faye, Egbide and Eluyela (2021) have argued that the type of audit firm employed by a firm to review its financial report enhances financial reporting quality. They further asserted that the big four counterparts in all of the financial reporting issues present to them and that the size of the audit firm is positively associated with audit quality. Such superiority is seen in terms of resources and audit technology. There is high intellectual argument as to which is best audit size that will produce higher total infraction precision among the two options. Therefore, this study predicts that the use of big4 auditors could enhance the quality of accounting information, due to high technology and manpower with diverse knowledge associated with them. Despite the arguments regarding audit firm size and financial reporting quality around the world, there are absent of empirical studies that investigated such issues in the listed food and beverages firms in Nigeria, which this study attempts to investigate.

Another issue that dominated the accounting literature is the association or relationship between audit firm tenure and the quality of financial reporting. This issue has been subject to extensive debate and the conclusions have been mixed. The debate on audit firm rotations has received considerable attention over the years. The seeming evidence of the effect of audit firm rotation on financial reporting quality has been anecdotal. Some studies have been able to suggest that financial reporting quality is lower when auditor's tenure is short. It is important to note that a negative association between reporting quality and short auditor tenure may be attributable to the out-going auditors own effort. This has provided an avenue for us to empirically examine the effect of audit firm rotation on financial reporting quality in Nigeria (Adeleke, 2021).

OBJECTIVES OF THE STUDY

The major objective of the study is to assess the impact of audit quality attributes on the financial reporting quality of listed food and beverages firms in Nigeria. Other specific objectives are;

- To examine the effect of audit firm size on the financial reporting quality of listed food and beverages firms in Nigeria.
- To determine the effect of auditor rotation on the financial reporting quality of listed food and beverages firms in Nigeria.
- To assess the effect of audit delay on the financial reporting quality of listed food and beverages firms in Nigeria.

RESEARCH QUESTIONS

The study is being guided by the following research questions as follows:

- What is the effect of audit firm size on the financial reporting quality of listed food and beverages firms in Nigeria?
- How does audit rotation affect the financial reporting quality of listed food and beverages firms in Nigeria?
- What is the relationship between audit delay and the financial reporting quality of listed food and beverages firms in Nigeria?

RESEARCH HYPOTHESES

Based on the above objectives, the following are the hypotheses of the study

- Audit Firm Size has no significant effect on the financial reporting quality of listed food and beverages firms in Nigeria.
- Auditor Rotation has no significant effect on the financial reporting quality of listed food and beverages firms in Nigeria.
- Audit delay has no significant effect on the financial reporting quality of listed food and beverages firms in Nigeria.

REVIEW OF RELATED LITERATURE

CONCEPTUAL REVIEW

Concept of Audit and Audit Quality Attributes

Titman and Trueman (1986) see audit quality as the accuracy of the information reported by auditors. Therefore, audit quality combines the ability of an auditor to detect a breach (auditor competence) and the willingness to report such a breach (auditor independence). Additionally, if auditors appear to lack independence, this increases the perception that they are less objective and therefore less likely to report a discovered misstatement.

An audit is therefore defined by price water house coopers (2013) as the examination of the financial reports of an organization as presented in the annual report, by someone I, ndependent of that organization. The financial reports in the context of audit includes a statement of financial position, an income statement, a statement of changes in equity, a cash flow statement, and notes comprising a summary of significant accounting policies and other explanatory notes. According to the Institute of Chartered Accountant's of Nigeria (2010), an audit refers to a systematic process of objectively obtaining and evaluating evidence in respect of certain assertion about economic actions and events to ascertain the degree of correspondence between those assertions and established criteria and reporting the results to interested parties over a particular period of time. On the other hand, the Institute defined an auditor as a person or audit firm with final responsibility for the audit. In the words of IAASB (2013), an auditor is used to refer to the person or persons conducting the audit, usually the engagement partner or other members of the engagement team, or, as applicable, the firm.

External auditor in this regard refers to independent auditor who is not subject to management control and linked him to independent audit, which refers to the provision of reasonable assurance that published audited financial statements are free from material misstatements and are in accordance with legislation and relevant accounting standards (ICAN, 2010). Adeleke (2021) define auditors as intermediaries between the management of an entity and external parties having interests in the entity. According to them, auditors have a duty to form and express an opinion as to whether or not the financial statements prepared by the management show a true and fair view of the entity's financial position and performance.

The purpose of an audit therefore, is to enhance the degree of confidence of intended users in the financial statements, which is achieved by the expression of an opinion by the auditor on whether the financial statements are prepared, in all material respects, in accordance with an applicable financial reporting framework (ISA, 200). The standard further states that, in the case of most general purpose frameworks, that opinion is on whether the financial statements are presented fairly, in all material respects, or give a true and fair view in accordance with the framework.

However, the concept of audit in this study refers to an assurance engagement that involved objective process of obtaining and evaluating evidence in respect of financial statements, in order to form an opinion that published financial statements are free from material misstatements and intentional errors, and are in accordance with relevant legislation. While an auditor is the person with final responsibility for the audit, who serve as intermediary between the

managers of an entity and external parties having interests in the entity. The interests of those parties is usually accounted for in the financial reports of an entity at the end of each accounting period, which external independent auditors certify. For the opinion of external auditors to be accepted with higher degree of confidence by the users of financial reports, there should be a quality audit work.

The IAASB (2013) stressed that to achieve high quality financial reporting, audit quality is an essential element. The board opined that global financial stability is supported through high quality reporting; and audits can help foster trust in the quality of reporting through audit quality. With this in mind the IAASB developed framework for audit quality that describes in a holistic manner the different elements that create the environment for audit quality at the engagement, firm, and national levels, as well as relevant interactions and contextual factors.

Audit quality is defined by IAASB (2013) as auditors applying a rigorous audit process and quality control procedures that comply with laws, regulations and applicable standards. It encompasses the key elements that create an environment which maximizes the likelihood that quality audits are performed on a consistent basis. These elements are inputs, processes, outputs, interactions, and contextual Factors. The objectives of the Framework for Audit Quality include; raising awareness of the key elements of audit quality; encouraging key stakeholders to explore ways to improve audit quality; facilitating greater dialogue between key stakeholders on the topic (IAASB, 2013). The IAASB framework attributed the primary responsibility for performing quality audits to auditors, and emphasized that audit quality is best achieved in an environment where there is support from other participants in the financial reporting supply chain.

The IAASB expects that the Framework for Audit Quality will generate discussion in the financial reporting supply chain, and positive actions to achieve a continuous improvement to audit quality. Quality audits involve auditors who respond properly to contextual factors. Contextual factors are described as having the potential to impact the nature and quality of financial reporting and, either directly or indirectly, audits quality (IAASB, 2013).

In view of the necessity of audit quality in achieving high quality financial reporting, DeAngelo (1981) conceptualized audit quality to mean the market-based joint probability that a given auditor will both detect material misstatements in the client's financial statements and report the material misstatements. She emphasizes the role of the market in assessing audit quality through financial reporting; however, the willingness to report discovered material misstatements is defined by DeAngelo (1981) as auditor independence. Therefore, according to DeAngelo (1981), audit quality is a function of the auditor's ability to detect material misstatements (auditor competence and auditor independence).

Quality of Financial Reporting

Financial reporting are the product of the accounting system. Tang, Chen and Zhijun (2008) defined financial reporting quality as the degree to which financial statements provide information that is fair and authentic about the financial position and performance of an enterprise. Jonas and Blaurchet (2000) also stipulates that the quality of financial reporting is the complete and unambiguous information that is not designed to misinform users. Baxter and Cotter (2007), defines financial reporting quality as the precision with which financial reports convey information about the firm's operations, in particular its cash flows, in order to inform equity investors. Financial report must contain true, accurate and appropriate information for the purpose

intended for in the right time.

Characteristics of Financial Reporting

Annual report contains financial information which are used by investors, shareholders, creditors and stakeholders which helps in making decisions. This report is prepared by the managers and subject to an audit by professionally qualified auditors who add to the credibility, reliability, relevance and acceptability of the information (Muhammad, Ayoib & Noor, 2016).

The following are the characteristics of financial report in terms of fundamental and enhancing qualitative characteristics underlying decision usefulness as defined by IASB, 2008; relevance and faithful representation, understandability, comparability, verifiability and timeliness.

Relevance simply means the impact of information in the financial report, to the various users and interested parties. It is also the capability of making a difference in the decisions made by users in their capacity as capital providers (IASB, 2008)

Faithful representation means how the condition of the business is reflected accurately. This is measured using neutrality, completeness, freedom from material error, and verifiability (IASB, 2008)

Understandability means the information should be presented so that a reader can easily comprehend it. That is, when the quality of information is meaningful to the users. This can be measured by transparency and clearness of the information presented in annual reports (Courtis, 2005; IASB, 2006).

Comparability is the level of standardization of accounting information that allows the financial statements of multiple organizations to be compared to each other. This is measured by the consistency in use, the accounting policies and procedures from period to period within a company (Beuselinck & Manigart, 2007).

Timeliness refers to the provision of information to users quickly for them to act. That is, having information available to decision makers before it loses its capacity to influence decisions and also the time it takes to reveal the information that is related to decision usefulness in general (IASB, 2008).

THEORETICAL FRAMEWORK

For the purpose of this study, agency theory would be the best theory to be adopted because shareholders of an organization will delegate some duties to the management and this brings about agency theory.

The agency Theory is a common practice in research that explains the relationship between the principal (shareholders) and the agent (managers). The origins of the agency theory can be traced back to Jensen and Meckling (1976) and the discussion of the problem of the separation of ownership and control. They suggested that managers of other people's money cannot be expected to watch over it with the same anxious vigilance one would expect from owners and that negligence and profusion, therefore, must always prevail, more or less, in the management of the affairs of such a company. They defined the relationship between the principals, such as shareholders and agents such as the managers and held that managers will not on their own act to maximize the returns to shareholders unless appropriate governance structures are implemented to safeguard the interests of shareholders. Separation of ownership and control leads to potential conflicts of interest between both parties. This may be because the parties may have different goals, and the managers may not act on behalf of the best interests of the shareholders (Jensen & Meckling, 1976). Gerayli, Yanesari and Ma'atoofi (2011) confirmed that this agency problem leads to the demand for external auditing.

Agency theory supports the delegation and the concentration of control in the board of directors and use of compensation incentives (Yunus, 2011).The

agency theory presents a basis for the governance of firms via different internal and external control mechanisms. These mechanisms are designed to ensure agent-principal interest alignment, protect shareholders' interests and thus reduce agency cost (Martinez, 2010). However, several factors may lead to manipulation, regardless of the kind of relationship between principals and their agents, such as pressure, opportunity and ethics. Therefore, the kind of relationship between principals and their agents may reduce manipulation but cannot eradicate it.

EMPIRICAL REVIEW

Madugba, Howell, Nwanji, Faye, Egbide and Eluyela (2021), in their study, the effect of audit committee quality on the quality of financial reporting of DMBs in Nigeria. A descriptive research design was adopted and secondary data sourced from annual accounts of seven DMBs for seven years were used to test our hypotheses. Descriptive statistics, normality test, a multicollinearity test and regression analysis were used to examine the data. A notable outcome revealed that except for several audit committee meetings held in a given year the other independent variables were found to be insignificant and are not, therefore, determinant of financial reporting quality in DMBs in Nigeria. The study concluded that audit committee quality is not a determinant of financial reporting quality in DMBs in Nigeria and the study recommends that ability should be paramount for the appointment of members to the audit committee and advises that the audit committee should always be given adequate consideration by management in decision making.

Adeleke (2021), the study examined the effect of audit committee characteristics on the quality of financial report of listed financial institutions in Nigeria. The study adopted the correlational research design. The population size was fifty seven (57) financial institutions listed on the Nigerian Stock Exchange as at December 2017. A sample size of forty (40) companies was selected using purposive sampling technique. Data was collected through secondary sources from annual report of selected companies and Nigerian Stock Exchange factbook for the years 2008 to 2017. Data collected was analyzed through descriptive statistics, panel data analysis and pooled ordinary least square regression. The findings of this study show that audit committee size and diversity have significant effects on the quality of financial report. The study therefore, concludes that audit committee components and background profile affect the quality of financial statement. It recommended that the size of the audit committee, diversity among the committee and the experience, area of specialization, expertise among the audit committee should be taken into consideration because it can positively affect the quality of financial statement.

Ibrahim, Abdulazeez and Muktar (2020) in their study, the impact of audit committee on financial reporting quality of listed companies in Nigeria. Cross sectional data was obtained from the Nigerian Stock Exchange fact books and the financial statements of five (5) listed DMBs over a period of six years (2013 – 2018). The modified Jones (2011) model was adapted to measure financial reporting quality. The data was analyzed using STATA 14.0. The study reveals that audit committee independence and audit committee financial expertise has a significant impact on financial reporting quality of listed DMBs in Nigeria. The study concludes that audit committee members' qualifications has an insignificant impact on financial reporting quality of listed DMBs in Nigeria. Based on the conclusion, the study recommends that DMBs in Nigeria should ensure that their boards are independent as this is likely to enhance financial reporting quality.

Bicer and Feneir (2019) carried out a research on the impact of audit committee characteristics on

environmental and social disclosures. Linear Regression Analysis was used in estimating the relationship between predictive and criterion variables and found out that there is no statistically significant relationship between financial expertise on the level of environmental and social disclosure. Thus, while some studies confirm a positive and beneficial relationship of audit committee and performance of the firm, other studies confirm no relation exist.

Eyenubo, Mohamed, Tunku and Safinaz (2017) did an empirical analysis on the financial reporting quality of the quoted firms in Nigeria: does audit committee size matter? The paper examined the relationship of audit committee size and financial reporting quality in Nigeria. Used a sample of 189 companies and 664-year observation from the period of 2011-2015 and panel data regression was adopted. Also, the study found that audit committee size was positive and significant with financial reporting quality.

Onyabe, Okpanachi, Nyor, Yahaya and Mohammed (2018) conducted a study on audit committee meeting, expertise and financial reporting quality of listed deposit money banks in Nigeria. This study examined the effect of audit committee meeting and expertise on financial reporting quality of listed deposit money banks (DMB's) in Nigeria. The study used panel data obtained from the Nigerian Stock Exchange fact books and the financial statements of fifteen (15) listed deposit money banks over a period of ten years (2007-2016). The study used cross sectional and time series research design. The modified Jones (2011) model was adopted to measure financial reporting quality. The data was analyzed using STATA. The study revealed and concluded that the effect of audit committee meeting on the financial reporting quality of listed deposit money banks in Nigeria in model 1 is positive and insignificant while it is negative and insignificant in model 2. Also, the study revealed that the effect of audit committee expertise on the financial reporting quality of listed deposit money banks in Nigeria is negative and insignificant in model 1 while in model 2 it is negative and insignificant.

Research Gap

The result of empirical literature on the relationship audit attributes and financial reporting quality are conflicting, as such necessitate further research despite those conducted in Nigeria and across, as little need to be done to improve the researches to suit the Nigerian context given the differences in technological advancement, level of economic growth, politics, laws, leadership style and level of awareness. Hence, this study covers the period spanning.

METHODOLOGY

The research design employed in this study is the survey design. This is because data are collected from the study subjects. The population of the study comprises of all the twenty one (21) food and beverages firms listed on the floor of Nigerian Stock Exchange (NSE) Market as at 31st December, 2020 and are operating throughout the period of the study (2015-2020). This population is considered apt because the method of data collection requires that only current operation is recognized. However, six (6) firms were filtered out and fifteen (15) firms emerged as the sample of the study. A senior staff member each of the selected firms is requested to supply needed data by filling out the questionnaire. The sampling procedure employed is the simple random sampling procedure. The maximum likelihood estimation (MLE) regression technique is used in this study. Specifically, the study employs the censored or Tobit pooled regression model. The Stata 14 statistical package is used to estimate the parameters of the adopted model. The following

models are specified for this purpose.

FRQ = β0+β1AUDFSZ + β2AUDROT +β3AUDDLY + μ ……. (1)

Where:

FRQ = Financial Reporting Quality

AUDFSZ = Audit firm size

AUDROT = Audit rotation

AUDDLY = Audit delay

β_0= Intercept

β_1– β_3 Parameters

μ = error level incorporating omitted variables

The level of significance adopted in this study is the 5% level of significance which is usually considered adequate for studies in administrative and other behavioural sciences.

DATA PRESENTATION AND ANALYSIS

Descriptive Statistics

Table 1 presents the descriptive statistics. The table shows that each of the variables had maximum rating of up to 4 and a minimum rating of up to 0.

Table 1: Descriptive Statistics.

VARIABLE	Obs	Mean	Std. Dev.	Min	Max	p(Kurtosis)	p(chi^2)
FRQ	15	2.9167	1.2926	1	5	0.0002	0.0000
AUDFSZ	15	2.5167	1.2554	1	4	0.0242	0.0805
AUDROT	15	3.1333	1.2685	2	5	0.2406	0.0356
AUDDLY	15	2.6167	1.1945	1	5	0.0652	0.0960

Source: Researchers' Computation Using STATA 14

Table 1 show that all the variables have approximately the same level of mean values (which can be approximated to 3). Only the simulation analysis has a mean value that is higher than 3. The standard deviations of all the variables are over 1.00. The p-values of the Kurtosis and Chi squared show that the data are significantly normally distributed.

Correlation Analysis

Table 2: Correlation Matrix

	FRQ	AUDFSZ	AUDROT	AUDDLY
FRQ	1.0000			
AUDFSZ	0.1628	1.0000		
AUDROT	0.2653	0.3179	1.0000	
AUDDLY	0.3083	0.3830	0.2357	1.0000

Source: Researchers' Computation Using Stata 14

Table 2 shows that all the variables are positively correlated. The independent variable (audit firm size) has the lowest positive relationship with the dependent variable, while expected audit delay has the highest positive correlation with the dependent variable. The table shows the absence of the problem of auto-correlation because no two variables are perfectly correlated, neither are they nearly so.

Regression Results

Table 4.3 shows that the model is generally significant and well specified (as shown by the p-value of the Chi-square value (0.0137). The Pseudo R^2 value (0.0575) shows that only about 6% of the systematic changes in the dependent variable (Audit rotation effectiveness) can be explained by changes in the explanatory variables taken together. This suggests that there are many other significant factors in the effectiveness of audit rotation which are outside our adopted model.

Ordered Logistic Regression — Number of obs= 60; Prob > chi2 = 0.0137; Pseudo R2 = 0.0575

FRQ	Coef.	Std. Err.	z	P>z
AUDFSZ	0.0169	0.2286	0.07	0.941
AUDROT	0.3846	0.2310	1.66	0.096
AUDDLY	0.4916	0.2355	2.09	0.037

Source: Researchers' Computation Using Stata 14.

Financial Reporting Quality and Audit Firm Size (AUDFSZ): With a coefficient of 0.0169 the results show that financial reporting quality has a positive effect on Audit firm size efficiency. A probability value of 0.941 indicates that the positive effect is insignificant even at 10% level of significance. This leads to the acceptance of the null hypothesis that financial reporting quality has no significant effect on the audit firm size of Nigerian quoted firms. This finding is in line with the finding of Madugba, Howell, Nwanji, Faye, Egbide and Eluyela (2021); Ibrahim, Abdulazeez and Muktar (2020).

Financial Reporting Quality and Audit Rotation (AUDROT): With a coefficient of 0.3846 the results indicates that financial reporting quality has a positive effect on audit rotation efficiencies a P-value of 0.096 indicates that the positive effect is not significant at 5% level of significance. This leads to the acceptance of the null hypothesis that simulation analysis has no significant role on audit rotation of Nigerian quoted firms. This finding is consistent with the findings of Adeleke (2021); Bicer and Feneir (2019).

Financial Reporting Quality and Audit Delays (AUDDLY): With a coefficient of 0.4916 the results show that financial reporting quality has a positive effect on audit delay efficiency. A probability value of 0.037 indicates that the positive effect is significant at 5% level of significance. This leads to the acceptance of the alternative hypothesis that the use of expected financial reporting quality has a significant effect on audit delay of Nigerian quoted firms. This finding is consistent with the findings of Eyenubo, Mohamed, Tunku and Safinaz (2017); Onyabe, Okpanachi, Nyor, Yahaya and Mohammed (2018).

IMPLICATION, CONCLUSION AND RECOMMENDATIONS

Implication of Findings

The findings from this study have implication to the policy makers and auditors. The findings implied that rotation of auditors does not matter with regard the quality of financial reporting. Therefore the regulators concern over the auditor tenure is not a major problem in the listed food and beverages firms in Nigeria. The findings also suggest the engagement of large audit firms in order to achieve a higher quality financial reporting.

CONCLUSION

In line with the findings of this research, the study concludes that audit quality attributes are significant in improving the financial reporting quality of the listed food and beverages companies in Nigeria during the period covered by the study. That is, audit attributes examine in this research has significantly improved the financial reporting quality of listed food and beverages firms in Nigeria. The study specifically concludes that the size of the auditor has significant positive effects on the quality of financial reporting. That is, engaging the services of the big 4 auditors could minimize earnings management and improve the quality of firms' financial reporting of food and beverages firms in Nigeria. Similarly, the study concludes that, auditor rotation has no significant effect on the financial reporting quality of the listed food and beverages firms in Nigeria during the period under review.

RECOMMENDATIONS

Emanating from the findings and conclusions of this study, the following recommendations are considered necessary:

• Regulators of the listed companies in Nigeria should emphasize and encourage the use of audit quality attributes examined in this study; especially the auditor size, audit delay and auditor remunerations. This is with a view to improve the quality of the reports by mitigating earnings management and other unethical corporate practices, which affect the quality of reporting and going-

concern of an entity.

• Regulatory agencies around the world should not emphasize auditor rotation as it appears insignificance in providing higher quality reports in the listed food and beverages firms in Nigeria.

• The regulators and the managements of listed companies in Nigeria should emphasize and employs the services of large reputable audit firms (big 4) as it appears to be positively related with financial reporting quality.

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AUTOMATIC GUIDED VEHICLE SYSTEM: A NEURO-FUZZY ANALYTIC APPROACH

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ABSTRACT

This paper presents an automatic guided vehicle (AGV) motion tracking control system. With the application of neuro-fuzzy control algorithms and the development of electronic technology, AGV is developing toward high speed, high precision, openness, intelligence, and networking, and it also puts forward higher requirements for motion control systems. With the intent to solve the problem of inefficiency and delay in production lines in terms of good delivery in warehouse packaging and the objective of realizing high-speed and high-precision position control, AGV must rely on advanced control strategies and excellent motion control systems. In this paper, according to the requirements of the control system, the embedded microcontroller is selected as the core to design the motion control system. The paper studies the automatic guided vehicle motion tracking control system. The simulation of the motion tracking control of the intelligent robot is performed using MATLAB, the Simulink model as well as the graph showed the AGV could reach the moving goal successfully.

***Keywords*:** Automated guided vehicle (AGV), Motion tracking, control system, obstacle avoidance, Neuro fuzzy controller.

INTRODUCTION

Automatic Guide Vehicle AGV refers to a vehicle equipped with electromagnetic or optical automation devices that can travel on the road with safety and various transmission functions. An automated guided vehicle is a programmable mobile vehicle that follows marked lines or ground wires as programmed, automatic steering vehicles are robots that run on the floor of a facility using a combination of software and sensor management systems, they are the most widely used unmanned aerial vehicles in the industry to move materials around a manufacturing facility or warehouse. AGVs are used in almost every industry, including pulp, paper, metals, newspapers, and general manufacturing. Transfer of material or finished product and storage in a bed is one example of the use of AGV in factories. The AGVs (automated guided vehicles) began as transport devices developed to assist the manufacturing system. In the industrial robotics field, they are defined as transport vehicles driven by a computer system with different mechanical configurations. Earlier inventions on AGVs can be traced back to Barrett Electronics in 1954. It is used to distribute materials in warehouses and to move and operate production facilities between production areas and storage areas. It

consists of different components like cranes and hoists, elevators and lifts, conveyors, robots, automated storage and retrieval systems, torque converters, and so on, which are focused on the process of transferring something from one place to another. Utilization of components, either individually or from a combination point of view, is determined by their application or pre-assigned flexibility. Tracking is one of the most important aspects of AGV control and a prerequisite for completing accurate road tracking work. However, we proposed a linear proportional control of neuro-fuzzy control method efficiency for increased accuracy and productivity, high availability, and reliability report random material handling capability due to the programmability and integrated operation of all AGVs Leobner et al. (2011).

This is an intelligent handling robot which is embedded in the microcontroller board programme of Fuzzy system, which has multiple mounting sensors and controllers. A space for the servo is also left to turn the mechanical manipulator. The robot can turn smoothly in all directions, etc. With the intent to solve the problem of inefficiency and delay in production lines in terms of good delivery in warehouse packaging and the objective of realizing high-speed and high-precision position control, AGV must rely on advanced control strategies and excellent motion control systems. The size of the robot body part is based on the demand of the client, where it adopts intelligent bus servos and supports various controls. Metal gears and imported potentiometers are mounted on the arm of the robot, and the robot has six degrees of freedom in its robotic arms with every joint controlled separately Thylén (2023).

LITERATURE REVIEW

Probabilistic robotics is discussed in Thrun, and Fox (2005), with a focus on topics such as uncertainties and unpredictable changes in environments, sensor limitations, inaccurate robot actuation, modeling errors, and computational limitations for vehicles and robots. They present methods for approaching and solving the problems connected to these topics, and this book was a fundamental informational source for a different paper called A comparison of line extraction algorithms using 2D range data for indoor mobile robotics Rundong et al (2017).

In their paper on Nguyen et al. (2007), an experimental evaluation of different line extraction algorithms from 2D laser scans is conducted. It is a relevant topic given that multiple line segments could create a map that may be used for future navigation. Further on, in the article by Wang et al. (2020), six authors approach the topic of combining the dynamic occupancy grid mapping algorithm with multi-object tracking using a camera in order to reduce the needed computational power even further.

The article on lattice planning is extensively covered by Bergman (2019), and lattice planning is the method used for path planning in this thesis. These authors use different methods to calculate feasible movements. In the paper presented and investigated by Halld´en and Saltvik (2018) called Obstacle circumvention by automated guided vehicles in industrial environments Their approach was to use feature extraction to identify edges and corners to use as reference points. These reference points are then used for path planning. In summary, the problems discussed have been approached before, but in every implementation case, some parameters always differ. Mallikarjuna (2016), The literature discussed gave a lot of different perspectives and approaches to the presented problems, but in this thesis project, a method has been designed by integrating and adapting existing methods into a system to solve this specific problem.

MATERIAL AND METHOD

Automated guided vehicles (AGVs) are being extensively used for intelligent transportation and distribution of materials in warehouses and auto production lines due to their attributes of high efficiency. Such vehicles travel along a predefined route to deliver desired tasks without the supervision of an operator by analytical grade and electronic control sensors. An automated guided vehicle must avoid obstacles efficiency delivery of product to destination.

Depending on the positions of the target or goal and the obstacle(s) relative to the automated guided vehicle, as the automated guided vehicle in figure 1 moves toward the target and sensors detect obstacles, it is important to control the avoiding strategy and motion control of the speed. In this, we use a color recognition sensor to measure the intensity of light reflection by different colors, and a single-track sensor is used to When the detected object appears within the detection range, the infrared ray is reflected with sufficient intensity, and the infrared receiving tube is saturated. The sound sensor is the most sensitive and is used to detect ambient sound intensity.

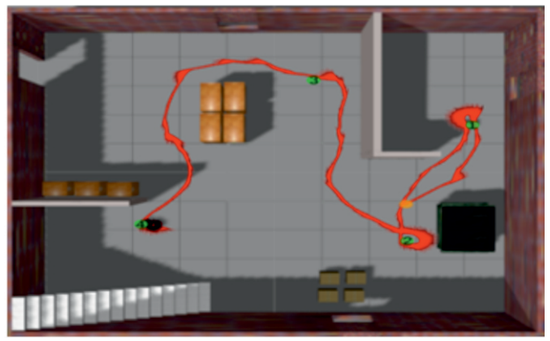


Figure 1 obstacle-avoidance-robot

An ultrasonic sensor protects the automated guided vehicle robot from hitting the wall and measures the distance from the wall or other obstacles. As close as possible to the measured distance, the motion control will achieve its intended goal by looking for an alternative route. When there are barriers or obstacles in the environment, the automated guided vehicle robot's response is based on sensory information about the obstacles and the targeted position. In addition to this, sensors determine if something or an object is in the forward motion of the vehicle. They detect something and respond; the automated guided vehicle robot will pause or find another way based on the program before checking if the obstacle is still present. In this paper, we used the most popular algorithm, the ON and OFF algorithm, as the ultrasonic sensor are fixed in front of the robot. It emits ultrasonic waves and measures the wave reflected from the obstacle surface to give a value corresponding to the distance of the obstacle Rifai (2016).

METHOD

PATH DECISION

The proposed scheme considers a AGVs decisions on path selection. This is done through different methods: frequency select mode (wired navigation only) and path select mode (wireless). Figure 2 shows the motion of the end-effector as the superposition of the base motion and the joint motion, which can be expressed as link 1….link n which been control by manipulator to it direction by joint action of the programme.

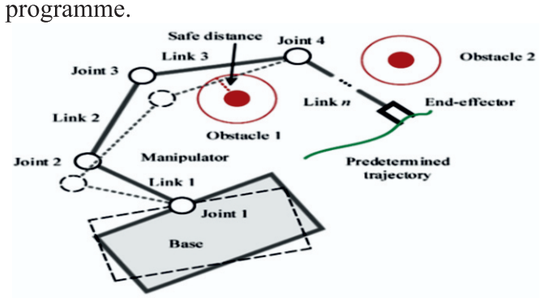


Figure 2 Motion dimensions and a manipulator Hassan et al (2014)

Path select mode: AGV using the path select mode chooses a path based on preprogrammed paths. It compares the measurements taken from the sensors to values given to them by programmers. When an AGV approaches a decision point, it only has to decide whether to follow paths 1, 2, 3, etc. This decision is rather simple since it already knows its path from its programming. This method can increase the cost of an AGV because it requires a team of programmers to program the AGV with the correct paths and change the paths when necessary this method is easy to change and set up.

CONTROLAND AUTONOMOUS DESIGN

Model-Based Design is a mathematical and visual approach for developing complex autonomous and control systems, enabling you to use digital models from design, analysis, and simulation to automatic code generation and verification. Figure 3 is a controller model-based design in automated material handling applications like pick-and-place, motion control, autonomous algorithms with AI, and vibration suppression for a robot arm, AGV, stacker crane, and more. Through virtual prototyping, you can also analyze system performance before the manufactured hardware is available for testing.

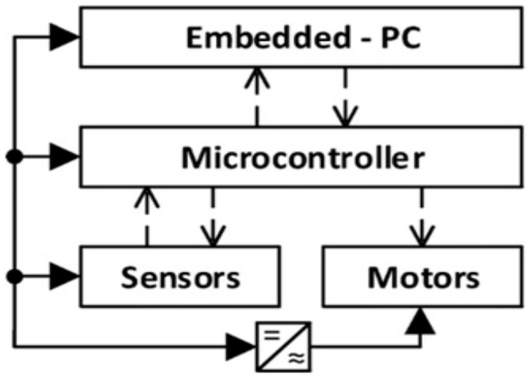


Figure 3 Architecture of an automated guided vehicle in terms of the electrical power distribution

TRANSMISSION MODEL OF AGV GRADING

The transmission is made up of several planetary gear sets. A **planetary gear** (also known as an epicyclical gear train) consists of two gears mounted so that the center of one gear revolves around the center of the other. Figure 4 is a carrier connects centers which show case with two gears and rotator arm, which controls the programming of the node, called the planet gear or planet pinion,

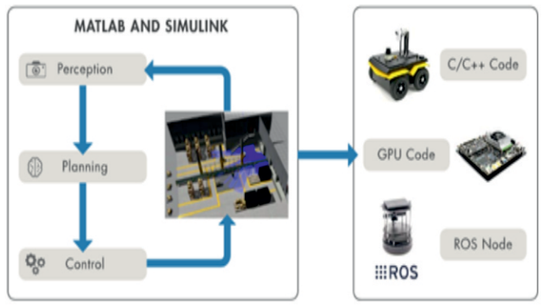


Figure 4 transmission model of AGV grading

IN-VEHICLE (OPPORTUNITY) CHARGING:

Automatic and opportunity battery charging allows for continuous operation. On average, an AGV charges for 12 minutes every hour for automatic charging, and no manual intervention is required. If an opportunity is being utilized, the AGV will receive a charge whenever the opportunity arises. When a battery pack gets to a predetermined level, the AGV will finish the current job that it has been assigned before it goes to the charging station.

AGV MODEL

Typically, AGVs are operated using differential drives. These are characterized by two wheels on the same axis that are powered separately, which controls speed and direction. Figure 4 shows the resulting movements of an AGV as a function of the speed of the left wheel v_l and the right wheel v_r. The speed of the AGV can be specified for both the translational speed v and the Angular speed ω depending on the

two wheel speeds as

$$V=\frac{V_R+V_l}{2}$$

$$\omega=\frac{V_R+V_l}{lAGV}$$

Were L.AGV the gauge of AGV for rotational speed of AGV which be converted to

$$V=\frac{\varphi}{\frac{1}{2}lAGV}$$

Into a translatory speed in the system

navigation only) or via a magnetic tape on the floor, not only to guide the AGV but also to issue steering commands and speed commands.

The transmission consists of a torque converter, a planetary gearbox, and a differential. The torque converter is connected to the engine on the impeller side and to the gearbox input shaft on the turbine side. Figure 5 is analytical role of the torque converter is to allow the engine to be disconnected from the gearbox at standstill and assure a linear, smooth engine coupling with the gearbox at vehicle launch. The torque converter also acts as an engine torque amplification device, especially at high speed slip ratios.

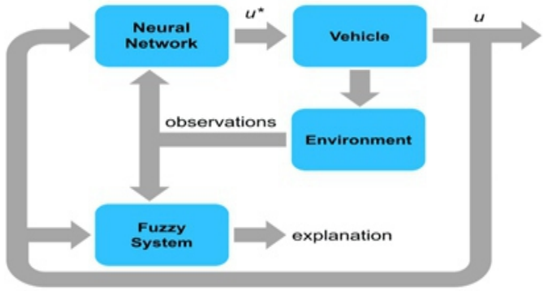


Figure 5 Simulation model of AGV

MODEL COMPONENTS AND SYSTEMS

With physics-based models built in Simulink and Simscape, you can generate synthetic fault and degradation data, identify the best sensors, and simulate future performance. Create or repurpose Simulink and Simscape models of components and systems. Tune model parameters to match real-equipment performance. Generate synthetic fault and degradation data for training predictive algorithms.

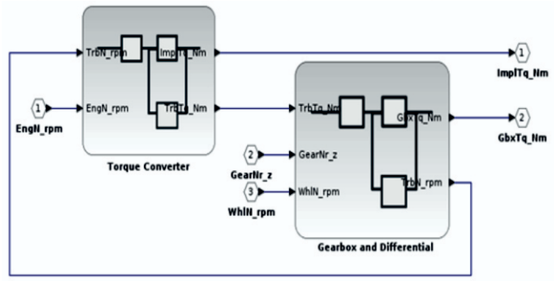


Figure 6 Model of AGV control system

Shorten response times, transmit less data, and make results immediately available to operators by implementing your MATLAB algorithms on embedded devices and in enterprise IT/OT systems that incorporate the rules.

- Eliminate hand-coding by generating code in MATLAB for real-time processing directly on assets and edge devices.
- Scale MATLAB algorithms by integrating with a variety of cloud platforms, recoding, or creating custom infrastructure.
- Creating a reliable predictive algorithm: access, clean, and explore data, then use predictive algorithms. Get started quickly with application-specific functions and reference examples.
- Access streaming and archived data using built-in interfaces to cloud storage, databases, data historians, and industrial protocols.
- Extract and rank time-domain, frequency-domain, and application-specific features with the Diagnostic Feature Designer.
- Identify faults and predict time-to-failure using low-code AI, statistical, and model-based methods of neuro-fuzzy for AGV applications.

RESULT AND DATA ANALYSIS

Perception and localization Enable robot vision to build environment maps and localize your mobile robot. Develop mapping, localization, and object detection applications using sensor models and

prebuilt algorithms so your mobile robot can learn its surroundings and location. With MATLAB, a torque converter is used, with the following performance and torque coefficient characteristics:

where:

i_{tc} [-]-torque converter speed ratio

k_{tc} [-]– torque converter torque coefficient

λ_{tc} [-] – torque converter performance coefficient

The torque converter torque and performance characteristics function of the speed ratio are displayed in graphical format below.

Gearbox and Differential

The governor equations of the gearbox model in the model is

T_g [Nm]- gear box torque, i_x [-] -gearbox ratio η_x [-] =gearbox gear efficiency

The gear ratio and gearbox efficiency in each gear are displayed in the table and images below.

Gear [-] Nm	i_x [-] Ratio	η_x [-] Efficiency
1	4.381	0.930
2	2.860	0.948
3	1.917	0.973
4	1.363	0.987
5	1.000	1.000
6	0.822	0.987
7	0.731	0.987

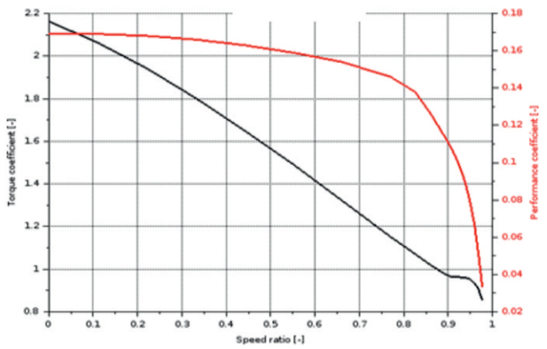


Figure 7: Modules for translatory movement regarding

Figure 7 shows the three identified movement modules for translatory movement regarding the electrical power consumption of $P_{AGV,el}$. These are acceleration, rolling at constant speed, and finally braking to a standstill. For braking, it must be considered that negative power may occur for individual runs. This power can generally be used for recuperation in order to recharge the accumulator.

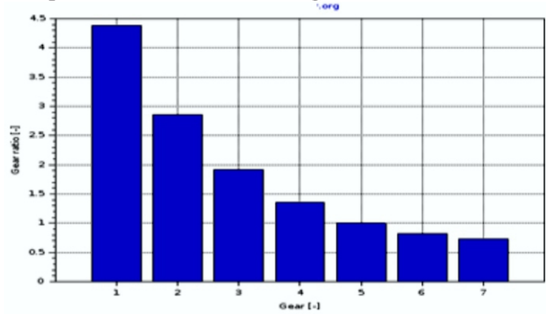


Figure 8 speed variation of the AGV

In order to analyze the relationship between speed and time in terms of its impact on energy efficiency, it is necessary to consider energy consumption. For this purpose, Fig. 8 shows the respective energy requirements at varying speeds and payload weights. It can be seen that an increased payload weight leads to a general rise in energy consumption, as can be seen from the increasing power. Furthermore, it can be seen that an increase in speed with a constant payload leads to a lower energy requirement. This is mainly due to the shorter driving time. It follows that an AGV is most efficient when it is operating at its maximum speed. Although this leads to an increased power requirement, the energy consumption is reduced by saving driving time, as pictured in

CONCLUSION

Automated guided vehicles often share factory distribution of product and roadways, and safety systems are up to the task. Naturally, our AGV systems are relevant for good and service. Feedback systems with the most modern and standard components, additional safety features integrated to meet site-specific needs. Hence, it was concluded that AGVS plays a major role in engineering industries for mass production factories with large areas to improve the material handling technique at a faster rate, increase efficiency, and minimize transportation costs and time.

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BACTERIAL EXAMINATION OF USED MICROPHONES IN PUBLIC PLACES: A CASE STUDY OF YENAGOA METROPOLIS

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ABSTRACT

Microphones are commonly used in public gatherings. Bacterial contamination of microphones is a major health hazard because it aids the transmission of different diseases among users. The study was designed to examine bacteria on used microphones among social gatherings in Opolo, Bayelsa State, Nigeria. A total of 40 microphones were randomly sampled. Each microphones sampled were swabbed with swab sticks and were transferred into EDTA bottle containing a normal saline for bacteriological analysis, following a standard method. The Bacteria identified were Escherichia coli, Pseudomonas aeruginosa, Bacillus cereus, Streptococcus sp. and Staphylococcus aureus. Staphylococcus aureus (54%) was highly isolated, followed by Bacillus cereus (26%), Streptococcus sp (10%), Escherichia coli (6%) and Pseudomonas aeruginosa (4%). Staphylococcus aureus was highly prevalent on uncoated microphones at worship centers than social gatherings, followed by Bacillus cereus. The results shows that public microphones are contaminated with pathogenic bacteria. Therefore, personal hygiene on the use of public microphone must be adopted to avoid contracting of diseases.

***Key word**: Bacteria, Contamination, Microphone, Social gatherings, Worship centers*

INTRODUCTION

Microphones are among the most commonly touched surfaces instrument, and are commonly used in worship centers, schools, seminars, ceremonies, public gatherings etc. Bacterial contamination of microphones is a major health hazard and plays an important role in the transmission of different diseases in public gatherings, schools and churches (Osita *et al.,* 2019). Bacteria can be transfer from one place to the other, through air and can be found on surfaces with human contact. Roxburgh (2005) demonstrated that bacteria can be readily transferred from hands to almost any frequently used surfaces. Scientific research has shown that commonly used surfaces are potential sources of infectious bacteria leading to the spread of disease (Reynolds *et al.,*

2005).

The human part mostly associated with the microphone is the mouth and the hand. Majority of infection (Chandra *et al*.,2014) are spread through the hand and mouth contact with surfaces. Rusin *et al., (*2002), in a recent work stated that hard nonporous surfaces have the highest bacteria transfer rates to hands. The mouth is always in contact with the surfaces of a microphone at social meetings. This organ of the body carries oral bacteria that can be spread to the microphone surface. This part of the body is associated with certain diseases caused by oral bacteria (Petersen *et al.,* 2005). Diseases of the oral cavity continue to be a major human health issue all over the world (Petersen*, et al.,* 2005).

Many factors have been shown to influence the bacterial transfers between surfaces, including the source and destination surfaces feature. Studies have also shown that electronic surfaces can easily be contaminated with bacteria and can easily be transferred to hands and from hands to other part of the body (Rusin *et al.*, 2002; Bloomfield, 2000). As people come in contact with electronic or other surfaces like microphones, desks, keyboards, office furniture, lock handles etc, there is the possibility of picking up microbes deposited on them (Bashir *et al*., 2016). Microorganisms have been recorded to involve in moisture levels, pressure and friction between contact surfaces (Chen *et al*., 2002; Rusin *et al.,* 2002). Various bacteria have been isolated from public surfaces there by providing information on the relative hygiene of commonly encountered surfaces. Thus, with respect to literature that points out dangers associated with disease transmission through surfaces, the present study aimed at isolating and identifying bacterial contaminants present on used microphone in public places Opolo, Yenagoa, Bayelsa State, Nigeria.

MATERIALS AND METHODS:

STUDY AREA

The study was carried out in Opolo, Bayelsa state. It is geographically located between latitude 4° 47‟ 15‟ and 5°11‟ 55” North and Longitude. 6°07‟35” and 6°24‟00” East

SAMPLE COLLECTION

A total of 40 microphones were sampled randomly from worship centers and social gatherings. Twenty (20) microphones were collected from worship centers and 20 from social gatherings within Opolo, Bayelsa State, Nigeria. Two (2) microphones each were collected per worship center social gatherings. Each microphones collected were swabbed with the aid of sterile swab sticks moistened with 0.85% normal saline. The swab sticks were transferred into a sterile sample collection bottle containing a normal saline in an ice-bag and transported immediately to the Microbiology Laboratory of Niger Delta University, Amassoma , Bayelsa State for bacteriological analysis, following a standard method described by Cheesbrough, (2000, 2005 and 2006). The worship center sample locations are designated as 1,2,3,4,5,6,7,8,9,10 and 11 while social gatherings sample locations are designated as A, B, C, D, E, F, G, H, I, J and K.

CULTURAL TECHNIQUES

Microbial counts were enumerated by duplicate plating of 1mL serially diluted sample solution from 10^{-3} dilution factor, each from worship centers and social gatherings sampled, onto a prepared 20ml Nutrient Agar plate and was incubated at 37°C overnight. Different positive growth colonies from the microphone sample were randomly isolated based on their morphology and colors, for presumptive Bacteria. These randomly selected isolates were each streaked for purity into the prepared agar plates and incubated at 37°C to obtain pure Bacteria culture for identification.

MICROSCOPIC EXAMINATION AND IDENTIFICATION

Gram staining of positive isolates were carried out to differentiate gram positive bacteria from gram negative bacteria. Microscopically; gram positive bacteria still retain the purple color of the stain with cluster shaped, while gram negative bacteria had pink coloration with rod like shape. This was followed with biochemical test to identify the bacteria species associated with the sample microphones. The biochemical test used was Catalase test, Indole test, Lactose test and Coagulase test to identify presumptive bacteria species.

STATISTICAL ANALYSIS

Bacteria load was counted and recorded. Measure of spread was also calculated to determine their mean and standard deviation to take care of errors from sample results. The statistical tools SPSS (19 version) was used. A complete randomized design (CRD) one way classification ANOVA was used to test for significant ($P < 0.05$).

RESULTS AND DISCUSSION

Table 3.1 shows the Bacterial count recorded in the microphone's samples collected from Worship centers and social gatherings. The bacteria count recorded in the worship centers from uncoated microphones ranges from 2.4 – 3.1 x 10 ^{3}CFU/ml, while those from coated microphones ranges from 2.0 – 3.2 X 10^{3} CFU/ml. Microphones collected from social gatherings had bacteria count ranged from 2.8 - 4.8 X 10^{3}CFU/ml, from the uncoated microphones, while those coated had bacteria count range from 2.3 - 3.7 X 104 CFU/ml. A significant statistical difference ($p < 0.05$) between worship centers and social gatherings were recorded for the bacteria count. The bacteria count for uncoated and coated microphones of the control sample ranges from 1.2-1.4 x 10^{3} and 1.3 – 1.6 X 10^{3} CFU/ml as presented in

Table 3.1.

Bacterial Count of all Sampled Microphones and their Sample Locations

Worship Centers in Opolo			Social Gatherings in Opolo		
Sample Code	Rep.1 Uncoated mic. (10^3cfu/ml)	Rep.2 Coated mic. (10^3cfu/ml)	Sample Code	Rep.1 Uncoated mic. (10^3cfu/ml)	Rep.2 Coated mic. (10^3cfu/ml)
1	2.4	2.0	A	3.7	3.1
2	2.8	2.2	B	2.9	2.3
3	3.5	2.4	C	3.7	3.2
4	2.7	2.2	D	4.5	3.6
5	3.4	3.1	E	2.8	2.2
6	2.5	2.1	F	4.0	3.7
7	3.9	3.2	G	3.8	3.5
8	3.7	3.0	H	4.8	3.7
9	2.8	2.3	I	4.2	3.0
10	3.0	2.3	J	3.9	3.4
11	1.2	1.4	K	1.6	1.3

KEY: Rep=replicate

Results for the morphological and biochemical characteristics (Table 3.2) for all the pure isolates showed that *Escherichia coli, Streptococcus sp, Staphylococcus aureus, Pseudomonas aeruginosa and Bacillus cereus* were present. A total of five bacteria were identified, comprising of 5 families. These bacteria identified were mostly from the family *Enterobacteriaceae (Escherichia coli), Pseudomonadaceae (Pseudomonas aeruginosa), Bacillaceae (Bacillus cereus), streptococcaceae (Streptococcus sp)* and *Staphylococcaceae (Staphylococcus aureus)*. Some of these bacteria identified are normal flora or oral bacteria, opportunistic bacteria and some are pathogenic bacterium.

Morphological and Biochemical Characteristics of the Identified Bacteria

Parameter (Colony Morphology)	Characteristics				
	Colorless Colony	Colorless Colony	Creamy Yellow & Circular	Light Green Colony	colorless & circular
Gram reaction	- Rod	+Rod	+ cocci	- Rod	+ cocci
Elevation	Convex	Convex	Convex	Umbonate	Convex
Margin	Entire	Entire	Entire	Undulate	Smooth
Shape	circular	Circular	Irregular	Circular	Circular
Biochemical Test					
Cat.	–	+	+	–	+
Ind.	+	+	–	-	-
Lactose	+	+	+	-	+
Beta heamolysis	-	+		+	+
Identified Bacteria	*Escherichia coli*	*Streptococcus Sp*	- *Staph. aureus.*	*Pseudomonas aeruginosa*	*Bacillus Cereus*

-=Negative. += Positive. Cat= Catalase. Ind= Indole. Lac=Lactose.

Percentage (%) frequency of the identified bacteria on the surfaces of used microphones from worship center and social gatherings as recorded in Table 2.3.

Results showed that potential bacteria are associated with surfaces of the microphones. *Staphylococcus aureus* was highly isolated from both worship center and social gatherings. Its percentage prevalence on uncoated microphone was 60%, while for coated microphones was 30% from worship center. *Staphylococcus aureus* was also observed to have higher percentage prevalence from microphones samples from social gatherings for uncoated (70%) and coated (40%) microphones. The second prevalent bacterium was *Bacillus cereus* which has percentage prevalence 30% for both coated and uncoated microphone samples from worship center. It was recorded 70% prevalence rate from uncoated microphone as against 40% coated microphones samples from social gatherings. *Streptococcus sp.* was the third abundant bacterium isolated from the microphones. It recorded 10% prevalence rate as against 20% for uncoated and coated microphones respectively for worship centers and 10% for both coated and uncoated in social gatherings. The remaining bacteria recorded the least prevalence rate in their respective samples collected with a maximum of 10% prevalence rate. The least prevalence rate was observed with *Pseudomonas aeruginosa.*

Percentage Frequency of the Involving Bacteria Identified.

Identified bacteria	Microphones from worship centers 10:10:5			Microphones from Social gatherings 10:10:5			Total (%) prevalence
	Uncoated	Coated	Control	uncoated	Coated	Control	
Escherichia coli	-	1 (10%)	-	1 (10%)	1 (10%)	-	3(6%)
staphylococcus aureus	6 (60%)	3 (30%)	4(80%)	7 (70%)	4 (40%)	3 (60%)	27(54%)
Streptococcus sp	1 (10%)	2 (20%)	-	1 (10%)	1 (10%)	-	5(10%)
Pseudomonas aeruginosa	-	1 (10%)	-	-	1 (10%)	-	2(4%)
Bacillus cereus	3 (30%)	3 (30%)	1(20%)	1 (10%)	3 (30%)	2 (40%)	13(26%)

DISCUSSION

Microphones are of the most commonly touched surfaces today. In this study, the microphones examined were contaminated with a considerable number of Gram positive and Gram negative bacteria and this is in agreement with the research findings of Adamu *et al.,*(2012) and Catano *et al., (*2012) who obtained Gram positive and Gram negative bacteria from surfaces such as banknote, computer keyboards, curtains, cell phones, white coats and ties respectively. A significant statistical difference ($p < 0.05$) was recorded between those collected from worship center and social gatherings. The results obtained from this study revealed high level of bacterial contaminants on microphones collected from social gatherings than worship centers.

Result obtained also revealed that microphones are contaminated with considerable number of pathogenic bacteria most of which are Gram-positive and negative bacteria. The study showed that *Escherichia coli, Streptococcus sp, Staphylococcus aureus, Pseudomonas aeruginosa and Bacillus cereus* are the main bacterial isolates frequently associated with the microphones. There was a variation in the number of positive samples from one worship center to another and social gatherings to another. This variation in the number of positive samples from one place to another is likely to be as a result of the differences in hygiene and sanitary conditions in the environment. The bacteria may have found their way onto the surfaces through cross contamination, poor personal hygiene of the users, diseases spreading vectors. These organisms may probably have their way to the microphone handles through the skin and hand-to-hand contacts.

Findings from this study revealed *Staphylococcus aureus* to be the most frequently occurring isolate with the percentage occurrence of 60% on uncoated microphone, 30% for coated microphones from worship centers, 70% from uncoated microphones and 40% from coated microphones collected from event centers. This was found to be in agreement with the findings of Oluduro *et al.* 2011 who reported *Staphylococcus aureus* (35.8%) as the frequent bacteria contaminant of electronic hardware in Ile-Ife. *Staphylococcus aureus* is a normal flora and can

be picked up easily from any contacted surface both indoor and outdoor.

In a society of low hygiene, this probably explains its preponderance as a bacterial contaminant of surfaces. *Staphylococcus aureus* has also been associated with various infectious disease conditions and nosocomial infections. Since users constantly touch interfaces, there is every chance of introducing *Staphylococcus aureus* onto the interface in use. *Staphylococcus aureus* that was isolated from the samples is a major component of the normal floral of the skin and nostrils. This probably explains its high prevalence as a contaminant, as it can be easily discharged by several human activities including sneezing, talking, and contact with moist skin (Itah and Ben, 2004). This observation is in conformity with the finding of other researchers (Brooks *et al.,* 2007; Nworie *et al.,* 2012). It has also been associated with numerous infectious disease conditions such as boils, abscesses, wound infections toxic shock syndrome and pimples. It follows that since users constantly touch interface and often sneeze, there is every chance of introducing *Staphylococcus aureus* on to the interface in use. Also, airborne organisms can be transported from users to passerby.

Bacillus sp. was the second most prevalence bacteria isolated from the findings in this research, and their presence could be explained by the fact that *Bacillus sp*. are also ubiquitous in nature with their spores able to resist environmental changes, withstand dry heat and certain chemical disinfectants for moderate period. *Bacillus cereus* has percentage prevalence 30% for both coated and uncoated microphones samples from worship centers. It also recorded 70% prevalence from uncoated microphone as against 40% coated microphones samples from social gatherings (Table 3.3). This finding is in agreement with the research carried out by Datta *et al.,*(2009) who reported that large number of *Bacillus sp.* was transferred from fingertips or hands touching inanimate surfaces. Samy *et al.* (2012) also reported the isolation of *Bacillus sp* from environmental objects.

The isolation of *streptococcus* sp. from this study was in conformity with the work of Opera *et al.,* (2013) who reported the isolation of *streptococcus*sp. from surfaces. Gram-positive cocci isolated in this study indicate the possibility of the presence of oral infection on microphones surfaces. *Streptococcus spp.* was the third abundant bacterium isolated from the microphones. It recorded 10% prevalence as against 20% for uncoated and coated microphones respectively for both worship centers and social gatherings. This might be due to the fact that most people sneeze or spit on the surfaces while speaking in worship centers and social gatherings. Users fail to adhere to oral hygiene because they take the issue of hygiene with levity, they also lack the concept of face masked as a simple means of stopping this spread of infectious agents. *Streptococcus sp*. occurs as physiological flora in the oral cavity and intestines of humans and animals. In addition, they often inhabit the skin, throat, and upper respiratory tract. However, numerous *streptococci* occur as opportunistic pathogens, causing infections in the case of weak immunological response of the host body they occupy. Pathogenic *streptococci* may be those commonly causing infections in humans, and commensally and epizootic species which cause disease symptoms under specified conditions (Cole *et al.,* 2008).

The isolated gram negative bacteria *E. coli* and *pseudomonas erogenous* identified from sample microphones were not significantly high compared to the other bacteria strain isolated. These bacteria recorded the least prevalence in their respective sample collected with a maximum of 10% prevalence. *E. coli* is a normal floral bacterium that is associated with fecal contaminated substances. The microphones might have been handled with

contaminated fecal source. Gram negative sepsis, urinary tract infections are most commonly caused by *E. coli. Escherichia coli* is the most important pathogens and one of the leading causes of gastroenteritis, typhoid fever in developing countries like ours where safe drinking water and basic sanitation is lacking with high morbidity and mortality rate. The occurrences of *E. coli* on microphone surfaces was in accordance with the work of Amala *et al*., (2015) who reported the isolation of related gram negative bacteria strain from surfaces.

Pseudomonas aeruginosa was the least isolated from all the sampled microphones. The involvement of this pathogen has numerous implication to human health, thank God for the uses of face masked today. *Pseudomonas aeruginosa* is a common bacterium, Gram-negative opportunistic pathogen capable of infecting humans with compromised natural defenses and causing severe pulmonary disease (Driscoll *et al.,* 2007). It has a vast arsenal of pathogenicity factors that are used to interfere with host defenses. Pathogenesis in *P. aeruginosa* facilitates adhesion, modulate or disrupt host cell pathways, and target the extracellular matrix (Sadikot *et al.,* 2005). The propensity of *P. aeruginosa* to form biofilms further protects it from antibiotics and the host immune system. Infections caused by *Pseudomonas species* include endocarditis, pneumonia, and infections of the urinary tract, central nervous system, wounds, eyes, ears, skin, and musculoskeletal system. *P. aeruginosa* can cause infection in almost any part of the body, although it does not typically cause infection in a healthy host. People who are most susceptible to *P. aeruginosa* infections are those whose mucous membranes or skin have become compromised such that they no longer serve as a physical barrier to infection (Safdar *et al.,* 2005).

The emergence of these bacteria might be possibly related to the number of users, frequency of using, the surrounding that is unhygienic, the type of people using, also the lack of sanitary measures applied to the handling of microphone and the used of face marks i.e., This is in accordance with the work of Boone and Gerba (2010), who also reported that the level of contamination varies depending on the traffic exposure and the environment.

CONCLUSION

The findings of this study showed that microphones can aid in the spread of microorganisms between individuals and among groups at large. Pathogenic bacteria isolated from microphones in this study indicate that microphones can be vehicles for disease transmission.

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BANKING, SHAREHOLDERS' EQUITY RETURNS AND CORRUPTION PERCEPTION IN NIGERIA

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ABSTRACT

The study investigates the nexus between shareholders' return on equity in the banking industry and corruption perception in Nigeria. To achieve this, the study employed ex post facto research design and further used historical data spanning 1996 to 2020. The data was analysed and estimated using descriptive statistical tools and error correction technique. The findings indicate that corruption (corruption perception index), total deposit of deposit money banks and non-performing loans of deposit money banks collectively had negative and significant impact on shareholders' equity returns from deposit money banks in Nigeria. Consequently, the study concludes that the perception of corruption has a negative and significant relationship to the return on equity of deposit money banks in Nigeria. This further affirms the "sand the wheel hypothesis" which states that corruption has a devastating effect on growth and performance. On this premise, the study recommends that regulatory authorities and the relevant institutions established to fight corruption including the Central Bank of Nigeria (CBN), Nigeria Deposit and Insurance Corporation (NDIC), Securities and Exchange Commission (SEC), National Insurance Commission (NAICOM), Economic and Financial Crimes Commission (EFCC), Independent Corrupt Practices and Other Related Offences Commission (ICPC) among others, to ensure the enforcement of various legal provisions in the fight against corruption in Nigeria.

***Keywords*:** banking industry, corruption, deposit money banks, returns on equity.

INTRODUCTION

A country's economic progress depends on a strong financial system and a healthy banking system is an important part of it. A well-functioning banking system aids economic growth and poverty reduction, but a poorly-functioning banking system can stymie economic progress (Nzotta, 2014). Global economic issues have afflicted practically every industry in the twenty-first century, including the financial sector, of which banking is a major component (and in fact, arguably suffered the most). In the previous two decades, 465 banks have closed in the United States. Following the 2016 - 2018 recessions, Nigerian banks suffered as well, leading to the formation of Polaris Bank to take over Skye Bank's operations and assets (Kano, Tsang & Yeung, 2020).

From the 2009 intervention that created the Asset Management Corporation of Nigeria (AMCON) to

the aforementioned rescue of Skye Bank, the Central Bank of Nigeria (CBN) has been quick to bolster the sector (Central Bank of Nigeria, 2009). Despite these efforts, the banking system in Nigeria is yet to achieve full stability. One of the looming issues is the issue of non-performing loans (NPLs), which are the result of non-compliance with lending policies and prudential guidelines, both of which are offshoots of unethical practices. When a borrower fails to make any interest or principal payments for a specified/statutory time, usually ninety days, the loan is deemed non-performing. According to the National Bureau of Statistics (NBS) report from June 2019, Nigerian banks have a lot of these: 1.4 trillion naira or around 9% of total loans in the economy. Given that lending out loans and generating interest on them is a bank's fundamental business activity, Nigerian banks' refusal to do so is concerning and has hurt profitability (National Bureau of Statistics, 2019). The oil and gas sector, which Nigerian banks have historically favoured but has suffered since the 2014 oil price crisis, accounts for up to 40% (577 billion naira) of these NPLs (Central Bank of Nigeria, 2009).

However, banks are not the only ones who suffer from high NPLs; the entire economy suffers as well. Banks have become risk apprehensive and aware of their low asset quality, causing them to focus more on debt recovery, making it difficult for borrowers to obtain new credit. Many Nigerian people and small businesses struggle to obtain reasonably priced loans, and their situation is worse when a bank is risk adverse due to a large number of failed loans on its books. This tendency is undoubtedly due in part to the rising rate of corruption in emerging nations, which is higher than in industrialized economies. This is due to increased formal institutional failure, which results in inconsistencies between formal and informal institutions (Escandon-Barbosa, Urbano-Pulido&Hurtado-Ayala, 2019).

Corruption in banks can occur for a variety of reasons: entities can bribe politicians (for example, by skipping loan approval procedures to receive loans), banks can bribe politicians, and so on (e.g. to obtain regulatory forbearance). One possible outcome is the misallocation of loanable funds from good to bad projects, which usually leads to an increase in corruption (Badullahewage, 2019).As a result, an increase in the number of bad loans could lead to a decrease in the competitiveness of private investment, which could lead to slower economic growth. While a country with a highly corrupt governmental sector is more likely to have a highly corrupt financial sector, corruption in the banking industry does not always result in bad loans (Anaere, 2014). For example, a borrower with a successful project can bribe a loan officer to save time by circumventing the standard loan evaluation procedure. In this circumstance, the likelihood of completion can improve as a result of the timely completion of the project, according to Mauro (1995) for a similar reason for "speed money." Even if a poor project borrower obtains funding through corruption, no one can predict whether the financed project would eventually fail or succeed, but the chances of success are minimal.

Several studies have looked at the causes of shareholders' equity performance in the banking sector in order to improve it, but only a few have focused on corruption as an explanatory factor, with mixed results as to whether corruption is a fundamental determinant of banking sector performance (Ali, Fhima & Nouira,2020; Mongid & Tahir, 2011; Son, Liem & Khuong, 2020; Anaere, 2014; Kereke & Kurotamunobaraomi, 2016; Yakubu, 2019; Badullahewage, 2019; Chen, 2014; Udeh & Ugwu, 2018). Controlling for corruption would play an important effect on company performance, according to well-documented empirical studies. The findings of the empirical review imply that

corruption has the potential to boost profit margins and stock market development, or to cause them to deteriorate.

Although the “greasing the wheel” of corporate performance theorem appears to be an exception, research suggest that corrupt activities promote transactional processes and corporate performance in societies with low institutional governance. As a result, the review found that corruption has a positive impact on corporate profitability and capital market performance (Kereke & Kurotamunobaraomi, 2016; Mongid & Tahir, 2011; Ali et al., 2020; Ayaydn & Hayaloglu, 2014; Omodero & Dandago, 2018; Mai, 2020; Ming, 2018; Khan, Chaudhary, & Arshad, 2020; Asaad & Marane, 2020). Furthermore, a comprehensive examination of the literature revealed that corruption and corrupt behaviors "sand the progress wheel." This rule out the idea of 'positive corruption' fostering economic growth and improving bank performance. There is a negative association between corruption and the performance of deposit money institutions, according to existing studies (Anaere, 2014; Ojeka, Adegboye, Adegboye, Umukoro & Dahunsi, 2019; Yakubu, 2019; Aburime, 2009; Park, 2012; Ayaydn & Hayaloglu, 2014; Udeh & Ugwu, 2018).

The preceding discussion of empirical discourse on the topics of corruption and corporate performance indicates that findings and conclusion are not in agreement. This is exacerbated by the fact that the subject's theoretical underpinnings remain elusive. As a result, additional empirical researches are needed to improve our understanding of the consequences of corruption and the need of appropriately controlling it. Despite the large number of research on the influence of corruption on an economy, the findings have not been consistent. Existing research findings have not established an agreement on the type and direction of corruption's economic impact. This piques people's interest, especially in Nigeria, where the threat of corrupt practices continues to develop at an alarming rate. Even while empirical research on corruption and economic growth abound in the existing literature, there is still a large gap or vacuum to be filled, which this study aims to fill. Corruption has an impact on every aspect and industry of society, particularly the financial sector. For example, in Nigeria, there has never been a research on corruption and the performance of deposit money banks.

LITERATURE REVIEW

In order to examine the influence of corruption on banks' deposit mobilisation push in Nigeria, Babajide, Lawal, Amodu, Asaleye, Ewetan, Olokoyo andOluwatoyin (2020) discussed the short- and long-term linkages between bank net interest revenue and deposit liabilities associated to corruption. The study looked into the causal relationship between the bank variables chosen and fraud. On chosen variables, the analysis used quarterly data from the first quarter of 1993 to the fourth quarter of 2017. Separate bank deposit liabilities were connected with a corruption index and utilised as independent variables, while bank revenues were employed as the dependent variable, the Error Correction Paradigm and Engel Granger's co-integration technique were used to analyse the data. The findings indicate that various bank deposit liabilities that are connected with the corruption index have a long-term negative impact on bank profitability, but only corrupt fixed deposits are statistically significant. Total bank assets, total deposits and advances, and fraud all have a significant impact on bank profitability. The findings also show that dishonest fixed deposits and demand deposits benefit banks in the short run.

The impact of corrupt practises on financial hardship and banking sector crises is investigated by Ali et al (2020). For the years 2000 to 2017, panel data was collected from 38 nations. To do so, a dummy

variable (1) was used to represent moments of crisis and a dummy variable (0) was used to indicate periods of stability. While the independent variables used to gauge bank performance were net interest margin (a proxy for determining whether lending operations are efficient or not) and return on account. NIM has a favourable effect on banking crises, according to the calculated panel regression model. This was discovered to have a higher impact on banking sector instability than the measure of pro-cyclicality.

Yakubu (2019) wanted to know if corrupt activities boost bank performance in Ghana, a West African country. To do so, panel data from 11 deposit-taking institutions was collected and analysed using the generalised method of moment. Three econometric models based on three profitability indicators – return on asset, return on equity, and net interest margin – were developed. The corruption perception index (CPI), total asset, capital adequacy, cost to income ratio, liquidity ratio, MPR, and inflation rate were all regressed on these variables, the expected findings show that corruption and the cost-to-income ratio have a detrimental impact on profitability measurements in all three scenarios. Aside from net interest margin, asset and equity returns are boosted by total bank size and inflation rate. Apart from ROE, it has been observed that the capital adequacy ratio is a positive driver of ROA and NIM. The findings also imply that the liquidity ratio is a good predictor of profit estimates. MPR was also observed to have a negative impact on ROA and ROE while having a positive impact on Ghanaian banks' net interest margin.

Badullahewage (2019) looked on the link between corruption and bank transaction costs in Sri Lanka. The qualitative data was collected from 50 Colombo residents using a standardised questionnaire. The data was evaluated using descriptive statistics, chi-square, and the Mann Whitney test. Financial transactions in the banking industry are replete with corruption, according to the findings of the investigations. The findings also reveal that in the creation of huge loan accounts, loan officials engage in substantial wrongdoing and corruption. This leads in high transaction costs in Sri Lanka.

According to the analysis, Park (2012) examined the relationship between corruption and financial stability on the one hand, and economic development on the other, using panel data from 2002 to 2004. Corruption, according to panel regression estimates, increases the number of non-performing loans (NPLs). Corruption also aids improper credit facility allocation to non-viable ventures, according to the research. The findings show that corruption has a negative impact on the rate of growth of the gross domestic product. Inefficient resource allocation, according to the study, is a link between corruption and lower economic growth.

Ojeka et al (2019) investigated the impact of corruption and institutional issues on corporate performance in Nigeria. 135 companies registered on the Nigerian stock exchange provided panel data from 2013 to 2017. Transparency International and the World Wide Governance Indicators provided statistics on corruption (corruption perception index) and institutional variables (regulatory quality, rule of law, political stability, voice and accountability, and corruption control).The generalised method of moments was used to estimate the results. The findings show that corrupt activities have a detrimental impact on return on asset (ROA) and TobinQ (market value indicator). In the same way, institutional variables have a negative impact on ROA and TobinQ. This means that in Nigeria, corruption and a bad institutional environment impede company performance growth.

METHODOLOGY

The study adopted a quasi-experimental design

called ex post facto research design to examine how the independent variable relates with a dependent variable. This design is adopted because the researcher has no control over the variables of the study as a result of the fact that the relevant data have already been in existence.

The study used aggregate data from all banks for a period of twenty-four (24) years, out of the fifty-six (56) years that Nigeria has had banking activities since independence. This is due to the fact that the character of banks has changed over time. Secondly, the sample was chosen for the sake of convenience and represents approximately 34% of the overall period.

More specifically, data spans 1996 to 2020 were collated from annual reports of the Nigerian Deposit Insurance Corporation (NDIC), various publications of Transparency International (TI) and also the Central Bank of Nigeria (CBN) statistical annual bulletin.

The functional model for the study is expressed as follows;

$$ROEODMB_t = f(CPI_t, TDODMB_t, NPLODMB_t) \quad (1)$$

This model is further specified econometrically as follows;

$$ROEODMB_t = \alpha_0 + \alpha_1 CPI_t + \alpha_2 TDODMB_t + \alpha_3 NPLODMB_t + \varepsilon_{1t} \quad (2)$$

Where;

ROEODMB = Return on equity of deposit money banks

CPI= Corruption perception index

NPLODMB =Non-performing Loan of deposit money banks

TDODMB = Total deposit of deposit money banks

t stands for time in years

$\pounds_{it}$is the disturbance term.

RESULTS AND DISCUSSIONS

Econometric Results

Table 4.1: Unit Root Test for Variables at First Difference.

Variables	ADF Test Statistics	5% Critical value	P-values	Remarks
ROEODMB	-6.805108	-3.752946	0.0000	Stationary
NIMODMB	-5.475028	-3.752946	0.0002	Stationary
CPI	-6.238743	-3.752946	0.0000	Stationary
TDODMB	-3.781578	-3.769597	0.0097	Stationary
NPLODMB	-5.056203	-3.752946	0.0005	Stationary

Source: *E-views 10.0 output*

Table 4.1 shows that at first difference, all variables became stationary, as their absolute values of the ADF is greater than the critical values; and their probability values are all individually less than 0.05. Hence, need for co-integration tests.

Table 4.2 Co-integration Test Result

Sample (adjusted): 1998 2020
Included observations: 23 after adjustments
Trend assumption: Linear deterministic trend
Series: Roeodmb Roaodmb Nimodmb Cpi Tdodmb Nplodmb
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.973468	159.3744	95.75366	0.0000
At most 1 *	0.748483	75.89800	69.81889	0.0151
At most 2	0.555269	44.15236	47.85613	0.1068
At most 3	0.487819	25.51580	29.79707	0.1438
At most 4	0.349534	10.12702	15.49471	0.2711
At most 5	0.010187	0.235492	3.841466	0.6275

Trace test indicates 2 cointegratingeqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.973468	83.47637	40.07757	0.0000
At most 1	0.748483	31.74564	33.87687	0.0879
At most 2	0.555269	18.63657	27.58434	0.4431
At most 3	0.487819	15.38878	21.13162	0.2626
At most 4	0.349534	9.891531	14.26460	0.2191
At most 5	0.010187	0.235492	3.841466	0.6275

Max-eigenvalue test indicates 1 cointegratingeqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
Source: E-views 10.0 output

From the results on table 4.2, trace statistic has two co-integrating equations, while eigenvalue statistic has one co-integrating equation. The Null hypothesis of no co-integration among the variables at 5% levels will, therefore, not be accepted; meaning that a long-run relationship exists between the variables.

Table 4.3: ROEODMB Lag Selection.

VAR Lag Order Selection Criteria

Endogenous variables: ROEODMB CPI

Exogenous variables: C NPLODMB TDODMB

Date: 10/30/21 Time: 15:07

Sample: 1996 2020

Included observations: 21

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-146.8492	NA	7224.575	14.55706	14.85550	14.62183
1	-137.0346	14.95549	4214.038	14.00330	14.50069	14.11124
2	-126.3731	14.21532*	2312.478	13.36887	14.06522	13.51999
3	-119.1090	8.301848	1809.022*	13.05800*	13.95330*	13.25230*
4	-116.5223	2.463561	2316.715	13.19260	14.28686	13.43008

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

***Source:** E-views 10.0 output*

Table 4.3 shows a mixed result. The sequential modified LR test statistic shows 2 lags, while the remaining criteria (Final prediction error (FPE), Akaike Information Criterion (AIC), Schwarz information criterion, and Hannan-Quin information criterion) show 3 lags; so, the study adopts 3 lags for this model.

Table 4.4 Error Correction Model for Shareholders' Equity Return

Dependent Variable: D(ROEODMB)
Method: Least Squares
Date: 10/30/21 Time: 15:18
Sample (adjusted): 2001 2020
Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	101.0535	25.40342	3.977948	0.0041
CPI	-3.192196	1.310763	-2.435372	0.0409
D(CPI(-2))	5.434599	1.702569	3.192000	0.0128
D(CPI(-3))	1.861778	1.557227	1.195572	0.2661
NPLODMB	-3.157149	0.595668	-5.300178	0.0007
D(NPLODMB(-1))	2.953290	0.471211	6.267448	0.0002
D(NPLODMB(-2))	0.621417	0.433973	1.431925	0.1901
D(NPLODMB(-3))	1.718109	0.449760	3.820061	0.0051
TDODMB	0.000930	0.001635	0.568140	0.5855
D(TDODMB(-1))	0.018048	0.007109	2.538877	0.0348
D(TDODMB(-2))	-0.008011	0.007338	-1.091718	0.3067
ROEECT(-1)	-0.792160	0.274594	-2.884837	0.0204
R-squared	0.929137	Mean dependent var		-2.835000
Adjusted R-squared	0.831700	S.D. dependent var		34.09502
S.E. of regression	13.98729	Akaike info criterion		8.397884
Sum squared resid	1565.154	Schwarz criterion		8.995324
Log likelihood	-71.97884	Hannan-Quinn criter.		8.514511
F-statistic	9.535757	Durbin-Watson stat		1.708189
Prob (F-statistic)	0.001844			

Source: E-views 10.0 output

Tables 4.4 shows the findings of the error correction for the relationship between corruption perception index (CPI), total deposit of deposit money banks (TDODMB) and non-performing loans of deposit money banks (NPLODMB) on return on equity of deposit money banks (ROEODMB)

The findings reveal an R-squared value of 0.93. This implies that about 93 percent of the systematic variation in the dependent variable is explained by changes in our explanatory variables. This is surely a good fit as only about 7 percent of the systematic variation in our dependent variable is left unaccounted for by the model which can be attributed to the error term. Again, with an adjusted R-squared value of 0.83 showing that about 83% of changes in

return on equity are attributable to the joint impact of corruption (CPI), total deposit of deposit money banks (TDODMB) and non-performing loans of deposit money banks in Nigeria (NPLODMB).

Corruption perception index is negatively related to performance of deposit money bank as proxied by return on equity such that a unit change in corruption perception index will lead to 3.912 unit decrease in the performance of deposit money banks in Nigeria. It can be seen from the table that corruption perception index has a t-statistic value of -2.43 and a statistically significant probability value of 0.04 which signifies that there is a significant impact of corruption on performance of deposit money banks in Nigeria proxied by return on equity at 5% level of significance.

Total deposit of deposit money banks is positively and insignificantly related to the performance of deposit money banks such that a unit changes in total deposit of deposit money banks will lead to 0.0009 unit increase in the performance of deposit money banks in Nigeria. Non-performing loan is negatively and significantly related to return on equity of deposit money banks such that a unit change in non-performing loans will lead to -3.157 unit decrease in return on equity of deposit money banks.

The overall significant result (F-statistic) is 9.535 with a probability value of 0.001 signifying a statistically significant combined impact of corruption and performance of deposit money banks in Nigeria represented by return on equity. Again, this study discards the null hypothesis; and concludes that corruption has a significant relationship on the performance of deposit money banks in Nigeria represented by return on equity. The Durbin-Watson statistic value of 1.708 implies the absence of serial or autocorrelation among the variables. The error correction model value shows that ECM (-1) is well specified and the diagnostic statistics are good. The speed of adjustment of -1.659167 depicts a high level of convergence. This implies that about the disequilibrium or deviation from the variables in the previous period is corrected in the current year at a speed of 21 percent.

DISCUSSIONS OF FINDINGS

This study focuses on corruption and performance of deposit money banks in Nigeria. Corruption perception index (CPI) figures from Transparency International were employed as a proxy for corruption while shareholders' return on equity of DMBs was employed as proxy for performance to assess the interactions between the variables in Nigeria.

The findings indicates that corruption perception index is negatively and significantly related to shareholders' return on equity of deposit money bank such that a unit decrease in corruption perception index will lead to 3.91 unit increase in the performance of deposit money banks in Nigeria. It can be seen from the results that corruption perception index has a t-statistic value of -2.43 and a statistically significant probability value of 0.04 which signifies that there is a significant relationship between corruption represented by CPI and performance of deposit money banks in Nigeria proxied by return on equity at 5% level of significance. This result also supports the "sand the wheel" hypothesis which states that corruption has a devastating effect on bank performance. Our results here are in line with the findings of Udeh and Ugwu (2018); Yakubu (2019); Abud (2017) that found significant negative relationship between corruption and bank performance and disagree with the findings of Yekini et al (2020) that found a positive and significantly existing relationship between corruption and bank performance.

CONCLUSION AND RECOMMENDATIONS

The study investigates the nexus between

shareholders' return on equity in the banking industry and corruption perception in Nigeria. To achieve this, the study employed ex post facto research design and further used historical data spanning 1996 to 2020. The data was analysed and estimated using descriptive statistical tools and error correction technique. The findings indicates that corruption (corruption perception index), total deposit of deposit money banks and non-performing loans of deposit money banks collectively had negative and significant impact on shareholders' equity returns from deposit money banks in Nigeria. Consequently, the study concludes that the perception of corruption has a negative and significant relationship to the return on equity of deposit money bank in Nigeria. This further affirms the "sand the wheel hypothesis" which states that corruption has a devastating effect on growth and performance. On this premise, the study recommends that regulatory authorities and the relevant institutions established to fight corruption including the Central Bank of Nigeria (CBN), Nigeria Deposit and Insurance Corporation (NDIC), Securities and Exchange Commission (SEC), National Insurance Commission (NAICOM), Economic and Financial Crimes Commission (EFCC), Independent Corrupt Practices and Other Related Offences Commission (ICPC) among others, to ensure the enforcement of various legal provisions in the fight against corruption in Nigeria.

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